Chapter 3 Affected Environment

To determine whether a project alternative would have a significant effect on the human environment, an accurate understanding of the proposed project's environment is necessary as it exists *before* project development. This chapter describes, on a resource-by-resource basis, the existing environment that could be affected if the project were to proceed. This description provides a baseline against which project development impacts may be measured.

Much of the baseline information in this chapter has been taken from the Pogo project environmental baseline document (Teck-Pogo Inc., 2000f). Individual resource baseline reports from this document may be found at pogomineeis.com under "Baseline Documents."

3.1 Geology

3.1.1 Regional Geology

The project area is in the Yukon Crystalline Terrain (Weber *et al*., 1978). The predominate rock unit mapped is gneiss, probably Paleozoic in age. Granodiorite to quartz monzanite have been identified on the fringes of the Pogo Mine site. These granitic units are believed to be undifferentiated Tertiary and Cretaceous rocks. Gneiss, biotite gneiss, and quartzite are indicated in the vicinity of major tributaries of the Goodpaster River (West Creek, Central Creek, and Sonora Creek).

3.1.2 Local Geology

Gold mineralization in the Liese Creek area is hosted in a package of highly deformed, Precambrian to Paleozoic, amphibolite-grade paragneiss and lesser orthogneiss of the Yukon-Tanana terrain, a belt of rocks which stretches over 600 miles in Alaska and the Yukon. The gneisses are intruded by unaltered to quartz-sericite and altered Cretaceous granitoid rocks. The Cretaceous intrusive rocks are regionally extensive and previously assumed to be related to intrusions and mineralization in the Fairbanks gold camp (e.g., Fort Knox Mine) and elsewhere in the Yukon. Recent geochronological work is beginning to cast some doubt on this interpretation, suggesting that the rocks may be distinctly older.

The Liese Creek area is predominantly underlain by gneisses. To the north, the gneiss is intruded by the Goodpaster batholith, a large granitoid body of mid-Cretaceous age. Gneisses in Liese Creek are intruded by numerous granitoid dikes, presumably related to the Goodpaster batholith. Gold mineralization in the Liese Zone is in part hosted by large quartz vein/replacement bodies, which may be roughly parallel to and contemporaneous with the granitoid dikes. Zones of low-grade, quartz stockwork-hosted gold mineralization are also present. The youngest geologic unit in the area is a diorite dike in Liese Creek, which appears to be northwest-trending and steeply dipping, and to post-date and partly cut off mineralization on the northeast edge of the deposit.

3.2 Physiography

The Pogo Mine site is located in the Yukon-Tanana Uplands Physiographic Province (Wahrhaftig, 1965) of interior Alaska. The Goodpaster River flows south past the site and meanders within a confined alluvial valley with tributaries that drain the surrounding uplands. The tributaries have steep upper gradients and gentle lower gradients as they descend from an elevation of approximately 2,500 feet to the valley bottom. The area is regionally nonglaciated, leaving V-shaped valleys with steep side slopes, particularly in their upper reaches. On the uplands, coarse gravelly soils derived from the bedrock are common. Organic soils occur in tussock meadows associated with drainages.

Shaw Creek Valley is noticeably wider than the Goodpaster Valley, with its mouth at the Richardson Highway being approximately 8 miles wide. Shaw Creek Flats is a continuously frozen terrace of the Tanana River (Kreig and Reger, 1982). The surface is underlain by organic silts, silty sand, and gravelly alluvium. The northwest side of the Shaw Creek Valley is composed predominately of vegetated sand dunes.

3.3 Permafrost and Soils

Permafrost, or perennially frozen ground, is encountered throughout the project area, especially at lower elevations. Major engineering problems can arise where warming and melting of the permafrost occurs in fine-grained soils. Fine-grained permafrost soils may contain large amounts of interstitial or segregated ice. As the permafrost melts, the resulting volume reduction of the soil mass can cause subsidence (thaw settlement). Additionally, the excess moisture content in thawing fine-grained soils may cause instability on slopes and the downslope movement of the thawing soil mass.

Permafrost soils are classified on the basis of their tendency to undergo volumetric changes upon thawing. Thaw-stable permafrost soils are those that do not undergo significant volumetric changes and, as a result, do produce only minor engineering impacts upon thawing. Thaw-stable soils are typically sands and gravels containing minor amounts of fine soils such as silts.

Thaw-unstable permafrost soils do undergo significant volumetric changes and can create major engineering problems upon thawing. Fine-grained soils such as ice-rich silts and clays and silty sands are examples of thaw-unstable soils.

The Pogo Mine site is within the discontinuous permafrost region of central Alaska, and the occurrence of permafrost is widespread, especially at lower elevations. Thermistor cables installed at prospective tailings sites 1 and 4B indicate that permafrost temperatures are in the range of 29°F to 31°F. The relatively warm permafrost temperatures in central Alaska make the permafrost thermal regime thermally sensitive, and degradation can occur if the surface is cleared or disturbed. The presence or absence of permafrost in the Pogo area is highly dependent on topographically controlled microclimate, drainage, slope aspect, snow accumulation patterns, surface vegetation, and soils. Permafrost represents a significant engineering problem in the design of diversion ditches and the design of dams and impoundment reservoirs, especially those with a high hydraulic head. Permafrost in the Pogo area may be either thaw-stable or thaw-unstable, depending on the ice content of site-specific soil conditions.

3.4 Geotechnical and Seismic Considerations

Geomorphic processes, including erosion, mass wasting, and deposition, have resulted in a range of unconsolidated surficial soils overlying bedrock. The surficial soils in the Pogo area can be described as two predominate units: alluvium and colluvium. Alluvium is stratified riverbed deposits of sand, gravel, and cobbles that may have an overlying layer of fine-grained floodplain overbank deposits. In some valleys, in-filled channels and cutoff meanders contain organic silt and peat, commonly in a permafrost condition.

The colluvium is commonly a heterogeneous mixture of silt, sand, and gravel and cobble-sized angular rock fragments formed by the weathering products of the local bedrock that have been transported downslope by gravity. Fine-grained colluvium can occur on lower slopes as veneer or valley fillings along the base of slopes where eolian silt originally deposited on hilltops and hillsides has been re-transported downslope. These fine-grained colluvial deposits are commonly found at lower elevations in a permafrost condition and may contain considerable interstitial and segregated ice.

Three active faults that could affect the design of Pogo facilities are present in central Alaska. Specifically these are the Donnelly Dome, Denali, and McGinnis Glacier faults located to the south of the project area in the Alaska Range. These three faults are well identified and have surface expressions and evidence of significant movement in the last 10,000 years. Additionally, the Salcha Seismic zone located west of the project (oriented parallel to the Salcha River Valley) is considered to be active, although no surface expression of a fault has been discovered.

The estimated peak ground acceleration for the Pogo Mine site with a 2 percent probability of exceedance in 50 years is 0.21g (21 percent of gravity) (USGS, 2001).

3.5 Surface Water Hydrology

The Pogo project is located within the Goodpaster River basin, a tributary of the Tanana River, a tributary of the Yukon River (Figure 1.3-1). There are ten main surface water drainages within the Pogo claim block in the mine vicinity, excluding the Goodpaster River: North Creek, Liese Creek, Pogo Creek, Easy Creek, Star Creek, West Creek, Central Creek, Sonora Creek, Wolverine Creek, and Contact Creek (Figure 1.3-3). All are directly tributary to the Goodpaster River, except Sonora Creek, which is tributary to Central Creek. Principal surface water features associated with the mine area access corridors include Shaw Creek and its major tributaries, referred to as Gilles Creek and Caribou Creek (Figure 2.4-3). The access corridors also have a number of smaller crossings, including Rosa and Keystone in the Shaw Creek drainage and Wolverine Creek in the Goodpaster River drainage.

Surface water in the vicinity of the project is essentially undeveloped and pristine. Man-made structures modifying the flow regime or flow characteristics are nonexistent. Currently, local use for municipal water supply, irrigation, or industrial application is also nonexistent. Some incidental use of the Goodpaster River water as water supply to cabins located in the lower reaches is documented. All proposed project facilities, except the power line and access road corridors, would be located within the Liese Creek drainage basin and Pogo Creek drainage, and adjacent to the Goodpaster River itself. The access corridors are within the Shaw Creek drainage or on the ridge between Shaw Creek and the Goodpaster River. The following discussions focus principally on Shaw Creek, Goodpaster River, and Liese Creek because these are most subject to potential impacts.

3.5.1 Drainage Basin Physiography and Topography

Generally, the streams within the project area are typical for the east-central region of interior Alaska. The area in and around the proposed project area is composed of mountainous, nonglaciated terrain dissected by numerous deep, steeply sloping ravines/valleys and flattened/plateau uplands between drainages. These valleys contain ephemeral and intermittent stream channels that are typically high gradient streams near their source, often flattening to diffuse flows within willow/muskeg before their confluence with larger waterways. The regional terrain varies in elevation from 1,200 ft to 5,000 ft above mean sea level (AMSL) for a total relief of approximately 3,800 ft (Beckstead, 2000). The region in and around the project area has permafrost zones; however, permafrost is typically not located beneath or immediately adjacent to streams and rivers. Table 3.5-1 presents a summary of the project area streams and the physiographic characteristics of drainage areas. Drainage basin physiography and topography Drainage basin physiography and topography.

Table 3.5-1 Pogo Mine Project Area Drainage Physiography

	Stream Name	Drainage Area (sq mi)	Channel Length (mile)	Basin Relief (ft)	Flow Regime
Mine Area					
	Goodpaster River	1,502	131	2,700	Perennial
	North Creek	1.5	2.1	2,100	Intermittent
	Liese Creek	2.2	2.2	1,600	Intermittent
	Pogo Creek	1.1	0.8	1,800	Intermittent
	Easy Creek	1.4	0.5	2,100	Intermittent
	Star Creek	1.8	1.9	2,200	Intermittent
	West Creek	6.5	4.9	2,200	Perennial
	Central Creek	116	23	3,200	Perennial
	Sonora Creek	11.0	6.0	2,200	Perennial
	Wolverine Creek	1.7	6.2	1,900	Perennial
	Contact Creek	6.0	4.0	2,600	Perennial
Access Corridor					
	Shaw Creek	392	40.8	3,200	Perennial
	Rosa Creek	15.5	8.0	1,900	Perennial
	Keystone Creek	11.8	9.1	1,200	Perennial
	Caribou Creek	24.8	8.0	1,800	Perennial
	Gilles Creek	42.0	15.2	2,300	Perennial

The dominant stream, the Goodpaster River, is a meandering fluvial system in some reaches. As it approaches the confluence with the Tanana River, it becomes multi-channeled and highly meandering, with a slow-flowing and generally shallow main channel. Both the Goodpaster River and Shaw Creek lie in relatively broad valleys with floodplain terraces. More detailed descriptions of Liese Creek, Shaw Creek, and the Goodpaster River are provided below.

Liese Creek

Liese Creek is a small intermittent stream that drains the north side of the ridge containing the primary mineralized zone that would be mined. It flows above a portion of the ore body to be mined. The Liese Creek basin encompasses approximately 1,502 acres (Teck-Pogo Inc., 2002b) and ranges in elevation from 1,400 ft to 3,600 ft, for a total basin relief of approximately 2,200 ft. The channel length within this basin is approximately 2.2 miles. The basin is essentially rectangular in shape. The channel of Liese Creek lies on valley fill alluvium/colluvium consisting of gravel, cobble, and boulders in a matrix of fine to very fine sands. A high gradient, cascades, and few meanders characterize the Liese Creek channel morphology, with boulders and cobbles substrate in the upper reaches. The active channel width varies from 3 ft to 10 ft with a depth of approximately 2 ft (Teck-Pogo Inc., 2002b). In the lower reaches, the stream enters an alluvial fan area and the gradient flattens, pools form, and the channel becomes diffuse to nonexistent as it enters a large wetland near the Goodpaster River (Morsell, 2000). In this area, the alluvial fan of Liese Creek is nearly indistinct from the alluvial floodplain of the Goodpaster River.

Goodpaster River

The Goodpaster River is a major tributary of the Tanana River. The river is nonglacial in origin and possesses the channel morphology, sedimentology, and flow regime of a nonglacial river. The flow regime of the Goodpaster River is perennial. This river has a total drainage area of approximately 1,502 square miles (sq mi) (961,318 acres), of which approximately 677 sq mi (433,280 acres) are above the proposed mine site. The drainage basin ranges in elevation from 1,000 ft to 6,500 ft with a total basin relief of approximately 5,500 ft. The river channel lies on deep valley fill of alluvium consisting of sand, gravel, and cobbles. The lower reaches of this river are relatively shallow and slow due to the low gradient. The mid-reaches, near the proposed mine site, and the upper reaches are moderate in gradient, resulting in alternating mild rapids/riffles and pools. The river channel is contained within a broader valley that appears to function as a floodplain. The Goodpaster River, however, has a well-established channel with vegetated banks and a relatively stable, cobble- and gravel-armored channel bottom in its mid-reaches near the proposed mine site.

Shaw Creek

Shaw Creek is a medium-size perennial stream and a direct tributary of the Tanana River. Its confluence is approximately 7 miles downstream of the confluence of the Delta and Tanana rivers. The headwaters of Shaw Creek are located approximately 5 miles west of the Pogo claim block and are separated from the Goodpaster River drainage by a substantial ridge of mountains. Shaw Creek flows from northeast to southwest down a relatively straight, elongate valley bounded by mountains on both sides. Shaw Creek has multiple major tributaries contributing flow from the north and south sides of the valley. The proposed access corridor for the Shaw Creek hillside parallels Shaw Creek along the north side of the stream and crosses multiple named and un-named tributaries. Shaw Creek has a total drainage area of approximately 392 sq mi (250,880 acres), of which 53 sq mi, (33,920 acres) are upstream of the crossing of the proposed access corridor for the Shaw Creek hillside. The drainage basin ranges in elevation from 950 ft to 4,126 ft, for a total relief of approximately 3,200 ft.

The Shaw Creek channel is generally on alluvial/colluvial fill material, is relatively straight in the upper moderate gradient reaches, and becomes highly meandering in the mid-reaches and lower reaches. Some braiding occurs within a broad brushy plain in the lower reaches near the confluence with the Tanana River (Figure 2.4-3).

3.5.2 Stream Flow

Stream flow characteristics depend on the specific features unique to each drainage basin, such as size, shape, geology, topography, vegetative cover, and climate. Flows in the rivers and streams of central Alaska are driven by snowmelt, rainstorm runoff, and groundwater discharge. The high flow periods are a result of meteorological events such as thunderstorms and spring breakup/snowmelt. A discussion of the meteorology as it pertains to surface hydrology is presented below in Section 3.5.4 (Site Meteorology). Base flows in the area streams are the result of groundwater discharge. The flow regime of streams and rivers in the project area vary and range from ephemeral, for small unnamed drainages, to perennial for mid-sized creeks, to rivers such as the Goodpaster River. The major perennial streams experience their highest flows during May through September, and flows typically peak in late May. Precipitation records show that the peak period of precipitation occurs at almost the same time, with June, July, and August the months of peak precipitation. The timing of peak precipitation suggests that peak discharges for area streams are driven by snowmelt, and are supplemented or sustained through the summer by rainfall until fall freeze-up. The lowest flows occur during the winter months, caused by the extremely cold climate without mid-winter thaws that might generate snowmelt runoff. Winter base flow is supplied by groundwater discharge.

Continuous data for stream flow monitoring is not available for most of the streams within the project area, but instantaneous discharge measurements have been made on a number of streams and gauging/sampling locations throughout the project area. Locations of hydrologic monitoring stations are shown in Figure 3.5-1. Stream flow data have been compiled by Beckstead (2000). Discussion of stream flow quantity here is expressed in cubic feet per second (cfs). One cfs is equivalent to 448.8 gpm.

Flow records indicate that smaller creeks in the project area behave hydrologically differently than larger creeks, as would be expected. The computed annual volume of watershed runoff for smaller creeks (Sonora and Central) is 3.5 inches to 3.8 inches per year. The Goodpaster River, as a large watershed, produces approximately 6.2 inches per year (Beckstead, 2000) to 8.1 inches per year (Beckstead, 2002a). The difference between small and large watershed yields may be due to a number of factors including differences in groundwater recharge/discharge and differences in watershed elevation, slope-aspect composition (Beckstead, 2000), and the presence or absence of shallow aquifer recharge, storage, and release. The following discussion provides more detail for the three principal drainages that may be affected by this project.

Liese Creek Flows

Mean annual flow data from U.S. Geological Survey (USGS) gauging station records on Liese Creek (USGS Sta. No. 15477730) have been compiled (Beckstead, 2000). The continuous flow gauging station on Liese Creek encompasses 690 acres (1.08 sq mi) of the upper portion of the watershed. The total Liese Creek watershed has a drainage area of 2.2 sq mi. Because Liese Creek is an intermittent stream that has no flow during substantial portions of the year, there is limited continuous data for this creek. The no-flow period for Liese Creek appears to be November through April, although dry periods also have been observed in the summer months.

For the period of record that does exist (portions of 1999, 2000, and 2001 during periods of discharge), the typical flow was between 0.5 to 2.0 cfs. Peak flows as high as 6.1 cfs have been recorded.

Liese Creek presents a complex flow environment involving the alluvial/colluvial fill and subsurface flows. Observations suggest that the stream has losing and gaining reaches as the flow submerges into the valley fill and resurfaces down gradient.

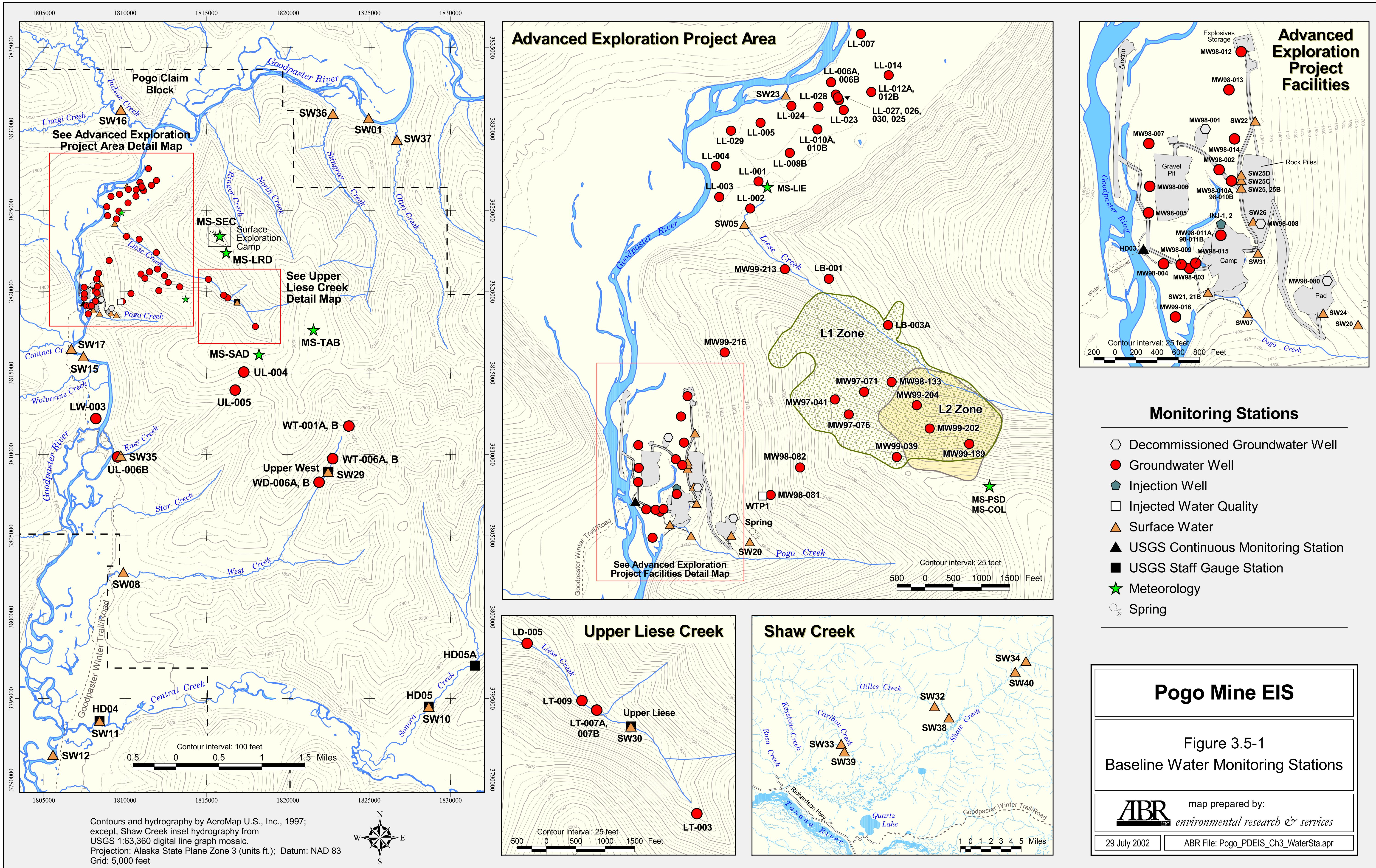


Figure 3.5-1
Baseline Water Monitoring Stations

Goodpaster River Flows

The Goodpaster River has been equipped with stations that monitor continuous flow since 1997 (Hoefler Consulting Group, 2001) (Figure 3.5-1). In 1998, the USGS assumed responsibility for the station near the project site. The Goodpaster is a perennial stream with continuous flow all year. Review of the monitoring data shows that the mean monthly base flows are approximately 50 cfs to 60 cfs during the winter months of November through April, while mean monthly discharges reach as high as 950 cfs, but are typically within the range of 400 cfs to 600 cfs, between May and September (Beckstead, 2000). Figure 3.5-2 presents the hydrograph of mean daily flow for the period of record from August 1997 to October 2001.

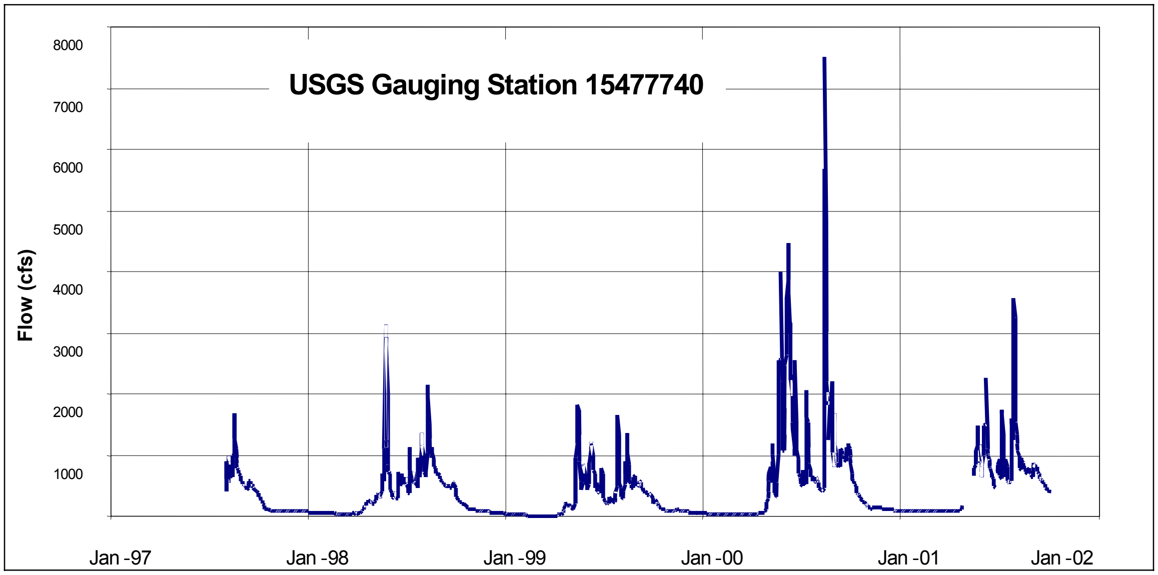
This hydrograph shows the wide variation in flow on a seasonal basis where the mean monthly discharge varies by a factor of 10 from approximately 60 cfs to more than 600 cfs. For the 5-year period of record, the minimum recorded mean daily flow was 10 cfs and the maximum recorded mean daily flow was 7,500 cfs. Discharge monitoring of other smaller watersheds (Central Creek and Sonora Creek) show similar maximum-to-minimum ratios of mean monthly flows, suggesting similar hydrologic responses, although on somewhat smaller scales. This historic data provides useful information for evaluating ungauged watersheds in the area. Figure 3.5-3 presents a plot of the frequency distribution of mean daily flow data for the period of record for the Goodpaster River. This flow characterization suggests that the flow regime is dominated by flows in the range of 50 cfs to 100 cfs. A secondary spike of flow frequency is shown at approximately 650 cfs to 700 cfs, representing the seasonal high flow.

An important aspect of understanding the flow regime of a stream and the susceptibility to environmental impacts is the extreme-low-flow condition. Because of the limited period of record, a statistically derived extreme-low-flow condition from measured flow data for the Goodpaster River is not possible. The estimated 7-day low flow at a recurrence interval of once in 10 years (7Q10) is estimated to be 18 cfs near the mine facilities (Teck-Pogo Inc., 2002d). This low flow was estimated based on a statistical comparison with the Salcha River, for which a long period (53 years) of record is available (Beckstead, 2002b). The period of record (5 years) for the Goodpaster shows 67 days during which the flow has been at 18 cfs or less. This high frequency of low flow reflects the extreme drought conditions experienced during 1999. The minimum monitored flow of 10 cfs is estimated at a recurrence interval of once in 100 years for drought flow condition.

Shaw Creek Flows

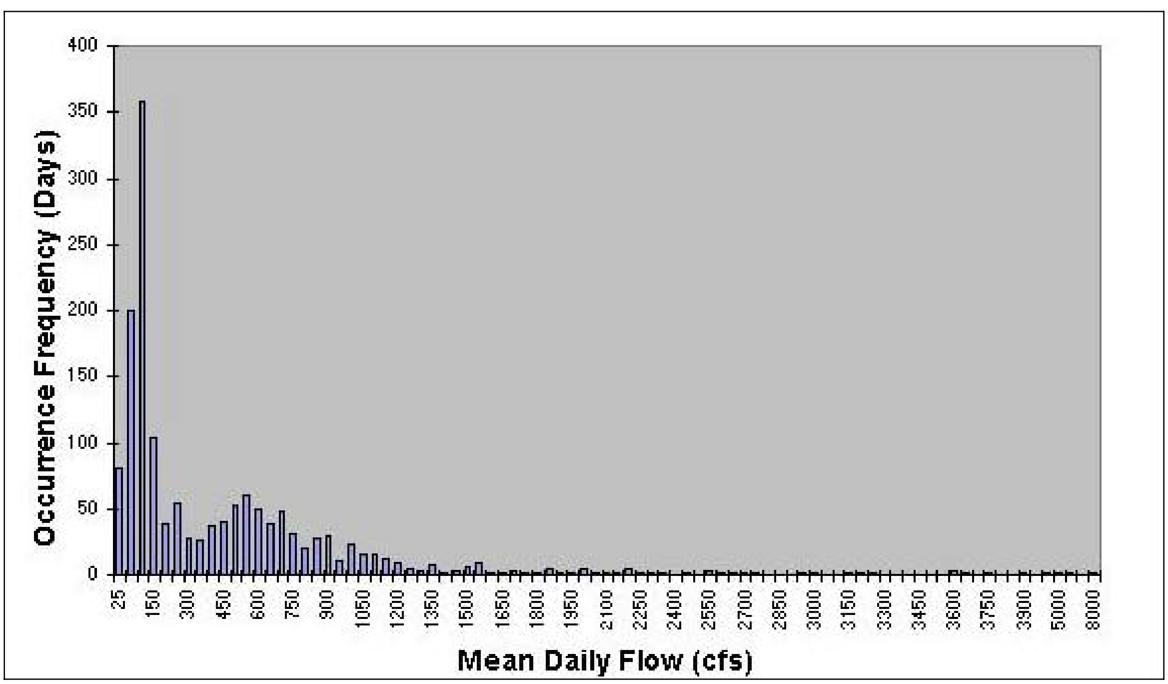
The flow regime of Shaw Creek is considered to be perennial. This stream currently has no USGS station providing monitoring of continuous stream flow; therefore, little flow data exists to characterize the discharge hydrology. Discharge measurements were made during water quality and stream survey work conducted as part of the environmental baseline studies for the Pogo Mine. The Shaw Creek watershed differs little from surrounding watersheds, suggesting that the hydrologic response of this watershed is probably quite similar to other gauged watersheds nearby. As described for Liese Creek and the Goodpaster River, the base flows are likely a result of groundwater discharge, while higher flows are responses to rainfall and snowmelt.

Figure 3.5-2 Goodpaster River Mean Daily Flow Hydrograph



Source: Teck-Pogo Inc. (2002d)

Figure 3.5-3 Goodpaster River Mean Daily Flow Frequency Distribution 1997-2001



Source: EDE (2002)

3.5.3 Flood Estimates

Determination of flood flows with the use of stream flow data requires a substantial period of monitoring record to provide a statistically defensible estimate. Stream flow monitoring on the watersheds within or adjacent to the project area and the access corridors covers a relatively brief period of time and is insufficient to provide flood flow estimates based on stream flow measurements. Flood flows can be estimated by other techniques, including comparison to similar watersheds with a substantial gauging period, or can be based on rainfall-runoff relationships and good rainfall frequency distribution data. The estimates for flood flow frequency presented here (Table 3.5-2) were determined with the regression analysis of similar regional watersheds as presented by Jones and Fahl (1994).

Table 3.5-2 Flood Frequency Estimates

Drainage Name	Flow Estimates (cfs)[1]					
	Q2	Q5	Q10	Q50	Q100	Q200
Rosa Creek[2]	200			795	934	
Rosa Creek[3]	180			710	834	
Keystone	160			630	742	
Caribou Creek	300			1,110	1,285	
Gilles Creek	430			1,570	1,820	
Shaw Creek[4]	510			1,830	2,115	
Wolverine Creek	30			130		
Goodpaster River[5]	5,800	8,770	10,600	14,500	16,000	17,500
Liese Creek[6]	15	46	51	93	112	158
Liese Creek[7]	24	71	99	137	165	231

[1] Teck-Pogo Inc. (2002b). Method of Jones and Fahl (1994), flow values for return intervals (occurrence frequency) of 2, 5, 10, 50, 100, and 200 years.
[2] Lower gauging station
[3] Upper gauging station
[4] At Shaw Creek Hillside Route corridor crossing
[5] At exploration airstrip
[6] At dam for recycling tailings pond
[7] At mouth

3.5.4 Site Meteorology

The climate of the area is classified as continental, which is characterized by large diurnal and annual temperature variations, low precipitation, low cloudiness, and low humidity. Surface winds are generally light, but can be affected by local topography (Selkregg, 1976).

The mine site is typical of other areas of central interior Alaska. Extreme cold conditions in the winter (-40ºF to +32ºF) and moderate temperatures in the summer (+41ºF to +86ºF) are characteristic (National Oceanic and Atmospheric Administration [NOAA], 2002) The meteorology of this site is particularly important to the surface water hydrology because the streams are nonglacial and stream flow is driven by melting of winter snow pack and summer rain showers and thunderstorms.

The closest meteorological station collecting long-term meteorological data is at Big Delta, approximately 36 miles southwest of the proposed mine site. At Big Delta, mean annual precipitation is 11.5 inches and mean annual snowfall is 41.3 inches (Leslie, 1989). Because meteorological data was not available for the mine site, six meteorological monitoring stations were operated through various times and at various locations at the site since 1996. Much of this period was characterized by relatively dry to extreme drought conditions, as reflected in the hydrologic analysis of gauged watersheds in this region.

Evaporation data was collected for the site during the summer months of 1998 and 1999. The evaporation pan was located at the MS-SEC site (Beckstead, 2000).

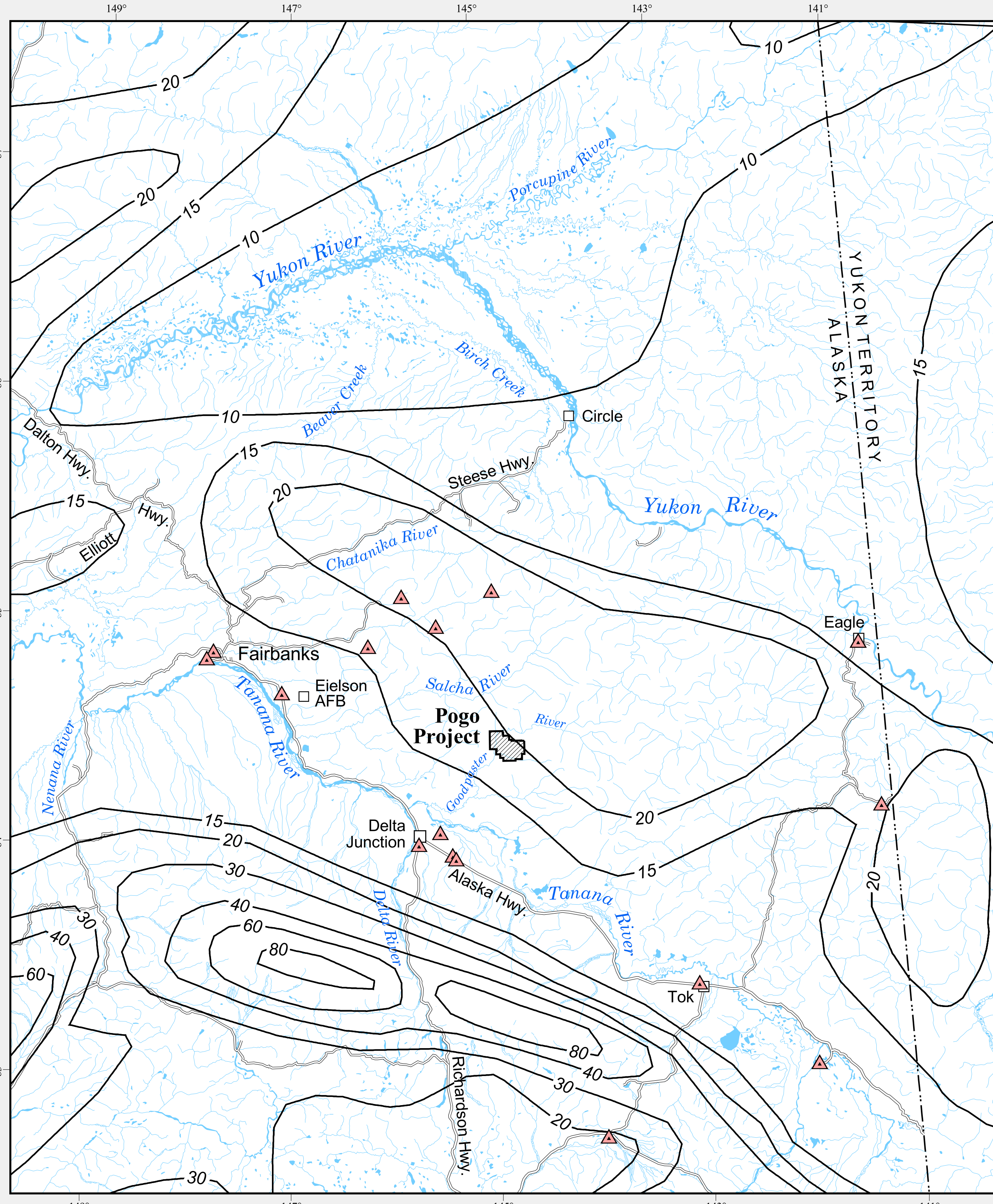
Extensive analysis of long-term records of snow pack, rainfall, and watershed yield was conducted during the baseline hydrologic studies and subsequent supplemental analysis. The result of this work estimated the average annual precipitation for the mine site to be 19 inches per year. This value was based on the USGS estimation of mean annual precipitation for west central Alaska (Jones and Fahl, 1994). The general regional precipitation map from the USGS is presented as Figure 3.5-4. Seasonal distribution of precipitation was determined from meteorological data collected on site, as well as the 61-year period of record at Big Delta (1937-1998). These data show the peak precipitation months are May through September. The least precipitation occurs during the winter and comes in the form of snow. The wettest month of the year appears to vary by year for site data, but is shown to be July for Big Delta precipitation data (Beckstead, 2000).

The distribution of precipitation with respect to topography and elevation (orographic effect) shows the period of record for meteorological stations at the site is short. As a result of the limited data set, determination of whether an orographic effect exists is difficult (Beckstead, 2000). More factors than a simple elevation-precipitation relationship play into true orographic effects for site-specific precipitation determination. Drawing from more extensive data in areas of similar climate and topography of central Alaska and the Yukon region (304 climatological stations, 102 snow survey sites, and 223 stream flow stations), it has been estimated there is roughly an 11 percent increase in precipitation for a 305-ft (100-meter) increase in elevation (Pullman, 2000). The proportion of this orographic effect shifts from rainfall to snow with increasing elevation, as would be expected (Clearwater Consultants, 1996).

As stated in the stream flow discussion, there is a reasonable and clear relationship between seasonal distribution of precipitation and stream flows. Simply put, the surface water hydrologic regime of the project area is strongly dependent on the quantity and time distribution of precipitation.

3.5.5 Vessel Navigation

There are approximately 70 cabins between the mouth of the Goodpaster River and river mile 36; five cabins between mile 36 and 56; three cabins above mile 56, one of which is above the proposed bridge location at the mine site at mile 68. During high use periods, it is not uncommon for between 25 and 40 recreational riverboats to use portions of the lower 33 miles of the river (below the South Fork) during a given weekend. On holiday weekends, as many as 60 to 75 recreational riverboats may use the lower Goodpaster River. The largest vessels operating on the Goodpaster River below South Fork are typically 24- to 26-foot inboard riverboats (Parker, 2003; Nay, 2003).



Legend

Mean Annual Precipitation (in)

NWS and NRCS Meteorological Stations

25 0 25 50 75 Kilometers

10 0 10 20 30 40 Miles

Precipitation contours (in) after USGS 1993; 1:2,000,000 scale
Map base: US DMA DCW
Projection: UTM Zone 6
Datum: NAD 27

Pogo Mine EIS

Figure 3.5-4
Mean Annual Precipitation (in)

ABR inc. environmental research & services

19 August 2002 | ABR File: Pogo_PDEIS_Ch3_Precip.apr

The proposed Goodpaster River bridge location is approximately 1,150 feet downstream, and 150 feet upstream, of bends in the river (Figure 2.3-1a). At this location, the river has a pool and riffle channel configuration, with pools of a few feet depth and riffles 1 to 2 feet in depth. The shallow normal depths of the river encountered at the proposed bridge location (2 to 4 feet between piers 1 and 4, zero between piers 4 and 6, 1 to 2 feet between piers 6 and 7) are a limiting factor on the size of watercraft that can navigate the river. The river at this location is navigable by recreational riverboats up to 20 feet in length (primarily jet boats) during high water, with observed traffic over the last five years of 3 to 5 craft per year. Approximately 6 inflatable rafts and 2 or 3 canoes per year have been observed during the same time period on float trips originating from airstrips in the upper Goodpaster Valley (Hanneman, 2003c).

Man-made structures modifying the flow regime or flow characteristics are nonexistent. There is no commercial navigation on the Goodpaster River at present, and no foreseeable commercial uses. There are no local service facilities. There are no vessels engaged in national defense activities or channel maintenance on the river. The COE has not completed a federal navigation project on the waterway and no guide clearances have been established for the waterway. Clearance gauges, however, are not necessary for the existing river traffic (Hanneman, 2003c).

3.6 Groundwater Hydrology

3.6.1 Hydrogeologic Setting and Sources of Data

Groundwater resources in the mine area occur in two main hydrogeologic environments. Ground water occurs under unconfined conditions in sand and gravel alluvial aquifers in association with streams and the Goodpaster River. Ground water also occurs in a fractured bedrock aquifer. Ground water in all aquifers tends to flow toward the Goodpaster River.

Groundwater data are available from an extensive collection program that included a monitoring well network (Figure 3.5-1), underground adit development, and underground test hole drilling. Hydraulic tests were performed at a production well in the Goodpaster Valley and at other wells and boreholes using packer techniques. Data also were obtained from isotope and geochemical studies, water level monitoring, water discharge measurements from the adit, and groundwater flow modeling. Unless otherwise cited, hydrogeologic information summarized below is derived from Brown (2002).

3.6.2 Geologic Units

This section describes geologic units present at the mine site. The geologic history of the area is described in more detail above in Section 3.1 (Geology).

Soil and Colluvial Deposits

Surficial soil and colluvial deposits are present through the upland areas and on steep slopes. Soils and colluvium are derived from local bedrock sources through mass wastage processes. There are no known glacial deposits in the area. The thickness of soil and colluvium ranges from 0 ft to an estimated 100 ft, depending on location. Discontinuous permafrost occurs in these deposits in some areas, especially on north-facing slopes.

Alluvial Deposits

Alluvial deposits occur in the Goodpaster River Valley and in the bottoms of contributory stream valleys such as Liese Creek and Pogo Creek. Alluvial deposits in general consist of silts and sands, with lenses of gravel, cobbles, and boulders. The alluvium in the Goodpaster Valley is at least 100 ft thick and contains permafrost along the valley margins. Alluvium in the Liese Creek drainage is present up to a maximum thickness of approximately 50 ft.

Bedrock

Bedrock in the area consists mainly of metamorphic gneiss with intrusive rocks that includes granite dikes and a diorite intrusive body. The gold-bearing ore is contained in two approximately parallel, tabular, gently dipping quartz sills or veins, each averaging approximately 15 ft in thickness and separated vertically by approximately 400 ft. The upper vein is known as the L1 quartz vein and contains the L1 ore body. The lower vein is known as the L2 quartz vein and contains the L2 ore body.

Rocks in the area are complexly folded and faulted. The locations of major identified faults are shown in Figure 3.6-1. Permafrost occurs in bedrock as deep as 300 ft in some locations, and is generally more prevalent and deeper on north- and west-facing slopes.

3.6.3 Groundwater Occurrence

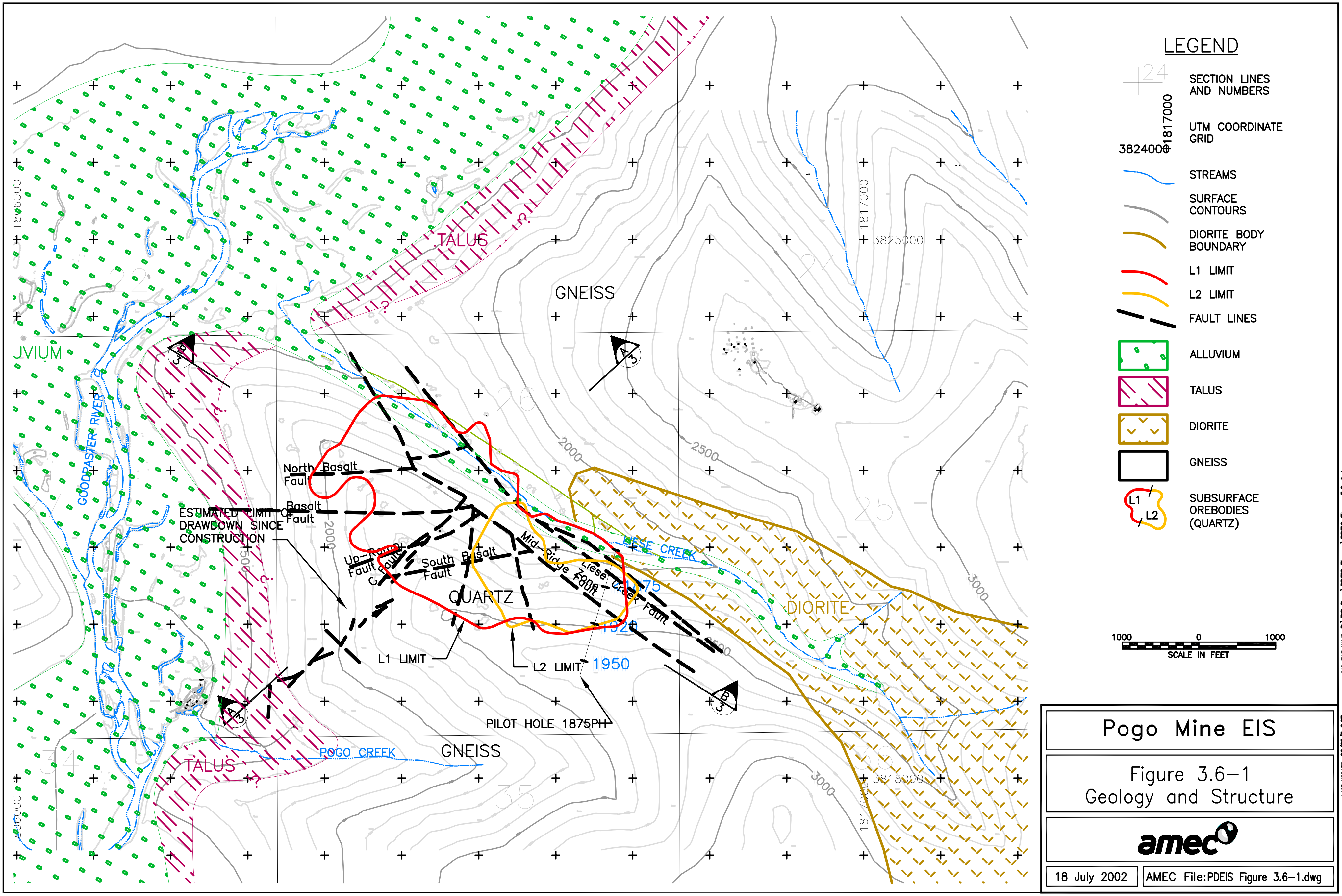
Ground water occurs under saturated conditions at depths ranging from the land surface near the Goodpaster River to 300 ft below ground surface beneath the ridge between Liese Creek and Pogo Creek. Ground water is recharged from snowmelt and rainfall in upland areas and from infiltration beneath creek beds in valleys. Ground water discharges to the Goodpaster River, except during peak flows.

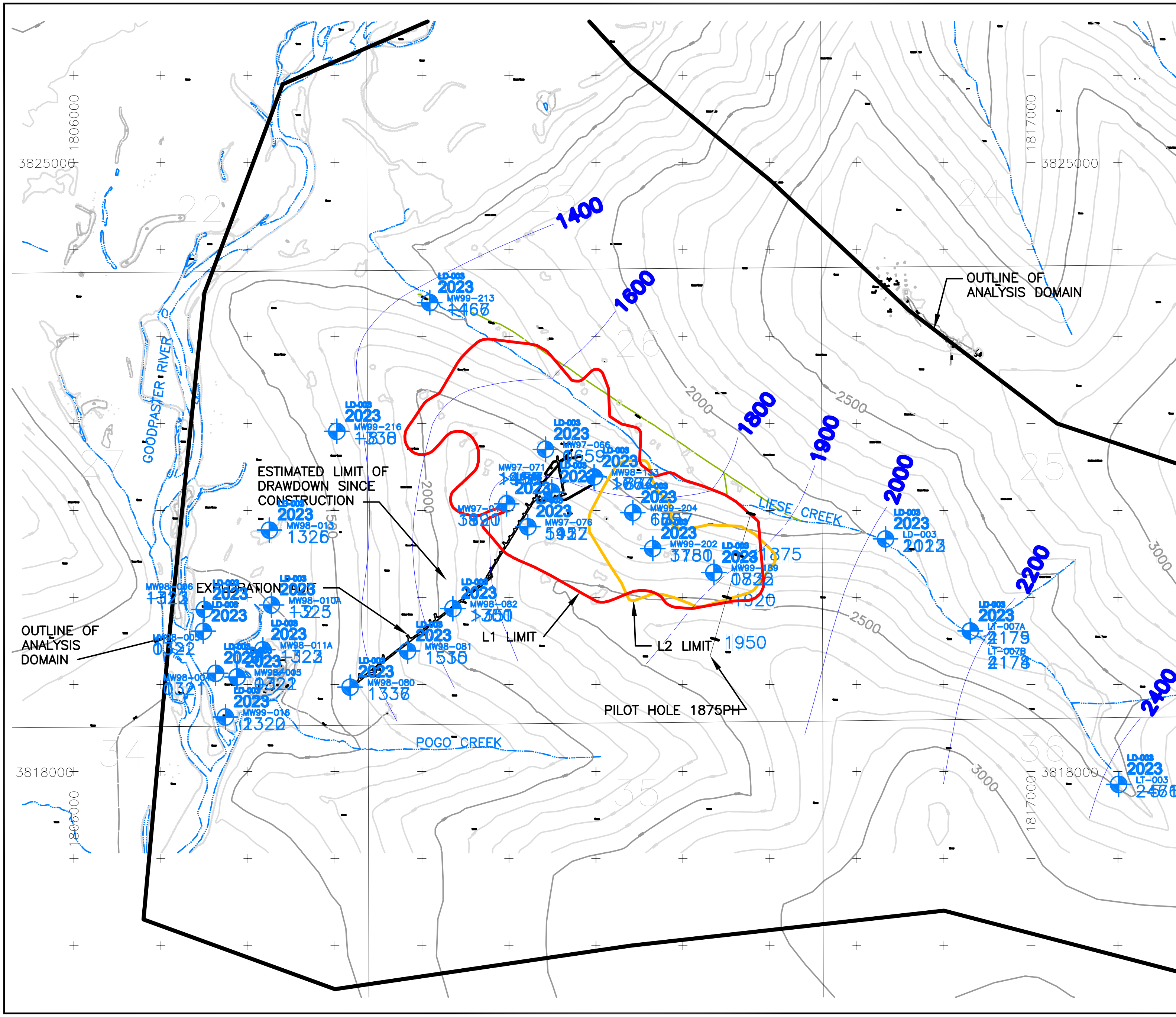
Figure 3.6-2 shows a plan view representation of the potentiometric surface of the bedrock aquifer that was present prior to development of the exploration adit. The development of the adit resulted in a decline of groundwater levels in the vicinity of the adit and redirection of groundwater flows toward the adit, rather than toward the Goodpaster River.

The vertical relationships of the ore body, water levels, the adit, and other features are shown in two profiles through the area (Figure 3.6-3). The location of the lines of the profiles are shown in. The cross sections show that water level data collected from numerous boreholes that penetrated the ore body shows consistent results on the position of the potentiometric surface in the area.

Liese Creek Alluvial Aquifer

Ground water occurs in alluvium associated with Liese Creek. Water levels in wells near the creek are approximately 20 ft below creek level, indicating that the creek loses water to the alluvial deposits for most of its length. Some sections of the creek periodically go dry. An estimated average discharge of approximately 50 gpm flows through the Liese Creek alluvium down valley toward the Goodpaster River (Brown, 2002).


LEGEND
SECTION LINES AND NUMBERS
UTM COORDINATE GRID
STREAMS
SURFACE CONTOURS
DIORITE BODY BOUNDARY
L1 LIMIT
L2 LIMIT
FAULT LINES
ALLUVIUM
TALUS
DIORITE
GNEISS
SUBSURFACE OREBODIES (QUARTZ)
SCALE IN FEET
1000 0 1000
TALUS
GNEISS
DIORITE
QUARTZ
GOODPASTER RIVER
LIESE CREEK
POGO CREEK
North Basalt Fault
Basalt Fault
South Basalt Fault
Up-Ramp Fault
Mid-Ridge Zone Fault
Liese Creek Fault
ESTIMATED LIMIT OF DRAWDOWN SINCE CONSTRUCTION
L1 LIMIT
L2 LIMIT
PILOT HOLE 1875PH
1950
3825000
3818000
1817000
2000
2500
3000
Pogo Mine EIS
Figure 3.6–1
Geology and Structure
18 July 2002
AMEC File:PDEIS Figure 3.6–1.dwg



Pogo Mine EIS

Figure 3.6–2
Pre–Development
Groundwater Levels

amec

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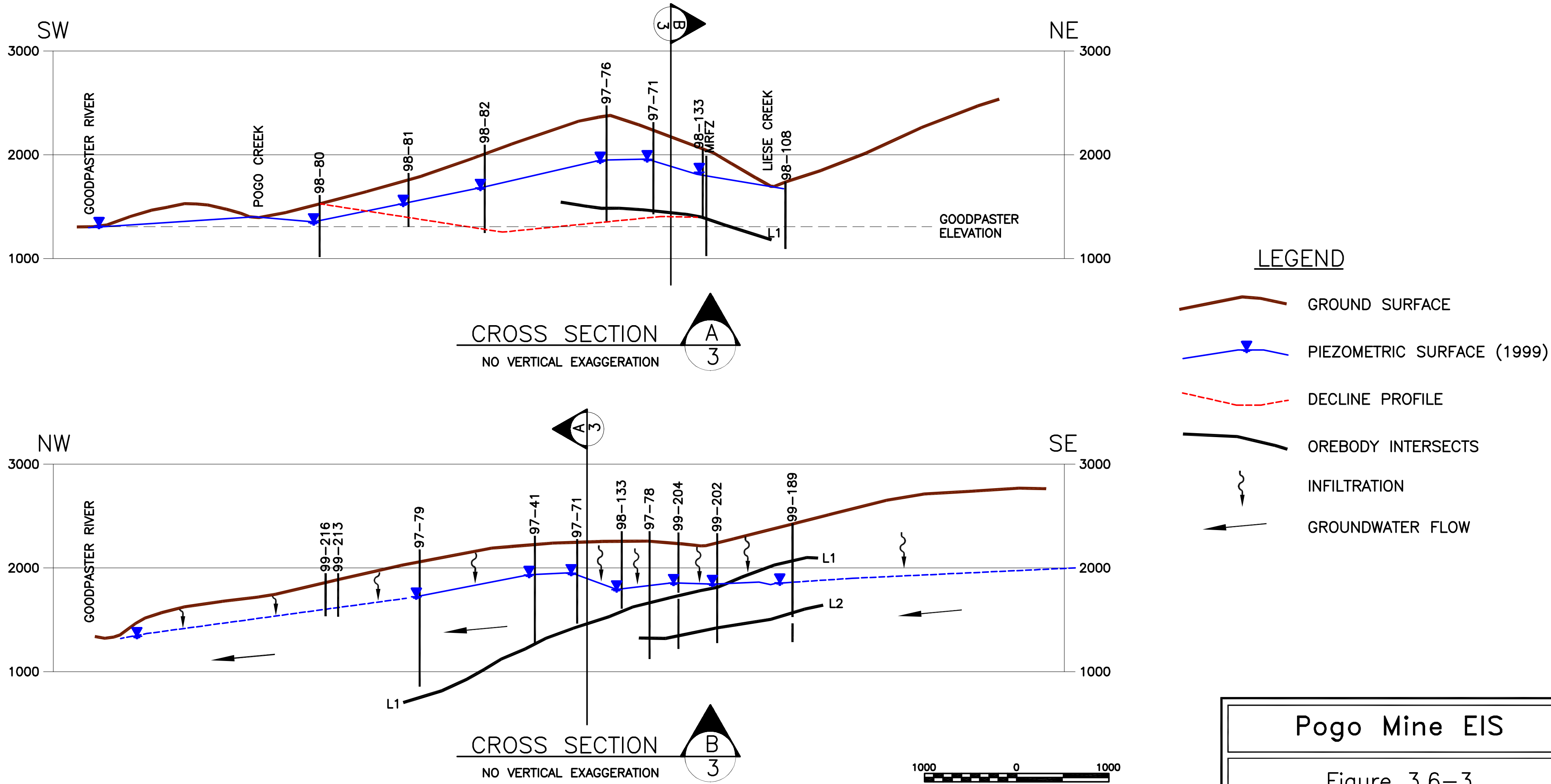

Pogo Mine EIS

Figure 3.6–3
Geologic Cross Sections

amec

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Goodpaster River Alluvial Aquifer

The alluvial aquifer associated with the Goodpaster River is a major water-bearing aquifer in the area, capable of sustaining yields of hundreds of gpm to wells. The aquifer is unconfined, consists of sand and gravel, is more than 100 ft thick in the center of the valley, and thins toward the valley margins. Permafrost is present along the valley margins. The aquifer is recharged by precipitation, snowmelt, surrounding alluvial and bedrock aquifers and creeks, and spring and summer high flows of the Goodpaster River. The aquifer also presently receives treated drainage water from the exploration adit through two injection wells. Groundwater flows in the aquifer are generally down valley and toward the Goodpaster River. While groundwater discharges to the Goodpaster River most of the time, bank storage effects create variable groundwater flow directions during high water stages of the Goodpaster. Water levels in the Goodpaster River alluvial aquifer are generally within 4 to 6 ft of the land surface, because of the relatively flat valley-bottom topography.

During 2000-2001, two wells injected approximately 80 gpm of water into the Goodpaster alluvial aquifer (AMEC, 2001a). A third well has been constructed to test the hydraulic characteristics of the aquifer and provide additional injection capacity (Emmerson *et al.*, 2002). The well is screened from 38 to 75 ft below grade and has a demonstrated capacity to produce 390 gpm with 8.55 ft of draw-down in the pumped well. Based on a 72-hour pumping and recovery test with several monitoring wells, the transmissivity of the aquifer is estimated to be 0.015 square meters per second (m^2/s).

Subsequent injection testing at rates up to 250 gpm demonstrated that water table mounding of approximately 2 ft would occur near the injection well at that rate (Davies, 2002b). This mounding was observed with an increase in water levels in sloughs in the area by that amount. The mounding was not high enough to cause surface water discharge to the Goodpaster River through the sloughs.

Bedrock Aquifer

Ground water in bedrock occurs exclusively in fractures, faults, and joints. Data has been collected from vertical and angle holes drilled from the surface in the mine area, in the dry stack area, and from horizontal and angled holes drilled from the adit and from the 1875 elevation in Liese Creek Valley.

- **Surface Holes** Wells penetrating bedrock in the vicinity of the ore zone exhibit widely variable characteristics depending on their interception of water-bearing structures. In general, much of the rock mass contains low densities of water-bearing structures and has low hydraulic conductivities. The median hydraulic conductivity computed from 41 hydraulic tests conducted in vertical boreholes is 3 ft/yr, with values ranging from 0.01 ft/yr to 500 ft/yr. It was generally observed that hydraulic conductivity values were higher in the quartz ore body than in the country rock.
- **Dry Stack Area Holes** Hydraulic testing also was conducted in the area of the dry stack tailings southeast of the ore body. The median hydraulic conductivity was 33 ft/yr, an order of magnitude larger than values determined near the ore body. Near-surface weathering and fracturing due to stress relief of the rock mass are considered to be factors in explaining the higher hydraulic conductivities.
- **Underground (Adit) Holes** Much of the information about the characteristics of ground water in bedrock is from the adit. The adit is almost entirely constructed within

the zone of saturation. The adit encountered water-bearing structures and caused drainage of the mine area at time and spatial scales comparable to those for mine development. Radial holes were drilled along the adit to further test hydrogeologic properties. The median hydraulic conductivity values reported for 41 hydraulic tests is 5 ft/yr. Water flow rates from underground holes varied from 0 to 100 gpm; however, only 5 of 54 holes reported more than 20 gpm of flow.

Numerous faults and fault systems were mapped as a result of the adit development and underground boreholes (Figure 3.6-1). Most faults drained a small amount of water that dissipated with time. The two most significant water-bearing structures are the Mid-Ridge Fault and the Liese Creek Fault Zone.

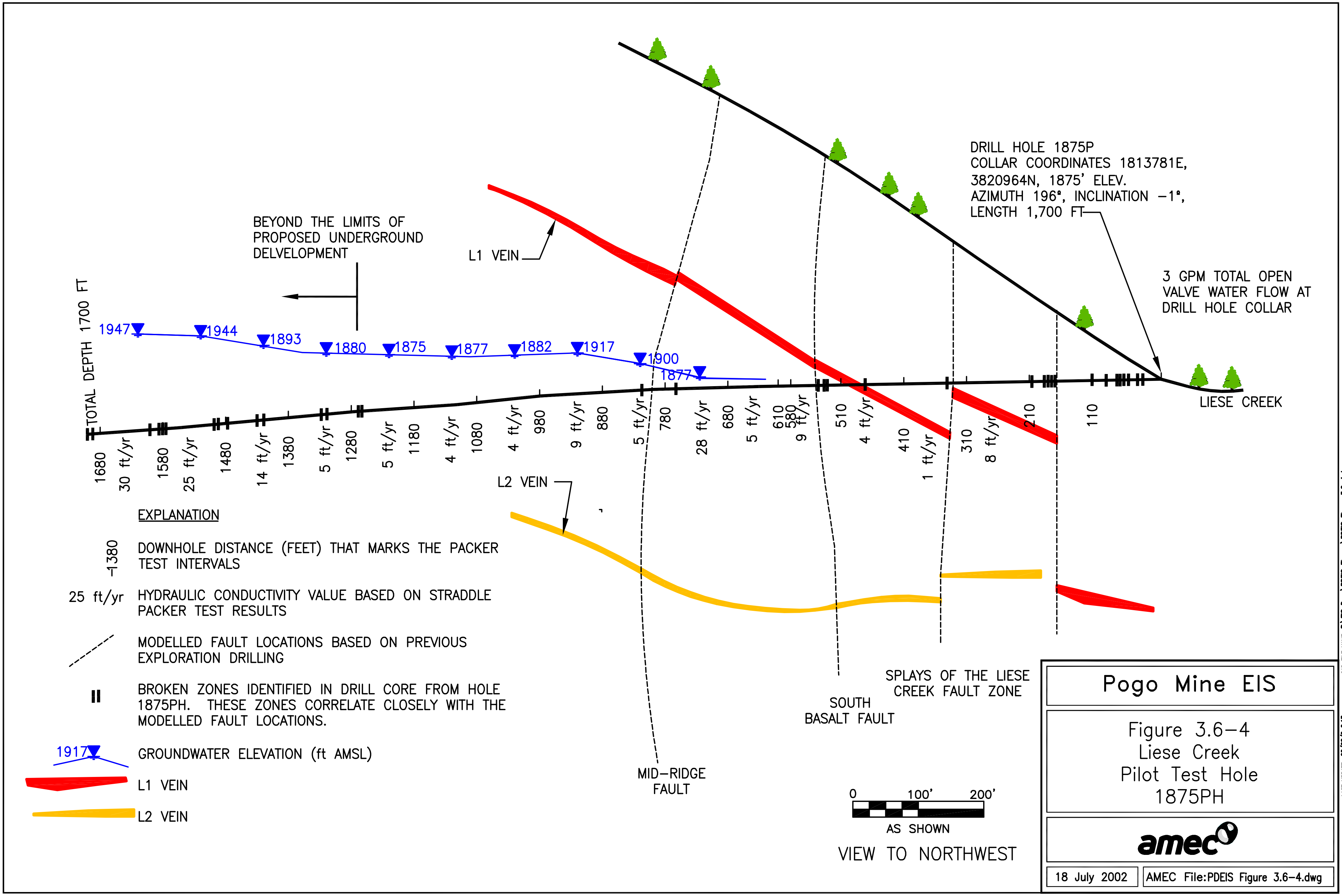
Two horizontal holes from the end of the adit penetrated the Mid-Ridge Fault and the Liese Creek Fault Zones. One hole (Hole 00U98C) produced a peak flow of 150 gpm and a sustained flow of 100 gpm. The calculated hydraulic conductivity from that hole for an assumed 100-ft aquifer thickness is 338 ft/yr, which is substantially higher than other values in the area. The other hole penetrating the fault zones exhibited minimal flow rates consistent with other holes in the area. Hole 00U98C shows that the Liese Creek Fault Zone has the potential to be a major water-bearing structure that is important for mine planning. The fault zone is located close to Liese Creek, which could present a substantial source of ongoing recharge to the fault zone and flow into the mine. There is considerable uncertainty in characterizing the hydraulic parameters of the Liese Creek Fault Zone as a result of the minimal amount of borehole data available for penetration of the zone. The discontinuous, fractured character of the aquifer also creates uncertainty about how the interconnectedness of aquifer fractures could change after development of the mine.

Approximately 1 year after initial development of the adit and the underground boreholes, groundwater drainage from the mine reached approximately 71 gpm. Flow from some of the underground boreholes was closed off to limit flows so that the capacity of the treatment and disposal system would not be exceeded.

As a result of drainage to the adit, water-level declines were observed in nearby wells, although the amounts of the declines were variable. More than 500 ft of water-level decline occurred adjacent to the adit and 31 ft of decline was observed 1,000 ft from the decline along the Mid-Ridge Fault. To illustrate the variability of hydraulic conductivity in the area, however, it should be noted that some wells located less than 300 ft from the adit showed water level declines of less than 32 ft.

- **1875 Pilot Hole** A nearly horizontal 1,700-ft borehole was drilled from the surface near Liese Creek at an elevation of 1,875 ft to penetrate the Liese Creek Fault Zone and the Mid-Ridge Fault to provide data for a proposed access decline at that location (Figure 3.6-4).

  Maximum observed flow of water from the hole was 3 gpm. Straddle packers were used to conduct 15 hydraulic tests in the hole, resulting in a median hydraulic conductivity of 5 ft/yr, with a range from 1 ft/yr to 28 ft/yr. The 1875 Pilot Hole is located approximately 2,000 feet up-valley from Hole 00U98C, which illustrates that the fault zones in the area are not uniform and can produce substantially different quantities of water in different areas.



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Summary Detailed review of all the hydraulic testing results shows that the rock mass is generally of low hydraulic conductivity with an overall median measured value of 5 ft/yr. Shallower zones tested (such as near the dry stack tailings) and the Liese ore zones generally have higher hydraulic conductivities. Estimates of hydraulic conductivities considered representatives of the different rock types in the area are:

- Ore body 5 ft/yr
- Country rock 0.5 ft/yr
- Near-surface rock 50 ft/yr

Vertical fracturing is probably more ubiquitous and probably more continuous than horizontal fracturing, resulting in higher average vertical hydraulic conductivities compared to horizontal hydraulic conductivities.

Groundwater Recharge

Groundwater flow systems in the area are recharged by infiltration of rainfall, snowmelt, and runoff. Areawide average rates of infiltration are estimated to be approximately 0.5 to 1 inch/yr, which is approximately 3 to 5 percent of average annual precipitation. Infiltration as a percentage of precipitation is lower than in many other lower elevations, lower latitude locations because of the presence of discontinuous permafrost, steep slopes, thin soils, bedrock with low hydraulic conductivity, and the typical intensity of rainfall and snowmelt events. Seepage losses to ground water from Liese Creek are inhibited by the intermittent flow of the creek and the silty sands present in the creek bottom.

3.7 Water Quality

3.7.1 Surface Water Quality

Surface water in the Pogo project area is clear and nonglacial, with slight to moderate organic staining observed during spring runoff. The surface water environment is generally pristine and overall water quality and physical characteristics are typical of unpolluted subarctic Alaska streams (Balding, 1976; Emery *et al*., 1985; Feulner *et al*. 1972). The water quality in the Goodpaster River is of a higher quality than in smaller tributary streams that are near the Pogo deposit, i.e., Liese (SW05 and SW30) and Pogo creeks (SW07) (Figure 3.5-1). Water quality and physical characteristics are influenced by the source of the stream flow, which varies seasonally. During the open water season – approximately late April through October – the source of stream flow is a combination of groundwater base flow and precipitation runoff. As discussed in Section 3.5 (Surface Water Hydrology), freezing conditions in the winter limit the source of stream flow to groundwater inputs.

Acquisition of baseline data for surface water quality in the Pogo project area was initiated in September of 1996, and routine sampling began in spring 1997. Modifications were made to the baseline monitoring as the proposed project development alternatives evolved. Sampling of fine-grained bed sediment was added to the monitoring plan in the spring of 1998. The surface water and sediment monitoring are ongoing. In 2001, surface water and sediment sampling were conducted nine times. The monitoring schedule included monthly sampling from February through October.

Although water quality data was collected in 1996 and 1997, a fairly substantial revision of the monitoring program was made in 1998 to both the monitoring locations and analytical methods. From 1998 through 2001, a consistent set of stations and analytical methods were maintained, with the exception of the addition and deletion of a few stations. The 1996 and 1997 data generally supports the later sampling data; however, because of the modifications to the program, it is difficult to directly compare the results. Hence, this summary of surface water quality focuses on the 1998 through 2001 sampling.

The water and sediment quality monitoring program was developed to establish both spatial and seasonal baseline conditions within the surface water and fine-grained bed sediments prior to the start of mine development. Additional detail on the surface water and sediment quality baseline studies can be found in the project's environmental baseline document (Boggs, 2001a).

Baseline Monitoring Stations

Baseline water quality monitoring was conducted on an 11-mile reach of the Goodpaster River and a 21-mile reach of Shaw Creek, both tributaries of the Tanana River (Figure 3.5-1). Eighteen stations were sampled in the 2001 baseline monitoring program. Sampling stations in the Goodpaster River drainage included the following.

- Two stations upstream of the ore body and proposed project development and exploration activities (SW01 and SW23)
- One station just downstream of the advanced exploration camp at the confluence of Pogo Creek (SW15)
- One station farther downstream of the ore body and proposed project development (SW12)
- Ten stations located on tributary streams potentially affected by the ore body or project facilities (SW05, SW07, SW08, SW10, SW11, SW29, SW30, SW35, SW36, and SW37)
- Two stations located at springs near the advanced exploration camp (SW20 and SW22), although SW22 was not sampled in 2001

Six stations were located along the proposed Shaw Creek Hillside road alignment in the Shaw Creek drainage (SW32, SW33, SW34, SW38, SW39, and SW40). Stations SW32, SW,33, and SW34 were only sampled in 2000.

Stations on Indian Creek (SW16) and Dry Stack Tributary (SW17), located on streams potentially affected by project facilities proposed in 1998, are no longer being sampled as part of the baseline monitoring program because alternative locations for those facilities have been identified.

Water Quality Summary

Surface water in the Pogo project area is of the calcium bicarbonate type and is low to moderately hard at approximately 50 mg/L of hardness and not exceeding 70 mg/L. The surface waters sampled exhibit a nearly neutral pH. All surface waters sampled were well oxygenated during all seasons, with the average percent saturation of oxygen exceeding 86 percent. None of the measured water quality parameters subject to EPA priority pollutant standards for fresh water aquatic life exceeded the criterion maximum concentration (CMC) (EPA, 1998); however, a few samples did exceed the criterion chronic concentration (CCC). Lead exceeded the EPA CCC at

SW15 and SW30 on two and one occasions, respectively. Mercury exceeded the EPA CCC at SW15, SW23, and SW30 on two, two, and one occasions, respectively. EPA fresh water aquatic life standards for nonpriority pollutants were exceeded by aluminum concentrations for CMC at SW07, and for CCC at SW05, SW07, SW15, SW22, SW23, and SW30. The secondary maximum contaminant level (MCL) standard for iron was exceeded at SW01, SW05, SW15, and SW23. Iron also exceeded the CMC at stations SW01, SW15, and SW23.

A summary of the water quality for Goodpaster River stations SW01, SW15, and SW23 is presented in Table 3.7-1. This table presents the mean concentrations measured at each station. Stations SW01 and SW23 are upstream of the proposed Pogo facilities, and SW15 is downstream. A summary for the Liese and Pogo creeks stations SW05, SW07, and SW30 is presented in Table 3.7-2.

These data demonstrate that certain constituents are present at higher concentrations (both total and dissolved) in the small creeks draining from the site (SW05 and SW30 in Liese Creek and SW07 in Pogo Creek) than in the main stem of the Goodpaster River. This difference in concentrations was observed for aluminum, arsenic, chromium, and nickel. The plots in Figure 3.7-1 and Figure 3.7-2 also demonstrate the elevated concentrations of arsenic in the Liese Creek stations. Pogo Creek had elevated concentration of total suspended solids (TSS), as indicated in Table 3.7-2. The impact of this elevated solids content can also be observed in the higher total metals concentrations for a number of parameters. The higher TSS concentrations in Pogo Creek are attributed to naturally occurring processes and not to exploration activities (Boggs, 2001a). The Alaska Water Quality Criteria for these waters is published in 18 AAC 70 – Water Quality Standards. The standards/criteria for toxics are adopted by reference from EPA standards as presented in 40 CFR, Chapter 1, 131.36.

Figure 3.7-3 and Figure 3.7-4 present the total concentrations of selected trace metals, NO_3, and TDS as a function of time for stations SW01 and SW15, respectively. These stations are above and below the location of the Pogo ore body. Although some differences exist between the two stations, the plots are relatively similar. For example, the TDS plots are very similar between SW01 and SW15, but some differences can be seen for manganese between these two stations.

Table 3.7-1 Goodpaster River - Surface Water Quality

General Parameters	Units	SW01	SW01	SW15	SW15	SW23	SW23
Ammonia Nitrogen	mg/L	0.067		0.061		0.049	
Bicarb Alkalinity	mg/L	38		40		38	
Field pH	pH units	7.06		7.06		6.93	
Field Temperature	deg C	4.3		4.3		4.6	
Kjeldahl Nitrogen	mg/L	0.188		0.182		0.19	
Lab Turbidity	NTU	1.22		1.9		2.38	
Nitrate Nitrogen	mg/L	0.236		0.245		0.248	
Settleable Solids	mL/L/hr	< 0.1		<0.1		<0.1	
Total Suspended Solids	**mg/L**	**4.7**		**5.4**		**4.9**	
Alkalinity	mg/L	37		40		38	
Chloride	mg/L	0.37		0.35		0.35	
Total CN	mg/L	0.0052		0.0041		0.0038	
WAD CN	mg/L	0.0025		0.0025		0.0025	
Hardness	mg/L	50.5		52.8		50.7	
Sulfate	mg/L	14.9		16.9		15.3	
Dissolved O_2	mg/L	12.22		11.83		11.96	
Dissolved O_2 % Saturation	%	93.3		90.8		91	
Total Dissolved Solids	**mg/L**	**75**		**75**		**74**	
Metals	**Units**	**SW01 Total**	**SW01 Dissolved**	**SW15 Total**	**SW15 Dissolved**	**SW23 Total**	**SW23 Dissolved**
Aluminum	µg/L	66.6	25.2	67.5	21.9	82.1	23.5
Arsenic	µg/L	0.23	0.21	0.29	0.25	0.26	0.2
Barium	µg/L	15.9	15.37	16	15.28	15.7	14.84
Cadmium	µg/L	0.021	0.023	0.024	0.028	0.019	0.019
Calcium	mg/L	14.2	14.3	14.6	14.8	14.2	14.2
Chromium	µg/L	0.65	0.7	0.84	0.82	0.64	0.71
Copper	µg/L	0.72	0.67	0.83	1.3	0.68	0.66
Iron	mg/L	0.11	0.0295	0.135	0.0307	0.155	0.032
Lead	µg/L	0.055	0.021	0.436	0.265	0.089	0.054
Magnesium	mg/L	3.59	3.61	3.84	3.85	3.63	3.62
Manganese	µg/L	6.74	3.1	10.4	6.85	7.93	3.52
Mercury	µg/L	0.004	0.0035	0.0069	0.0036	0.0053	0.0039
Nickel	µg/L	0.56	0.54	0.59	0.58	0.45	0.45
Potassium	mg/L	1.186	1.184	1.24	1.197	1.253	1.117
Selenium	µg/L	0.5	0.5	0.6	0.6	0.5	0.5
Silver	µg/L	0.009	0.008	0.01	0.009	0.008	0.007
Sodium	mg/L	2.45	2.588	2.41	2.55	2.40	2.45
Zinc	µg/L	1.02	2.39	1.02	2.54	1.05	2.4
Number of Samples		**32**		**35**		**30**	

Source: Boggs (2001a)

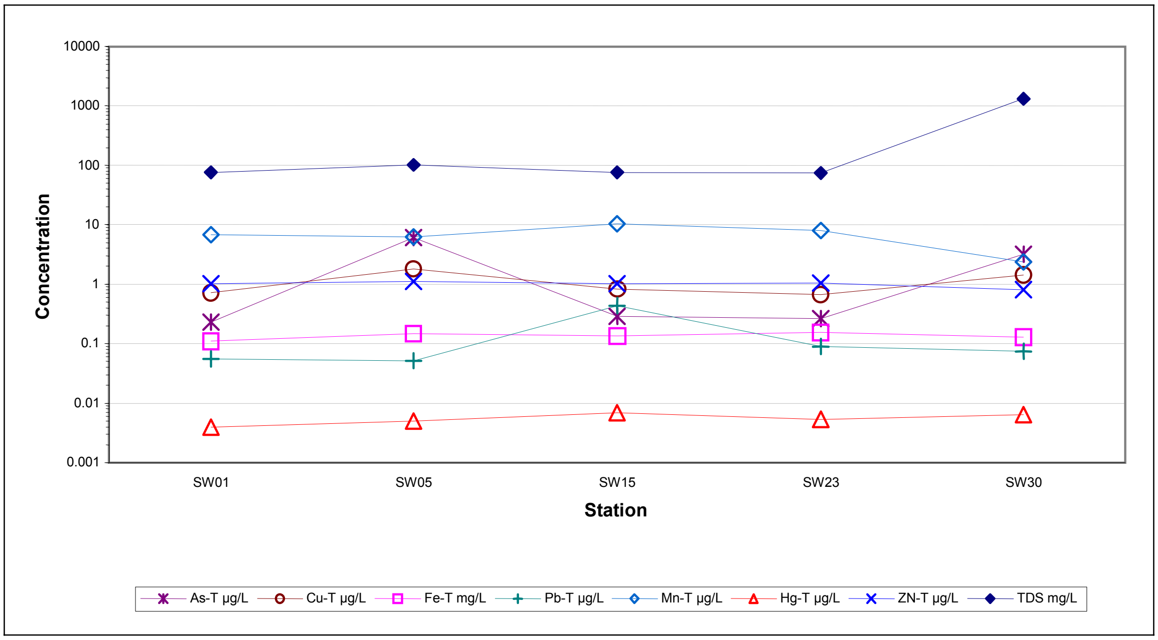
[1] Weak acid dissociable

Table 3.7-2 Liese and Pogo Creeks Surface Water Quality

General Parameters	Units	SW05	SW05	SW07	SW07	SW30	SW30
Ammonia Nitrogen	mg/L	0.154		0.184		0.024	
Bicarb Alkalinity	mg/L	43		58		40	
Field pH	pH units	7.06		7.15		6.82	
Field TEMP	deg C	3		1.9		1.3	
Kjeldahl Nitrogen	mg/L	0.5		0.42		0.36	
Lab Turbidity	NTU	2.5		162		0.9	
Nitrate Nitrogen	mg/L	0.83		0.67		0.88	
Settleable Solids	mL/L/hr	0.08		0.66		0.07	
Total Suspended Solids	**mg/L**	**3.1**		**588.9**		**4.6**	
Alkalinity	mg/L	44		55		40	
Chloride	mg/L	0.3		0.36		0.26	
Total CN	mg/L	0.0043		0.0072		0.0034	
WAD CN	mg/L	0.0025		0.0025		0.0025	
Hardness	mg/L	61.6		112		47	
Sulfate	mg/L	15.1		33		4.9	
Dissolved O_2	mg/L	13.1		13.6		24.2	
Dissolved O_2% Saturation	%	97.1		97.4		94.2	
Total Dissolved Solids	**mg/L**	**103**		**129**		**1332**	
		SW05	**SW05**	**SW07**	**SW07**	**SW30**	**SW30**
Metals	**Units**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**
Aluminum	µg/L	172.9	145.1	6317.5	122.4	203	152
Arsenic	µg/L	6.1	5.8	17	8.1	3.2	2.9
Barium	µg/L	18.2	17.8	73.1	17.4	18.5	17.9
Cadmium	µg/L	0.02	0.017	0.082	0.018	0.021	0.02
Calcium	mg/L	18.6	18.5	27.6	25.1	13.8	14.0
Chromium	µg/L	1.2	1.19	6.97	1.13	0.79	0.74
Copper	µg/L	1.8	1.8	11.6	2.1	1.43	1.4
Iron	mg/L	0.149	0.09	10.296	0.1	0.129	0.0628
Lead	µg/L	0.052	0.024	3.99	0.043	0.074	0.033
Magnesium	mg/L	4.01	4.02	9.34	6.83	2.98	2.98
Manganese	µg/L	6.18	4.98	156	30.09	2.38	0.77
Mercury	µg/L	0.005	0.0048	0.0238	0.0044	0.0064	0.0048
Nickel	µg/L	1.12	1.15	7.87	1.54	0.43	0.44
Potassium	mg/L	1.347	1.153	2.295	1	1	1
Selenium	µg/L	0.5	0.5	0.6	0.48	0.5	0.5
Silver	µg/L	0.016	0.009	0.029	0.008	0.007	0.007
Sodium	mg/L	1.729	1.61	3.357	3.038	1.057	1.179
Zinc	µg/L	1.11	2.59	15.5	2.8	0.8	2.12
Number of Samples		17		20		9	

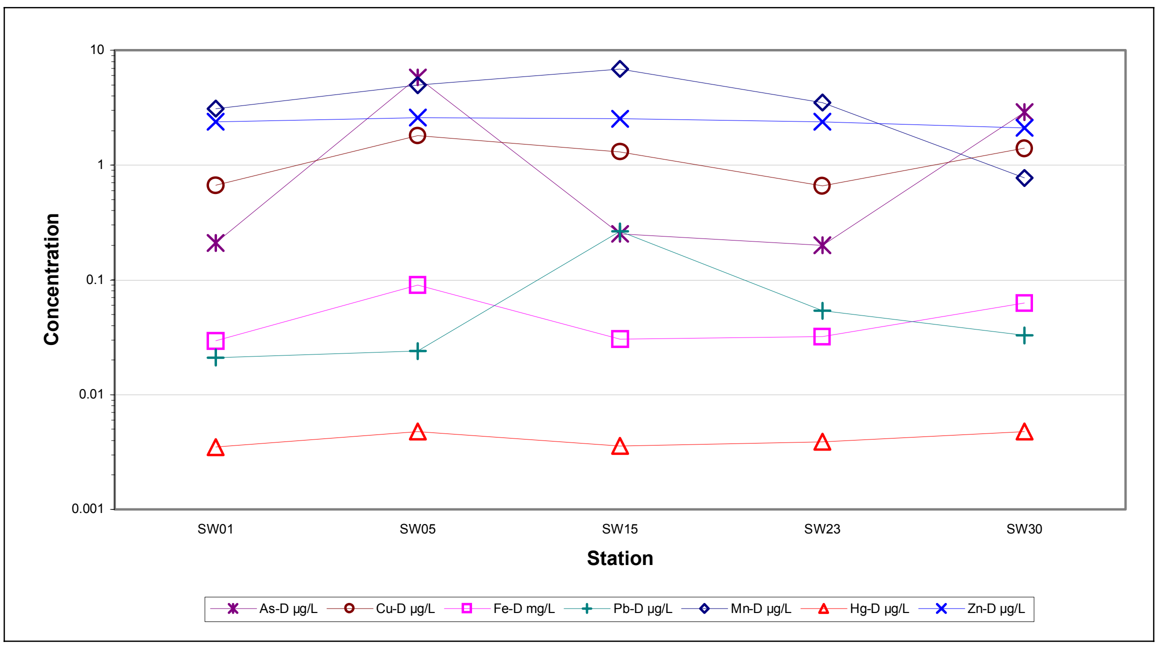
Source: Boggs (2001a)

Figure 3.7-1 Surface Water Quality: Average Total Trace Metal and TDS Concentrations at Selected Sampling Stations



Sources: Boggs (2001a) and Hanneman (2002b)

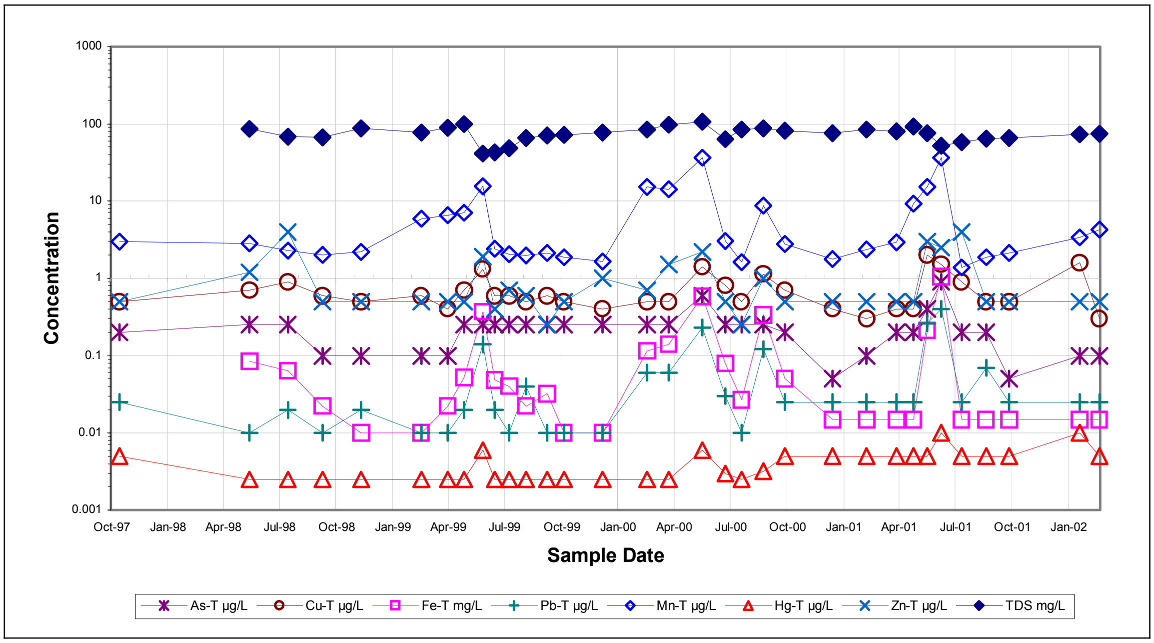
Figure 3.7-2 Surface Water Quality: Average Dissolved Trace Metal Concentrations at Selected Sampling Stations



Sources: Boggs (2001a) and Hanneman (2002b)

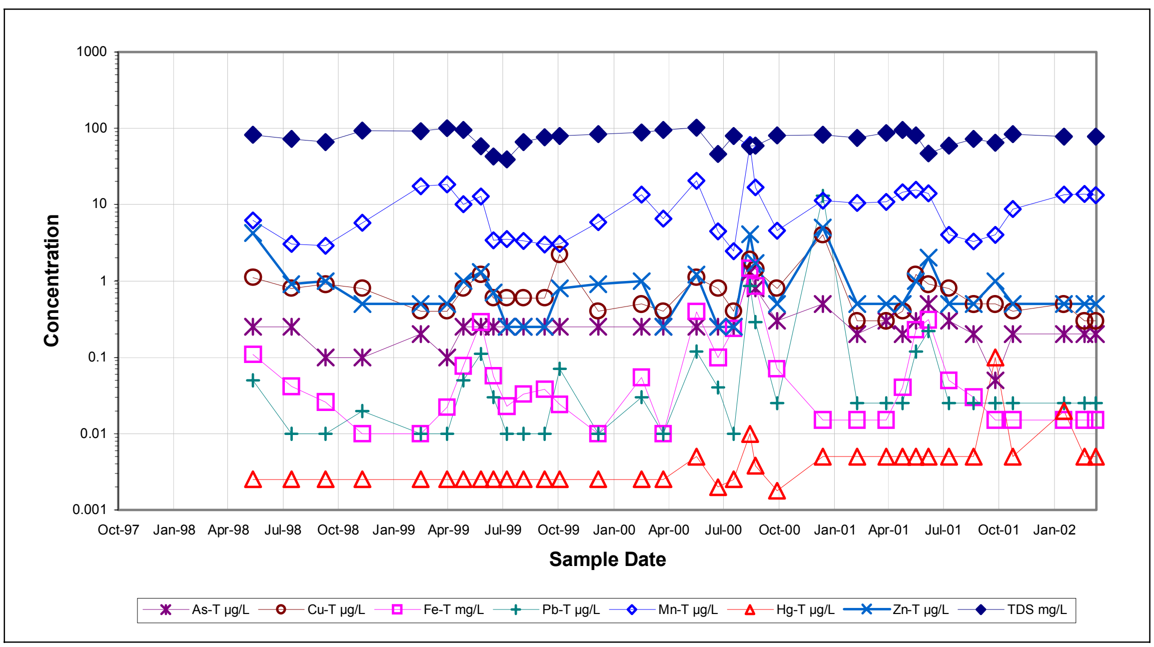
Notes: Data included in the Figures 3.7-1 and 3.7-2 are from sample class M, monitoring data, or sample class P, permit stipulated sample data. Results reported as less than the method reporting limit (<MRL) are set to 0.5 of the MRL for charting and statistical determinations. Total dissolved solids are noted as TDS.

Figure 3.7-3 Surface Water Quality at Station SW01: Total Trace Metal and TDS Concentrations over Time



Sources: Boggs (2001a) and Hanneman (2002b)

Figure 3.7-4 Surface Water Quality at Station SW15: Total Trace Metal and TDS Concentrations over Time



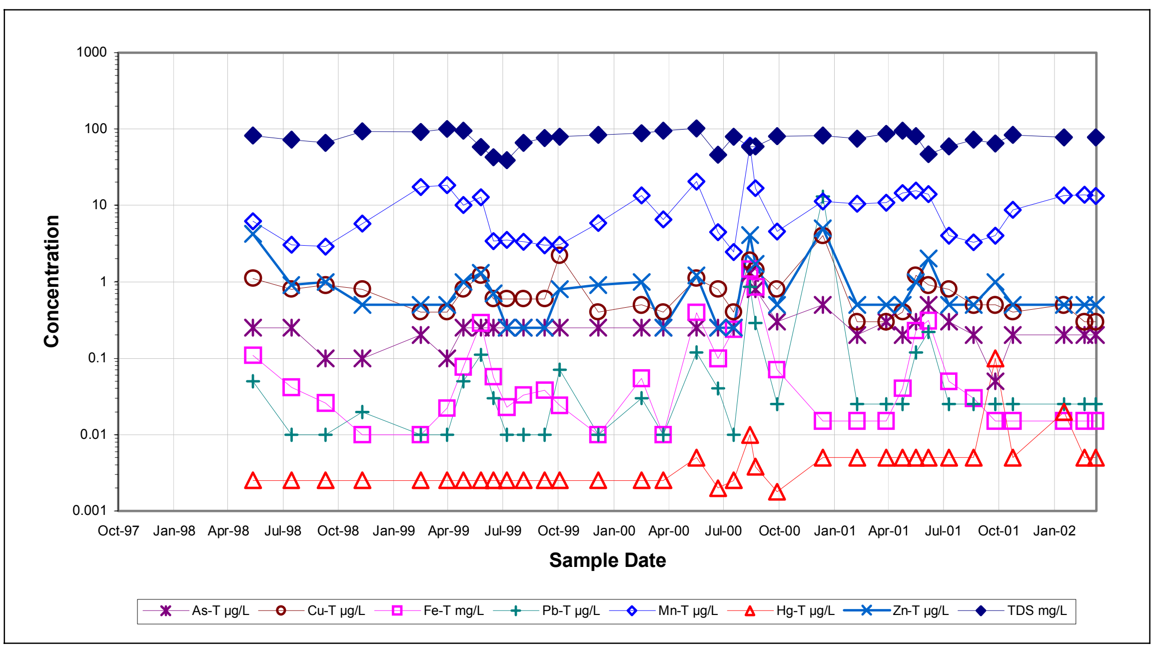
Sources: Boggs (2001a) and Hanneman (2002b)

Summary data for SW38, SW39, and SW40 are presented in Table 3.7-3. These stations are all located in the Shaw Creek drainage and represent Gilles Creek (SW38), Caribou Creek (SW39), and Shaw Creek (SW40). They are all located downstream of proposed crossings by the all season road. Three other stations in the Shaw Creek drainage (SW32, SW33, and SW34) are located upstream of stations SW38, SW39, and SW40, respectively. These stations had water quality results that were very similar to those presented in Table 3.7-3. In general, the stations in the Shaw Creek drainage had water quality that was similar to stations on the Goodpaster River such as SW01. Concentrations of most common ions were low (calcium, sodium, magnesium, and potassium) for the Shaw Creek stations. The concentrations of trace elements were low in general; however, SW39 (Caribou Creek) did have higher concentrations of both total and dissolved manganese on average than stations on the Goodpaster River or stations on other creeks in the Shaw Creek Drainage. For example, total manganese at SW39 averaged 118 micrograms per liter (μg/L) compared with 6.7 μg/L at SW01 on the Goodpaster River.

Sediment Quality

A summary of sediment quality sampling is shown in Figure 3.7-5. This figure presents the mean and standard deviation of sediment analyses at selected stations in the Goodpaster River and Liese Creek. The results demonstrate that the highest concentrations of arsenic and silver were present in Liese Creek (SW05 and SW30) compared to the stations on the Goodpaster River (SW01, SW15, and SW23).

Figure 3.7-5 Sediment Quality (1998-2001): Average Trace Metal Concentrations in Fine-grained Bed Sediments at Selected Sampling Stations



Sources: Boggs (2001a) and Hanneman (2002b)

Table 3.7-3 Shaw Creek Valley Surface Water Quality

General Parameters	Units	SW38	SW38	SW39	SW39	SW40	SW40
Ammonia Nitrogen	mg/L	0.04		0.05		0.03	
Bicarb Alkalinity	mg/L	42		60		70	
Field Conduct	µS/cm	81.7		81.1		106	
Field pH	pH units	6.58		6.57		6.66	
Field Temperature	deg C	7.5		5.8		6.1	
Kjeldahl Nitrogen	mg/L	0.13		0.26		0.16	
Lab Turbidity	NTU	0.8		4.2		1.8	
Nitrate Nitrogen	mg/L	0.232		0.143		0.295	
Settleable Solids	mL/L/hr	0.08		0.18		0.08	
Total Suspended Solids	**mg/L**	**2.1**		**15.4**		**3.5**	
Alkalinity	mg/L	42		60		70	
Chloride	mg/L	0.25		0.46		0.25	
Total CN	mg/L	0.0025		0.0025		0.0025	
WAD CN	mg/L	0.0025		0.0025		0.0025	
Hardness	mg/L	60.6		73		86.1	
Sulfate	mg/L	23		20		23	
Dissolved O_2	mg/L	30.62		12.13		12.07	
Dissolved O2 % Saturation	%	77.22		96.1		97.1	
Total Dissolved Solids	**mg/L**	**86**		**118**		**115**	
Metals	**Units**	**SW38 Total**	**SW38 Dissolved**	**SW39 Total**	**SW39 Dissolved**	**SW40 Total**	**SW40 Dissolved**
Aluminum	µg/L	20	12	204	21	80	14
Arsenic	µg/L	0.3	0.3	1.5	1.1	0.5	0.4
Barium	µg/L	8.51	8.55	17.1	14	18.4	17.7
Cadmium	µg/L	0.025	0.025	0.025	0.025	0.025	0.025
Calcium	mg/L	14.225	14.6	17.9	18.4	21.275	22.225
Chromium	µg/L	0.25	0.25	0.51	0.25	0.25	0.25
Copper	µg/L	0.8	0.9	1.5	1.3	1.1	0.9
Iron	mg/L	0.278	0.188	1.587	0.822	0.26	0.117
Lead	µg/L	0.025	0.036	0.12	0.025	0.125	0.025
Magnesium	mg/L	5.725	5.875	6.45	6.575	7.425	7.725
Manganese	µg/L	23.5	21.2	117.7	85.3	44	36.7
Mercury	µg/L	0.005	0.005	0.005	0.005	0.005	0.005
Nickel	µg/L	0.38	0.6	1.3	1.2	0.5	0.45
Potassium	mg/L	1	1	1	1	1	1
Selenium	µg/L	0.5	0.5	0.5	0.5	0.5	0.5
Silver	µg/L	0.005	0.005	0.007	0.005	0.009	0.005
Sodium	mg/L	2.25	2.75	3.75	3.75	2.75	2.75
Zinc	µg/L	1	5	1.4	3.9	1.5	3.4
Number of Samples		**4**		**4**		**4**	

Source: Boggs (2001a)

3.7.2 Toxicity Testing

Ambient toxicity testing was conducted on waters collected from selected monitoring stations in 1999 and 2000. Ambient toxicity testing evaluates the survival, growth, and/or reproduction of selected test organisms exposed to water collected from the site. These characteristics are generally evaluated by placing the test organisms in a series of dilutions of the site water. The waters used were 6.25, 12.5, 25, 50 and 100 percent concentrations of the site water. Simultaneously, other organisms of the same species are placed in laboratory water for control (zero percent site water).

In 1999 and 2000, water samples from surface water monitoring stations SW01, SW05, SW08, and SW15 were tested. Testing was conducted using the *Ceriodaphnia dubia* (*C. dubia*) partial life-cycle test and the fathead minnow (*Pimephales promelas*) survival and growth test. In 2000, testing of water from monitoring station SW05 could not be completed with either test organism because there was insufficient water in the creek for sample collection. The detailed results of this testing are presented in Boggs (2001c).

The results of the ambient toxicity testing are summarized in Table 3.7-4. Except for the 1999 fathead minnow test with SW05, these results indicate that the survival, reproduction, and growth of the test organisms was the same in water from the Pogo surface water monitoring stations and the laboratory control water.

The 2000 testing for station SW08 indicated a possible observed effect to the reproduction but not the survival of the *C. dubia.* The results indicated that reproduction was statistically lower for the 25 percent strength site water only. All other dilutions, including the 50 and 100 percent site water, had reproductive rates that were not statistically different than those of the laboratory controls. These responses by the test organism are not a typical or expected. Hence, these results are inconclusive for SW08.

Table 3.7-4 Ambient Toxicity Testing Summary Results

	1999 *C. dubia*		2000 *C. dubia*		1999 Fathead Minnow		2000 Fathead Minnow	
Monitoring Station	Survival	Repro-duction	Survival	Repro-duction	Survival	Growth	Survival	Growth
SW01	NE	NE	NE	NE	NE	NE	NE	NE
SW05	NE	NE	NR	NR	EO	EO	NR	NR
SW08	NE	NE	NE	PE	NE	NE	NE	NE
SW15	NE	NE	NE	NE	NE	NE	NE	NE

NE = No effect observed
PE = Possible effect observed
EO = Effect observed
NR = Not run due to unavailability of water

Source: Boggs (2001c)

The 1999 testing for station SW05 demonstrated a negative effect to the survival and growth of the fathead minnow. The no observed effect concentration (NOEC) and the lowest observed effect concentration (LOEC) for organism survival were estimated to be less than 6.25 percent and 6.25 percent, respectively. The NOEC and the LOEC for organism growth were also estimated to be less than 6.25 percent and 6.25 percent, respectively. Compared to other monitoring stations tested, SW05 has higher concentrations of arsenic, copper, nitrate, and ammonia. One or more of these constituents may have affected the fathead minnow growth and survival.

3.7.3 Groundwater Quality

Baseline groundwater chemistry for the Pogo project site has been characterized through collection and evaluation of groundwater chemistry data from 1998 through 2001 and is ongoing in 2002 (Golder Associates and AMEC Earth & Environmental [AMEC], 2001)

The baseline chemistry of the ground water in the bedrock was assessed through collection of samples from monitoring wells located in the Pogo Ridge area. The country rock wells are located in the adit alignment and in the country rock downgradient from the ore zones. The ore zone wells are located in both the L1 and L2 ore zones. The location of these wells is shown ni Figure 3.6-1). A list of wells sampled and their location in the different areas of the site is presented in Table 3.7-5. Eleven bedrock wells were sampled: seven wells represented the ore zone ground water and four in the country rock.

The baseline chemistry of the ground water in the Goodpaster River Valley was assessed by collection of samples from monitoring wells installed in the valley, west of the exploration adit. Fourteen monitoring wells and two large-diameter wells were sampled in the valley. Four wells are located near the Goodpaster River and 12 are located closer to the valley margin. Nested monitoring wells provide information about the upper and lower valley sediment ground water. Monitoring wells MW98-010A and MW98-011A were installed in the deeper portion of the valley sediments (between approximately 50 and 80 ft deep), whereas wells MW98-010B and MW98-011B were installed in the shallow portion of the sediments (less than 40 ft deep). An additional 21 wells were drilled in the Goodpaster River Valley in the vicinity of Liese Creek. These wells were completed with depths varying from 30 to 84 feet.

Table 3.7-5 Pogo Groundwater Wells

Ridge Bedrock		Goodpaster Valley			Liese Creek
Country Rock	**Ore Zone**	**Near River**	**Valley Margins**	**Near Liese Creek**	**Bedrock**
MW99-216 MW98-080, MW98-081 MW98-082	MW97-041, MW97-071, MW97-076, MW98-133, MW99-189, MW99-202 MW99-204	MW98-004, MW98-005, MW98-006, MW99-016	INJ1 INJ2 MW98-003, MW98-009, MW98-010A MW98-010B MW98-011A MW98-011B MW98-012 MW98-013 MW98-014 MW98-015	LL-001 Through L030	MW99-213, LB-001, LB-003A, LT-003, LT-007A, LT-007B, LD-005 LT-009

Source: Golder Associates and AMEC (2001)

Most wells were sampled on multiple occasions to provide a reliable evaluation of baseline water quality. Seven groundwater sampling events were conducted from June 1998 to September 1999. The frequency of sampling in 2000 and 2001 varied across the monitoring well network. In addition, monthly sampling of ground water at wells near the injection wells (INJ1 and INJ2) was started just prior to the initiation of the injection system in August 1999 and has continued through 2000 and 2001.

Liese Creek groundwater geochemistry was assessed through monitoring wells installed in the Liese Creek Valley. Eight bedrock wells were installed.

Chemistry Summary

Three groundwater quality types have been identified within the Pogo mine site area. They are: (1) country or nonmineralized rock, (2) ore zone, and (3) valley sediments. Ground water encountered in wells located in the country rock consists of a calcium/magnesium-carbonate/sulfate type ground water. Ground water in the ore zones has a larger proportion of sodium and is therefore a calcium/magnesium/sodium-carbonate/sulfate ground water. Ore zone L2 appears to have a more pronounced sodium signature than ground water in the L1 ore zone. Valley sediment ground water is characterized by calcium-carbonate type ground water, with some wells located closer to the country rock having a more pronounced magnesium signature, similar to that of the country rock wells.

The chemistry of each groundwater type is described in further detail below and is summarized in Table 3.7-6. For metals concentration in ground water, only dissolved metals content is discussed because it is more representative of actual aqueous phase concentrations.

Pogo Ridge Bedrock Wells

Ground Water in Country Rock

Ground water in the country rock is moderately hard to very hard (hardness range of 198 to 638 mg/L) and alkaline. Calcium and magnesium in the country rock are somewhat greater than in the valley sediments. Sulfate or bicarbonate can be the dominant anion, depending on the sample.

Concentrations of other major ions, such as sodium, are also elevated in ground water in the country rock relative to groundwater samples collected from the valley sediments near the river. Iron concentrations are at the lower end of the range observed in groundwater samples collected from the valley sediments. Heavy metals are generally present in trace concentrations. However, on occasion, more elevated concentrations are observed. Zinc concentrations in the country rock are elevated compared to those in ground water in other areas. Arsenic concentrations are generally low compared to those in ore zone wells.

Ore Zone Ground Water

Ground water from the ore zone is characterized by a larger range of hardness and TDS concentrations, but a similar pH range similar to that of ground water in the country rock. In the ore zone ground water, sodium is characteristically present in greater concentrations compared to those for the country rock.

Iron concentrations are highly variable, depending on the well, but can be quite elevated. Heavy metals are generally present in trace concentrations, but some peaks have been observed sporadically at various wells. Elevated arsenic concentrations were observed in many wells located in the ore zone, with several wells having arsenic concentrations greater than 2 mg/L. The highest concentrations detected was 5100 µg/L at well MW97-076. TDS concentrations were also elevated in the ore zone with a number of wells reporting concentrations above 900 mg/L.

Table 3.7-6 Ground Water Summary of Water Quality Ranges

	Units	Ridge Bedrock		Goodpaster Valley			Liese Creek	Water Quality Standards	
		Country Rock	Ore Zone	Near River	Valley Margins	Near Liese Creek	Bedrock	Drinking Water MCL	Fresh Water Aquatics CCC
General Parameters									
Hardness	mg/L	427	555	122	266	59	178		None[1]
		198	<1	51	25	41	76		
		638	1330	293	560	101	356		
TDS	mg/L	550	797	176	399	90	213		
		173	128	58	88	50	99		
		744	1760	443	746	548	430		6.5 – 8.51
pH	pH units	8.1	7.9	7.1	7.0	7.2	7.7		
		7.6	7.1	6.1	5.9	6.2	6.7		
		8.4	8.5	8.5	8.0	8.1	8.3		
Alkalinity	mg/L	285	296	58	98	41	116		> 20 mg/L, as $CaCO_3$ unless naturally lower[1]
		200	60	35	15	30	62		
		374	530	110	270	71	188		
Sulfate	mg/L	199	311	63	165	23	60		250 mg/L[1]
		93	11	15	3	12	5		
		271	951	174	355	44	192		
Dissolved Metals									
Aluminum	µg/L	161	38	12	85	23	21	200	
		1	1	2.0	1	0.25	1.5		
		1840	674	53	1040	120	125		
Arsenic	µg/L	44	1619	2	43	1.8	21	50[2]	
		9.4	9	0.05	3	0.05	1		
		153	5100	6.4	145	14.2	50		
Barium	µg/L	55	32	36	86	18	19		
		14	3.3	13	21	9.3	4.0		
		491	372	104	323	33	44		
Cadmium	µg/L	0.073	0.19	0.037	0.067	0.036	0.042	5	0.7-3.0
		0.01	0.01	0.010	0.010	0.01	0.01		
		0.45	1.3	0.110	0.280	0.13	0.35		
Calcium	mg/L	80	114	34	66	17	45		
		41	19	14	7	12	21		
		105	297	83	138	29	64		
Copper	µg/L	0.95	2.7	0.98	1.1	0.76	0.85	1000	7.2 – 37.1
		0.05	0.05	0.30	0.05	0.05	0.05		
		4.2	33.6	3.1	18.3	4.5	2.1		
Iron	mg/L	0.68	1.2	0.24	12	0.045	0.052	0.3	1
		0.01	0.015	0.010	2	0.01	0.01		
		3.26	19.2	2.0	30	0.37	0.28		
Lead	µg/L	0.55	0.21	0.065	0.21	0.037	0.042		1.4 – 10.9
		0.01	0.01	0.010	0.01	0.01	0.01		
		5.35	1.94	0.49	1.9	0.4	0.17		

Dissolved Metals									
Magnesium	mg/L	54	68	9.2	24	4	14		
		23	6	3.6	2	3	5		
		77	142	23	53	8	42		
Manganese	µg/L	237	249	481	1001	158	13	50	
		65	27	0.59	76	0.025	0.025		
		911	1130	1790	4750	1100	69		
Mercury	µg/L	0.015	0.024	0.016	0.015	0.0053	0.012	2	0.012
		0.0005	0.0005	0.0005	0.001	0.0005	0.0005		
		0.05	0.1	0.050	0.050	0.05	0.05		
Nickel	µg/L	12	11	0.86	1.38	0.39	0.53	100	98.6-497
		0.3	0.3	0.05	0.05	0.05	0.05		
		116	236	5.2	7.8	3.8	1.9		
Potassium	mg/L	3.8	4.0	1.3	2.38	1.0	1.4		5
		1	1	1.00	1.00	1	1		
		6.4	13	3.4	12.00	2.8	3.5		
Selenium	µg/L	3	1.2	0.50	0.62	0.5	0.5	50	
		0.5	0.5	0.50	0.50	0.5	0.5		
		19	5	1.0	3.0	0.5	1		
Silver	µg/L	0.012	0.024	0.0090	0.012	0.006	0.008	100	0.12
		0.005	0.01	0.0050	0.005	0.005	0.005		
		0.05	0.11	0.060	0.11	0.01	0.02		
Sodium	mg/L	29	37	4.2	10	3	4		
		8	3	2.7	1	1	1		
		48	94	7.0	60	6	11		
Zinc	µg/L	66	21	2.9	7.0	0.94	2.1		66.8 – 338
		2.3	4	0.50	0.8	0.25	0.5		
		660	88	35	88	6	10.6		
Number of samples		**26**	**35**	**78**	**112**	**128**	**35**		

[1] Alaska Water Quality Criteria (18 AAC 70, September 2000) Source: Golder Associates and AMEC (2001)
[2] Arsenic drinking water standard (MCL) is scheduled to change to 10 µg/L in 2006
Concentrations for each parameter are listed in order of Mean, Minimum, and Maximum
All concentrations are in mg/L or ug/L as indicated except pH which is in Standard Units
Hardness is as CaCO3 equivalent
Alkalinity is as CaCO3 equivalent
All metals results are dissolved values
Fresh Water Aquatic CCCs that are hardness dependent are presented for a hardness range of 59 to 400 mg/L

Goodpaster River Valley

Ground Water Near Goodpaster River

Monitoring wells MW98-004, MW98-005, MW98-006, and MW99-016 are located near the Goodpaster River and have generally similar geochemical signatures (by major ions) to those of surface water samples, including samples from the Goodpaster River. Although there are some variations, with MW99-016 having higher TDS and manganese concentrations than the other wells, it appears that ground water at these wells may be recharged by the river to some degree. The pH of ground water in these wells is near neutral.

The major dissolved constituents in the ground water include calcium, magnesium, alkalinity, and sulfate. Sodium and potassium concentrations are generally low, either less than or slightly above the method reporting limit (MRL). Dissolved metals are typically present at very low concentrations.

Valley Sediments Near the Valley Margin

Monitoring wells MW98-003, MW98-009, MW98-010A/B, MW98-011A/B, MW98-012, MW98-013, MW98-14, MW98- 015, and injection wells INJ1 and INJ2 are located closer to the valley margin. The geochemical signature of these wells is generally more similar to that of the country rock wells than it is to geochemical signatures of the other wells in the valley. A few of the wells (i.e., MW98-10B [shallow well] and MW98-14) have somewhat lower concentrations of dissolved constituents even though they are closer to the valley margin than the Goodpaster River. Generally, the ground water closer to the valley margins has a higher hardness and TDS than ground water closer to the Goodpaster River. TDS values are as high as 746 mg/L. Major ion concentrations are also higher: calcium, magnesium, sodium, alkalinity, and sulfate. Dissolved metal concentrations are higher in some wells near the valley margin for the following parameters:, arsenic at well INJ2 (145 µg/L), manganese at well MW98-012 (4750 µg/L), and zinc at well MW98-015 (88 µg/L).

Monitoring wells MW98-011A and B were installed in the lower and upper portions, respectively, of the valley sediments. Analyses of samples collected from these wells indicate that the chemical composition of the ground water in both the upper and lower sediments is similar, although slightly better quality (less mineralized) water is present in the deeper zone.

The nested wells MW98-010A and B, which are located closer to the valley margin, indicate that in this area the deeper water is more similar to that of country rock (more mineralized) compared to the deeper water of the shallow zone, which is more chemically similar to near-river ground water.

The ground water from well MW98-012 shows a chemistry that is different from the groundwater chemistry from other wells located in the valley. The ground water at this location is dominated by sodium, but with amounts of sulfate, chloride, and bicarbonate that are similar to those of the ore zone ground water. Well MW98-012 is located in a permafrost area; therefore, infiltration is limited and groundwater flow at this location is likely more sluggish than at other valley locations and exhibits higher concentrations of dissolved minerals.

A comparison of major cations (calcium and magnesium) suggests that the influence of groundwater inflow from bedrock on the composition of the ground water in the valley sediments is greater, in general, near the valley margin than near the river. In these areas, a higher portion of the ground water in the valley sediments may be derived from the bedrock groundwater flow system. Lower TDS soft waters, such as those observed near the river, may be present in recharge zones where the influence of bedrock groundwater contribution to the overall flow regime is less.

Goodpaster River Valley Near Liese Creek

Ground water wells LL-001 through LL-030 were installed in the alluvial gravels of the Goodpaster River Valley in the area where the Liese Creek channel drains into the wetlands. Ground water at these locations has a chemical signature similar to that of the surface water samples and near-river monitoring wells. However, concentration ranges are wider in the Goodpaster Valley wells near Liese Creek than in the surface water and near-river monitoring wells in the area of the exploration camp. The major dissolved constituents in the ground water include calcium, magnesium, alkalinity, and sulfate. Similar to near-river ground water, chloride, sodium and potassium concentrations are uniformly low, either less than or slightly above the MRL. Dissolved metals are also present at low concentrations.

Liese Creek Bedrock

The groundwater chemistry in the wells in the Liese Creek Valley are most similar to the Goodpaster River valley wells. Hardness and TDS are low compared to those characteristics for the Pogo Ridge bedrock wells. No elevated concentrations of dissolved metals other than iron and manganese were measured in these wells.

Groundwater Quality Comparison

Goodpaster River Valley

Water quality standards for drinking water and fresh water aquatic life (chronic) are included in the groundwater chemistry (Table 3.7-6). These standards are presented for comparative purposes and do not directly apply to naturally occurring ground water. According to 18 AAC 70.235(d), natural conditions represent applicable water quality criterion.

Parameter concentrations in groundwater samples from the valley bottom sediments generally meet their respective standards for drinking water and fresh water aquatic life (chronic), except for arsenic, iron, manganese, and, in some instances, aluminum or zinc. Exceedance of the drinking water MCLs for arsenic (of 50 µg/L) occurs at wells INJ2, MW98-011A/B, MW98-010A, and MW98-015, with the highest concentration at INJ2 (145 µg/L). The arsenic concentration in the lower portion of the sediments at well MW98-010A does not meet the drinking water MCL; however, the upper portion of the sediments (MW98-010B) does. Arsenic concentrations are below the MCL both in the upper and lower portions of the sediments at wells MW98-015 (deep well) and MW98-003 (shallow well).

Dissolved iron exceeded both the secondary MCL (0.3 mg/L) and the fresh water aquatic life standards (1 mg/L), and manganese exceeded the drinking water secondary MCL (50 µg/L) at all wells in the valley bottom sediments, except wells MW98-004, MW98-005, and MW98-006. Aluminum concentrations in the ground water are above the drinking water secondary MCL (200 µg/L) for all sampling events at wells MW98-010B and MW98-012 and on one occasion at well MW98-014. Copper and lead slightly exceeded the fresh water aquatic life criteria at well MW98-012. Zinc concentrations in ground water rose slightly above the fresh water aquatic life criteria on one occasion at wells MW98-009 and MW98-015, but decreased to below the criteria on all subsequent sampling events. No other fresh water aquatic life chronic criteria or drinking water standards were exceeded for dissolved metals.

Groundwater quality from wells in the Goodpaster Valley near Liese Creek show very few exceedances. The manganese concentration at well LL-001 was considerably above the drinking water secondary MCL, whereas results at well LL-002 installed upgradient from well LL-001 does not show any exceedance. Manganese concentrations slightly above the drinking water secondary MCL were observed at LL-003 and LL-012A. A slight exceedance of the drinking water MCL was also observed for mercury during one event at LL-012B. No other exceedances were observed at these Goodpaster Valley wells.

Bedrock Near Pogo Ridge

The bedrock ground water wells have a larger number of parameters that exceed the applicable standards. Arsenic, iron, and manganese exceed standards at most wells, while exceedances of aluminum, antimony, cadmium, copper, mercury, nickel, selenium, and zinc were also observed. The highest arsenic concentration in ground water (5.1 mg/L) is observed at well MW97-076, installed across the L1 ore zone. Arsenic concentrations are also above the drinking water MCL in ground water sampled from wells MW97-071, MW97-076, MW98-081, MW98-133, MW99-189, MW99-202, and MW99-204. Bedrock groundwater concentrations of manganese at all wells in the ridge, with the exception of well MW99-202, were greater than the drinking water secondary MCL. Iron concentrations also were above the drinking water secondary MCL. Iron concentrations also were above the fresh water aquatic life chronic criterion at most wells, except wells MW98-080, MW99-189, and MW99-202.

Zinc was above the fresh water aquatic life chronic criteria on two occasions at wells MW98-081, MW98-082, and MW99-204. Exceedances of the applicable standards were observed during one sampling event for aluminum (at wells MW99-204, MW99- 216, MW98-081, and MW98-082) and during some sampling events for copper (well MW99- 204), nickel (wells MW97-076 and MW98-080), mercury (well MW99-133), cadmium (wells MW97-076 and MW97-071), and lead (well MW99-204).

Liese Creek Bedrock

Groundwater quality from wells installed near Liese Creek show very few exceedances. The manganese concentration at well MW99-213 was slightly above the secondary MCL. No other exceedances were observed at the Liese Creek Valley wells.

3.8 Air Quality

3.8.1 Site Meteorology

The Applicant installed a prevention of significant deterioration (PSD) quality meteorological monitoring station near the mine site. Data has been collected from September 1998 to the present. Temperature, wind speed, wind direction, relative humidity, and total precipitation have been recorded at the station. Recorded temperatures in 1999 ranged from a high of 79°F to a low of –34°F, with summer average temperatures of approximately 55°F and winter average temperatures of approximately –20°F (Hoefler Consulting Group, 2001). These temperatures compare favorably with long-term averages reported at the Big Delta station.

Other data recorded at the PSD station for 1999 included a maximum wind speed of 13.2 meters per second, average wind speed of 2.6 meters per second, and average relative humidity of 65.4 percent (Hoefler Consulting Group, 2001). These results are very typical of the climate in interior Alaska.

3.8.2 Air Quality

Air quality is regulated through ambient air quality standards and enforcement of emission limits for individual sources of air pollution. The federal Clean Air Act required the EPA to identify National Ambient Air Quality Standards (NAAQS) to protect public health and welfare. These standards are presented in Table 3.8-1. The State of Alaska has adopted the federal NAAQS.

An area is classified as an attainment area if it meets the NAAQS standards, as a non-attainment area if it does not meet the standards, or as unclassifiable on the basis of available data [Clean Air Act, 107(d)(1)(A)(i-iii)]. Because no air pollutant data has been collected in the project area, it is considered unclassifiable. However, because the nearest road is approximately 36 miles away and the nearest point sources or pollutants are more than 40 miles away, it can be deduced that the area is presently meeting the NAAQS. Ability to meet NAAQS also can be demonstrated by comparing the project area to Fairbanks, which is the closest area that measures air pollutants.

Air pollutant data for the Fairbanks area indicates compliance with all NAAQS except for carbon monoxide (CO). High ambient levels of CO in the Fairbanks area are a result of vehicle travel that does not occur in the project area. Recognizing that the project area is away from any populated or industrial area, it can be concluded that ambient air quality in the project area is better than that measured in Fairbanks and is therefore in compliance with the NAAQS.

Table 3.8-1 National and State of Alaska Ambient Air Quality Standards

Pollutant	Averaging Time	Primary (Health)	Secondary (Welfare)
Particulate matter less than 2.5 µm diameter (PM2.5)	Annual arithmetic mean	15.0 µg/m^3	15.0 µg/m^3
	24 hours	65 µg/m^3	65 µg/m^3
Particulate matter less than 10 µm diameter (PM10)	Annual arithmetic mean	50 µg/m^3	50 µg/m^3
	24 hours	150 µg/m^3 [c]	150 µg/m^3 [c]
Ozone (O3)	1 hour	0.12 ppm [c]	0.12 ppm [c]
Carbon monoxide (CO)	8 hours	9 ppm [b]	N/A
	1 hour	35 ppm [b]	N/A
Sulfur dioxide (SO2)	Annual arithmetic mean	0.030 ppm [a]	N/A
	24 hours	0.14 ppm [b]	N/A
	3 hours	N/A	0.5 ppm [b]
Nitrogen dioxide (NO2)	Annual arithmetic mean	0.053 ppm	0.053 ppm
Lead (Pb)	Calendar quarter average	1.5 µg/m^3	1.5 µg/m^3

[a] Not to be exceeded.
[b] Not to be exceeded more than once per calendar year.
[c] Not to be exceeded more than one day per calendar year.

Source: 40 CFR 50.4-50.12

The Pogo Mine site is considered a PSD Class II area, and is over 200 kilometers from a PSD Class I area.

Existing sources of air pollutant emissions in the general area are minor (do not require an air quality permit), dispersed, and away from the project site. The Richardson Highway passes approximately 30 miles southwest and Big Delta and Delta Junction are approximately 32 miles and 38 miles southwest of the project site, respectively. Vehicular traffic in these areas primarily releases carbon monoxide (CO), but also contributes lesser amounts of unburned hydrocarbons, particulate matter, and oxides of nitrogen. These same compounds also are released from wood stoves in Big Delta and Delta Junction as well as from more remote cabins scattered in the general area. Even under the worst-case meteorological condition, measurable amounts of the pollutants from vehicular traffic and wood stoves would not be expected to be seen at the project site due to the relatively small quantities released at a great distance from the site. There are no other sources of air pollutants in the area that have a potential to impact the project site.

3.9 Noise

This section provides details on noise levels, noise regulations, project impact criteria, area land use survey, and ambient noise level projections. An introduction to acoustics and noise level descriptors is included for reference and to assist in understanding noise data and impact analysis.

3.9.1 Introduction to Acoustics

Human response to noise is subjective and can vary greatly from person to person. Factors that can influence individual response include the loudness, frequency, amount of background noise present before an intruding noise, and the nature of the work or activity (e.g., sleeping) that the noise affects.

The unit used to measure the loudness of noise is the decibel (dB). To better approximate the sensitivity of the human ear to sounds of different frequencies, the A-weighted decibel scale was developed. Because the human ear is less sensitive to higher and lower frequencies, the A-weighted scale reduces the sound level contributions of these frequencies. When the A-weighted scale is used, the decibel levels are denoted as dBA.

A 10-dBA change in noise levels is judged by most people as a doubling of sound level. The smallest change in noise level that a human ear can perceive is about 3 dBA, and increases of 5 dBA or more usually are noticeable. Normal conversation ranges between 44 and 65 dBA when speakers are 3 ft to 6 ft apart.

Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful, while levels higher than 80 dBA over continuous periods can result in hearing loss. Constant noises tend to be less noticeable than irregular or periodic noises.

Several factors determine how sound levels reduce over distance. Under ideal conditions, a point noise source in free space will attenuate at a rate of 6 dB per doubling of distance (using the inverse square law). An ideal line source (such as constant flowing traffic on a busy highway) reduces at a rate of approximately 4.5 dB per doubling of distance. Under normal conditions however, noise sources are usually some combination of the two examples, resulting in sound attenuation that lies somewhere between the two *ideal* reduction factors. Other factors that affect the attenuation of sound with distance include existing structures, topography, foliage, ground cover, and atmospheric conditions such as wind, temperature, and relative humidity. More detailed information on acoustics and sound transmission is contained in Appendix A-2.

3.9.2 Noise Level Descriptors

Noise levels used in this analysis for mining operations and other project-related noise sources (with the exception of blast noise) are stated as sound pressure levels in terms of decibels on the A-scale (dBA). The A-scale is used in most ordinances and standards, including the applicable standards selected for this project. To account for the time-varying nature of noise, several noise metrics are useful. The equivalent sound pressure level (L_{eq}) is defined as the average noise level, on an energy basis, for a stated time period (for example, hourly).

Other commonly used noise descriptors include the L_{max}, L_{min}, and L_n. The L_{max} and L_{min} are the greatest and smallest root-mean square sound levels, in dBA, measured during a specified measurement period. The sound level descriptor L_n is defined as the sound level exceeded "n" percent of the time. For example, the L_{25} is the sound level exceeded 25 percent of the time; therefore, during a 1-hour measurement, an L_{25} of 60 dBA means the sound level equaled or exceeded 60 dBA for 15 minutes during that hour.

For reference, Table 3.9-1 shows sound levels for some common noise sources and compares their relative loudness to that of an 80-dBA source such as a garbage disposal or food blender.

3.9.3 Noise and Vibration Criteria

This subsection describes the noise standards and regulations used for evaluation of potential impacts associated with the Pogo Mine project. Several regulations and ordinances were examined and used to derive the project impact criteria. Sources included the Federal Highway Administration (FHWA), EPA, the U.S. Bureau of Mines (BOM), and the US Department of Transportation (USDOT). Details and general information on the individual noise and vibration criteria are contained in Appendix A.2.

The severity of noise impacts will be determined by the project-related increase over the existing average ambient noise level and the project-related energy average hourly noise level (L_{eq}), at each representative receiver location. As previously stated, human sensitivity to changes in noise levels will vary depending on certain conditions. Normally, the smallest change in ambient (broadband) noise levels that a human ear can perceive is approximately 3 dBA. Increases of 5 to 7 dBA are usually noticeable to most people, and a 10-dBA change is judged by most people as a doubling of the sound level. Given this information, the measured existing noise levels, and information from the EPA and BOM, the impact criteria used to determine significance for the Pogo project are given in Table 3.9-2.

In addition to the criteria given in Table 3.9-2, noise-sensitive receivers along haul routes that exceed the FHWA residential impact criteria of 67 dBA were considered to have a high traffic noise impact. Details on the traffic noise criteria are given in Appendix A-2.

There are no existing vibration criteria applicable to the proposed project. Estimates of expected vibration levels are used because vibration readings are dependent on the source of vibration, the transmitting medium, and distance from the vibration source. For the purpose of this analysis, vibration impacts included those that may interrupt normal living or working conditions at sensitive receptors located close to the facility and those that may cause structural damage to nearby buildings or environment. Table 3.9-3 contains the criteria used to evaluate potential vibration impacts.

3.9.4 Project Area Land Use

Land use within a 50-mile radius of the Pogo Mine site was investigated for land use sensitivity to noise and vibration. The large 50-mile radius was used to include access route options to the proposed mine location. Land use in the study area includes residential, commercial, light and heavy industrial, and undeveloped lands. The majority of residential land use in the study area occurs near the Richardson Highway, between Big Delta and Delta Junction, with several residential uses along Shaw Creek Road. Other noise-sensitive land uses include numerous cabins near the Goodpaster Winter Road and in the vicinity of Quartz Lake, and multiple recreational areas located throughout the project area.

Table 3.9-1 Sound Levels and Relative Loudness of Typical Noise Sources Found in Indoor and Outdoor Environments

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage, Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Garbage disposal, food blender (2 ft), pneumatic drill (50 ft)	80	Moderately loud	Reference loudness
Vacuum cleaner (10 ft) Passenger car at 65 mph (25 ft)	70		1/2 as loud
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room, bird calls	40	Moderately quiet	1/16 as loud
Typical wilderness areas	35		
Quiet library, soft whisper (15 ft)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Sources: Beranek (1988) and EPA (1971a)

Table 3.9-2 Levels of Noise Impacts

Low Impact	Moderate Impact	High Impact
No noise-sensitive sites are located in the project area, or the increase in noise levels with project implementation is projected to be less than 5 dBA at noise-sensitive sites and the overall project related hourly average noise level does not exceed 50 dBA L_{eq}.	Increases in noise levels with project implementation are expected to be between 5 dBA and 10 dBA, and the overall project-related hourly average noise level does not exceed 50 dBA L_{eq}. Determination of level of impact considers existing noise levels and the presence of noise-sensitive sites.	Project activity would cause an increase in existing noise levels of 10 or more dBA, and overall project-related hourly average noise levels exceed 50 dBA L_{eq}. Determination of level of impact considers existing noise levels and the presence of noise-sensitive sites.

Table 3.9-3 Levels of Vibration Impacts

Low Impact	Moderate Impact	High Impact
No vibration-sensitive sites are located in the project area, or the increase in vibration levels with implementation of the project remains at or below 0.5 in./sec at vibration-sensitive sites.	Increases in vibration levels during blasting are between 0.5 in./sec and 2.0 in./sec. Determination of significance also will consider existing noise levels and the presence of noise-sensitive sites.	Proposed project would cause an increase in the vibration levels during blasting of 2.0 in./sec or greater.

3.9.5 Ambient Noise Levels

Ambient noise levels in the project area were projected for areas with noise sensitivity using measured noise data from similar areas. The measured data was taken from the Ft. Knox and True North mine projects at several locations near Cleary Summit and the Olnes Subdivision, northeast of Fairbanks (CH2M Hill, 1993; Minor & Associates, 2000). The Ryan Lode data was measured near the town of Ester, just west of Fairbanks (Minor & Associates, 1998). In addition, traffic volume information from ADOT/PF was used to project traffic noise levels in the existing noise environment. Finally, information contained in EPA guidance (1971b) was used to verify the projected ambient noise levels.

For the purpose of describing the existing ambient noise environment, several areas with noise sensitivity that could be affected by the project were identified. For each of the identified areas, ambient noise levels were projected. The noise sensitive areas were:

- Shaw Creek Road, Shaw Creek Lodge, and vicinity
- Big Delta and vicinity
- Quartz Lake Recreational area and vicinity
- Delta Junction and vicinity
- Goodpaster Winter Trail to Goodpaster River Crossing and vicinity
- Goodpaster River between Pogo and Liese creeks at the mine site
- Richardson Highway for areas not covered above

For each of these areas, noise levels and existing noise sources were identified from on-site inspections, land use information, and a general understanding of the activities in the given areas. Major noise sources common to most areas 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 US Air Force training missions, and heavy truck traffic on the Richardson Highway.

Noise levels from these sources can vary greatly, depending on the location of the receiver relative to the noise source. For example, maximum pass-by noise levels from heavy trucks along the Richardson Highway could reach 86 dBA at 50 ft from the highway. Noise levels at residences, however, will vary depending on their proximity to the highway and the level of shielding, if any, between the highway and the residence. Maximum fly-over noise levels from aircraft and helicopters, which will continue to be the highest instantaneous noise source, can vary from 106 to 131 dBA L_{max} at 100 ft above ground level. It should be noted, however, that the maximum noise levels only occur for a short time, and therefore raise the average ambient hourly L_{eq} very minimally.

Other noise sources include passenger vehicle traffic and miscellaneous residential, recreational and commercial activities, including chain saws, generators, and occasional small weapons firing. Noise related to ongoing mining exploration and other industrial activities is also expected to be noticeable in some locations. Other less noticeable sources include wind; wildlife, such as birds; and water noise near moving creeks and rivers. The following sections provide details on the projected ambient noise levels and existing noise sources.

Shaw Creek and Vicinity

Noise levels during summer months are dominated by traffic noise from the Richardson Highway, local access traffic, and occasional aircraft overflights. Other noise sources include residential and recreational activities. During winter months, major noise sources also include a significant level of snow machine activity. Noise levels during summer are projected to range from 32 to 50 dBA L_{eq}. Winter noise levels are projected at 27 to 40 dBA L_{eq}. Table 3.9-4 contains the range of noise levels projected for this area during summer and winter months for daytime and nighttime hours.

Table 3.9-4 Ambient Noise Levels for Shaw Creek and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Rural Area	Near Highway	Rural Area	Near Highway
Winter Months[3]	32-35	37-40	27-31	31-35
Summer Months[3]	35-37	45-50	32-35	37-40

1 Data derived from on-site noise monitoring in the Olnes Subdivision and similar areas and from the EPA (1971a).
2 Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
3 For the analysis, summer is April through August, and winter is September through May.

Quartz Lake and Vicinity

Quartz Lake is located approximately 3 miles from the Richardson Highway. Major noise sources in the area include recreational activities and aircraft. ATVs and snow machines also are expected in this area as part of general recreation and mine exploration. Highway noise may be audible at times, depending on the location and level of traffic. Noise levels are projected to be highest in the southwestern sections of the lake due to noise from the Richardson Highway. Ambient noise levels are projected at 29 to 45 dBA L_{eq} on the side of the lake closest to the highway, and 27 to 43 dBA on the side of the lake away from the highway. Table 3.9-5 provides a summary of projected ambient noise levels for the Quartz Lake area.

Table 3.9-5 Ambient Noise Levels for Quartz Lake and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Southern Area	Northern Area	Southern Area	Northern Area
Winter Months[3]	35-38	32-35	29-32	27-31
Summer Months[3]	42-45	40-43	35-37	32-35

1 Data derived from on-site noise monitoring near Chena Hot Springs, in the Olnes Subdivision and similar areas, and from the EPA (1971a).
2 Daytime is defined as 7am to 10pm, and nighttime as 10pm to 7am.
3 For the analysis, summer is April through August, and winter is September through May.

Big Delta and Vicinity

Big Delta is located on the Richardson Highways, and traffic noise from the highway is expected to be the dominant noise source in the area. Other noise sources include local access traffic, some commercial and residential activities, and aircraft overflights. Winter noise levels are projected to range from 33 dBA L_{eq} in rural areas, to 51 dBA L_{eq} for structures located near the Richardson Highway. Noise levels during the summer months are projected at 35 to 55 dBA L_{eq}. Table 3.9-6 contains an ambient noise summary for the Big Delta and surrounding area.

Table 3.9-6 Ambient Noise Levels for Big Delta and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Rural Area	Near Highway	Rural Area	Near Highway
Winter Months[3]	41-43	46-51	33-35	40-45
Summer Months[3]	45-47	50-55	35-37	42-47

1 Data derived from on-site noise monitoring in the community of Ester and from the EPA (1971a).
2 Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
3 For the analysis, summer is April through August, and winter is September through May.

Delta Junction and Vicinity

Delta Junction is located at the junction of the Richardson and Alaska highways. Major noise sources near Delta Junction include traffic on the Richardson and Alaska highways, aircraft from Allen Air Force Base and the local airport, and commercial, industrial, and residential activities. Structures located near the main highways are projected to have noise levels ranging from 48 to 61 dBA L_{eq}. For structures located in rural areas, away from the highways, noise levels are projected at 32 to 45 dBA. Table 3.9-7 provides a summary of projected ambient noise levels for the Delta Junction area.

Table 3.9-7 Ambient Noise Levels for Delta Junction and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Rural Area	Near Highway	Rural Area	Near Highway
Winter Months[3]	39-43	53-57	32-37	48-53
Summer Months[3]	42-45	56-61	35-40	50-55

1 Data derived from on-site noise monitoring in Ester, northern Fairbanks, and from the EPA (1971a).
2 Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
3 For the analysis, summer is April through August, and winter is September through May.

Goodpaster Winter Trail

Main noise sources include recreational activities, including some motorized vehicles, such as ATVs and outboard motors in the summer and snow machines in the winter. Winter noise levels are projected to range from 27 to 35 dBA L_{eq}, with summer months ranging from 30 to 37 dBA L_{eq}. Table 3.9-8 provides a summary of expected maximum and minimum noise levels for the summer and winter months.

Table 3.9-8 Ambient Noise Levels for Goodpaster Winter Road and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Min	Max	Min	Max
Winter Months[3]	30	33	27	35
Summer Months[3]	32	37	30	37

[1] Data derived from on-site noise monitoring in the Olnes Subdivision and the Ft. Knox area before the mine was constructed and information from the EPA (1971a)
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

Goodpaster River (near Pogo Creek)

The sound levels of the main noise sources for the Goodpaster River between Pogo and Liese creeks near the proposed Pogo Mine site are low, particularly during summer. They consist of recreational activities, including some motorized vehicles such as ATVs and outboard motors in the summer and snow machines in the winter. Winter noise levels are expected to be similar to those for the Goodpaster Winter Road, and are projected to range from 27 to 35 dBA L_{eq}. Noise levels in the summer months are projected to range from 32 to 42 dBA L_{eq} due to increased recreational activity and noise related to the river. Table 3.9-9 provides a summary of expected maximum and minimum noise levels for the summer and winter months.

Table 3.9-9 Ambient Noise Levels for Goodpaster River near Pogo Creek[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Min	Max	Min	Max
Winter Months[3]	30	33	27	35
Summer Months[3]	34	42	32	39

[1] Data derived from on-site noise monitoring in the Olnes Subdivision and the Ft Knox area before the mine was constructed and information from the EPA (1971a).
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

Richardson Highway (General Area within 300 feet)

For those areas not covered above and located close to the Richardson Highway, additional noise level projections were preformed. The noise levels presented in Table 3.9-10 are for structures located within 300 ft of the Richardson Highway. This area includes any residents or other land uses between Big Gulch and Delta Junction and locations north of Big Delta. Noise levels are presented for structures located less than 150 ft and between 150 and 300 ft from the Highway. Actual noise levels will depend on the topography and shielding between the roadway and receiver location.

Table 3.9-10 Richardson Highway Ambient Noise Levels for Shaw Creek Vicinity[1]

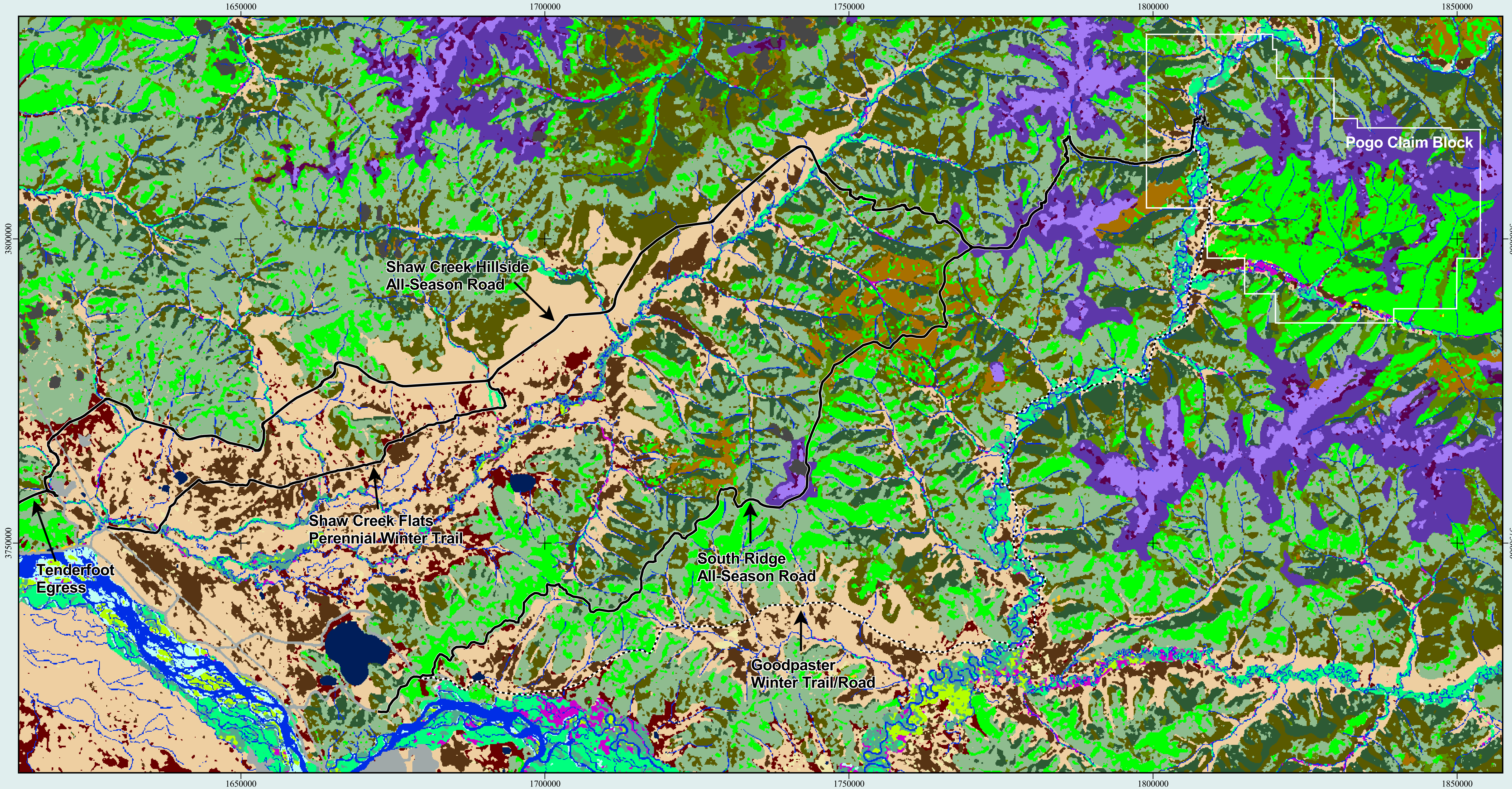
Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	50 to 150 ft	150 to 300 ft	50 to 150ft	150 to 300 ft
Winter Months[3]	56-61	49-56	45-50	38-45
Summer Months[3]	58-63	51-58	47-52	40-47

[1] Data derived from on-site noise monitoring along the Richardson, Elliot, and Steese highways.
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

3.10 Vegetation

Vegetation in the overall project area was mapped for purposes of identifying wildlife habitats (ABR, 2000). This habitat classification incorporated physiographic characteristics (riverine, lowland, upland, subalpine, alpine) and vegetation types. Figure 3.10-1 shows wildlife habitats, including vegetation types, throughout the project area. Table 3.10-1 describes the habitat types and shows their percentage cover in the project area.

Vegetation has been mapped in more detail, using a somewhat different system, in most of the Pogo claim area and along access corridors (Three Parameters Plus, 2000a, 2000b; ABR, 2001). These maps may be viewed on the EIS project web site (www.pogomineeis.com). The most abundant habitats in the project area are needleleaf forests, broadleaf forests, mixed broad- and needleleaf forests, and shrub thickets dominated by scrub-form birch (*Betula glandulosa*, or hybrids of *B. glandulosa* and *B. papyrifera*) (Three Parameters Plus, 2000b; ABR, 2001). Vegetation in the project area is highly influenced by wildfire, with tall broadleaf shrub and broadleaf forest communities representing early and mid-successional stages after fire (ABR, 2000).



Wildlife Habitat Classes

Alpine Meadow	Upland Mixed Forest	Riverine Barrens
Alpine Dwarf Scrub	Upland Needleleaf Forest	Riverine Scrub
Subalpine Needleleaf Woodland	Upland North-facing Needleleaf Forest	Riverine Broadleaf Forest
Cliff	Lowland Meadow	Riverine Mixed Forest
Bluff Meadow	Lowland Low Scrub	Riverine Needleleaf Forest
Upland Tall Scrub	Lowland Broadleaf Forest	Rivers and Streams
Upland Needleleaf Woodland	Lowland Needleleaf Forest	Cloud and Shadow
Upland Broadleaf Forest	Lakes and Ponds	Human Modified

N W E S

2 0 2 4 6 8 Km
1 0 1 2 3 4 5 Mi

Supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.10-1
Project Area Vegetation/
Wildlife Habitat Classes

ABR inc. *environmental research & services*

25 July 2002 | ABR File: Pogo_PDEIS_Ch3_Habs.apr

Table 3.10-1 Descriptions of Project Area Habitat Classes

Ecotype Class	Description
Alpine Meadow	Wet to moist alpine areas on flats and gentle slopes dominated by sedges with an understory of dwarf or low shrubs. Organic accumulation generally is thin and rock is close to the surface. Vegetation is dominated by sedges (*Carex bigelowii, C. aquatilis*) and shrubs (*Dryas octopetala, Vaccinium uliginosum, Salix reticulata, S. planifolia, Arctostaphylos alpina*).
Alpine Dwarf Scrub	Dry, excessively drained, rocky soils above treeline on weathered bedrock dominated by dwarf shrubs. Permafrost is common at high elevations and north-facing slopes. Vegetation is dominated by dwarf shrubs (*Dryas octopetala, Salix arctica, Arctostaphylos alpina*) and includes sedges (*Carex bigelowii*), numerous forbs, and abundant lichens (*Cladina* spp.). Class includes alpine rocky barrens and partially vegetated areas.
Subalpine Needleleaf Woodland	Alpine to subalpine areas in the vicinity of treeline with a canopy composed of low and tall shrubs and scattered trees. Moist, rocky soils have thin to moderately thick organic horizons, are excessively to well-drained, and are associated with weathered bedrock. Permafrost status is uncertain. Vegetation is dominated by shrubs (*Alnus crispa*, *Betula nana, Salix planifolia, Ledum decumbens, L. groenlandicum, Vaccinium uliginosum, V. vitis-idaea*), sedges (*Carex bigelowii*), and mosses (*Hylocomium splendens, Aulacomnium turgidum*). The scattered spruce (*Picea glauca* and *P. mariana)* often are stunted.
Cliff	Partially vegetated or barren, steep, rocky outcrops. Cliffs are found along river valleys and very steep upper slopes. Isolated outcrops and tors also are included in this class.
Bluff Meadow	Dry, steep, south-facing bluffs that support grasses, forbs, and shrubs. Soils generally have a high fraction of angular fractured bedrock, although some have a moderate accumulation of loess. Drainage is good to excessive, and permafrost is absent. Common species include woody plants (*Artemisia frigida, Juniperus communis, Populus tremuloides),* grasses *(Elymus innovatus, Calamagrostis purpurascens)*, mosses *(Rhytidium rugosum)*, and lichens.
Upland Tall Scrub	Early successional upland areas with vegetation dominated by tall shrubs and broadleaf saplings. Moist, rocky to loamy soils are well-drained, have very thin organic horizons, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. This post-burn stage is dominated by *Betula papyrifera* or *P. tremuloides* saplings and *Alnus crispa* or *Salix* spp. shrub thickets Other plants include grasses (*Calamagrostis canadensis)*, forbs (*Epilobium angustifolium)*, and the moss *Polytrichum juniperinum*.
Upland Needleleaf Woodland	Upland areas on slopes and plateaus underlain by loess and thin residual soils. Vegetation is dominated by low and tall shrubs with scattered mature trees. Permafrost status is uncertain. Common shrub species include *Betula nana, Alnus crispa, Vaccinium uliginosum, Ledum groenlandicum*, and *V. vitis-idaea*. Trees present include *Picea glauca* and *P. mariana*.
Upland Broadleaf Forest	Moist, well-drained, unfrozen sites with thin to moderate loess deposits on upland slopes. The open to closed forest canopy has *Betula papyrifera* or *Populus tremuloides,* young spruce trees *(Picea glauca, P. marina),* and shrubs *(Alnus crispa, Viburnum edule, Rosa acicularis, Empetrum nigrum)* and grasses (*Calamagrostis canadensis*) in the understory. Trees can vary from small saplings to old, mature trees.
Upland Mixed Forest	Moist, well-drained soils on upland loess, dunes, and residual soil deposits that support an overstory dominated by a mixture of broadleaf and needleleaf trees. Permafrost may be present on north-facing slopes. Dominant species include *Picea glauca*, *P. mariana*, *Betula papyrifera*, *Populus tremuloides, Alnus crispa, Cornus canadensis, Geocaulon lividum, Linnaea borealis,* and *Vaccinium vitis-idaea*.
Upland Needleleaf Forest	Well-drained upland forests dominated by an open canopy of *Picea glauca* or *P. mariana,* ericaceous shrubs, and the moss *Hylocomium splendens*. Soils are unfrozen, have shallow organic horizons, and occur on residual soils and loess. Common understory species include *Alnus crispa, Betula nana, Ledum groenlandicum, Vaccinium uliginosum,* and *Geocaulon lividum*.

Table 3.10-1 Descriptions of Project Area Habitat Classes

Ecotype Class	Description
Upland North-facing Needleleaf Forest	Steep north-facing slopes with needleleaf forests. Soils vary from unfrozen, well-drained, moist rocky soils to frozen, wet, thick organic soils. The open to closed tree canopy is dominated by *Picea mariana,* and the understory includes *Salix planifolia*, *Betula nana, Rubus chamaemorus, Hylocomium splendens, Sphagnum* spp., and *Pleurozium schreberi*.
Lowland Meadow	Depressions and pond margins on lowland flats dominated by sedges and grasses. Organic layer is thin to thick and is underlain by lowland loess or riverine silts. Included in this class are in-filling or drained ponds, pond edges, abandoned river channels, and shrub-poor sedge–moss bogs. Dominant species in wetter sites include *Carex aquatilis, C. rostrata, Eriophorum angustifolium, Typha latifolia,* and *Scirpus validus; Sphagnum* mosses are common in bog sites. Moist sites generally are dominated by *Calamagrostis canadensis*.
Lowland Low Scrub	Lowland areas with vegetation dominated by low shrubs. Wet, loamy to organic soils are poorly drained and underlain by permafrost. The open to closed canopy of low shrubs is dominated by *Betula nana*, ericaceous shrubs (*Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea, Chamaedaphne calyculata*), and up to 25% *Picea mariana* or *Larix laricina* (larch). Tussocks (*Eriophorum vaginatum*) may be common. Other plants include *Salix planifolia, Rubus chamaemorus, Hylocomium splendens*, and *Sphagnum* spp.
Lowland Broadleaf Forest	Lowland areas dominated by broadleaf trees. Moist to wet, loamy to organic soils are somewhat poorly drained, have moderately thick to very thick organic horizons, and are underlain by permafrost. The open to closed overstory is dominated by *Betula papyrifera*, although *Picea glauca* and *P. mariana* often are present in the understory. Other plants include *Alnus* spp., *Rosa acicularis*, *Calamagrostis canadensis*, and *Equisetum arvense.* Lowland tall shrub communities, dominated by open to closed thickets of *Alnus* or *Salix* spp. are included in this class.
Lowland Needleleaf Forest	Lowland areas dominated by needleleaf forest. Soils are sandy–loamy to organic, usually frozen, and commonly found on bogs, abandoned floodplains, and gentle slopes. The open to closed forest canopy is dominated by *Picea marina.* Wet, organic sites have ericaceous shrubs (*Salix planifolia*, *Betula nana, Rubus chamaemorus, Hylocomium splendens, Sphagnum* spp., and *Pleurozium schreberi)*. Better drained, sandy sites have *Ledum groenlandicum, Vaccinium vitis-idaea, Pentaphylloides floribunda,* and *Hylocomium splendens.* Lowland mixed forest is included in this class, and the canopy includes more *Betula papyrifera*.
Lakes and Ponds	Lacustrine water bodies with or without emergent or floating vegetation. Lakes are found associated with thaw basins and depressions underlain by bedrock. Common plants include *Potamogeton alpinus, P. foliosus, P. gramineus, Nuphar polysepalum,* and *Isoëtes muricata.*
Riverine Barrens	Unvegetated or partially vegetated (<30% cover) river bars that are flooded frequently. Colonizing species include *Salix alaxensis*, *S. interior*, and *Equisetum arvense*.
Riverine Scrub	Early successional communities on well-drained, gravelly soils on active or inactive floodplains. Common plants are low and tall shrubs *(Salix alaxensis, S. arbusculoides, S. bebbiana, S. planifolia, Alnus tenuifolia),* balsam poplar (*Populus balsamifera),* saplings, and forbs (*E. arvense*) and grasses (*Calamagrostis canadensis*).
Riverine Broadleaf Forest	Riverine areas with moist, loamy to gravelly soils and vegetation dominated by broadleaf trees. Canopy is composed of open to closed *Populus balsamifera* or *Betula papyrifera* forests with *Picea glauca, Alnus tenuifolia, Calamagrostis canadensis, Fragaria virginiana,* and *Equisetum arvense* in the understory.
Riverine Mixed Forest	Riverine areas with moist, loamy soils and vegetation dominated by needleleaf and broadleaf trees. The well-drained soils have thin organic horizons interbedded with loamy sediment The forest has a closed canopy of *Picea glauca* and *Populus balsamifera*, although *P. glauca–Betula papyrifera* stands also occur. The understory is a mixture of species found in broadleaf and needleleaf riverine forests.

Table 3.10-1 Descriptions of Project Area Habitat Classes

Ecotype Class	Description
Riverine Needleleaf Forest	*Picea glauca* forests on inactive floodplains. Soils are well- to excessively drained with thin organic horizons over interbedded silt and sands and river gravels. Associated species include *Rosa acicularis, Cornus canadensis, Geocaulon lividum, Rhytidiadelphus triquetrus,* and *Hylocomium splendens.*
Rivers and Streams	Glacial and nonglacial rivers that include headwater, braided, and meandering morphologies. In larger rivers, water flows throughout the year in deep channels.
Cloud and Shadow	Areas obscured by clouds and shadow and thus have not been assigned a habitat class. This class includes a small area of steep north-facing slope.
Human Modified	Vegetated and barren areas that have been cleared for human use. Modification includes agriculture, groups of structures, transportation ROWs, and nonvegetated clearings

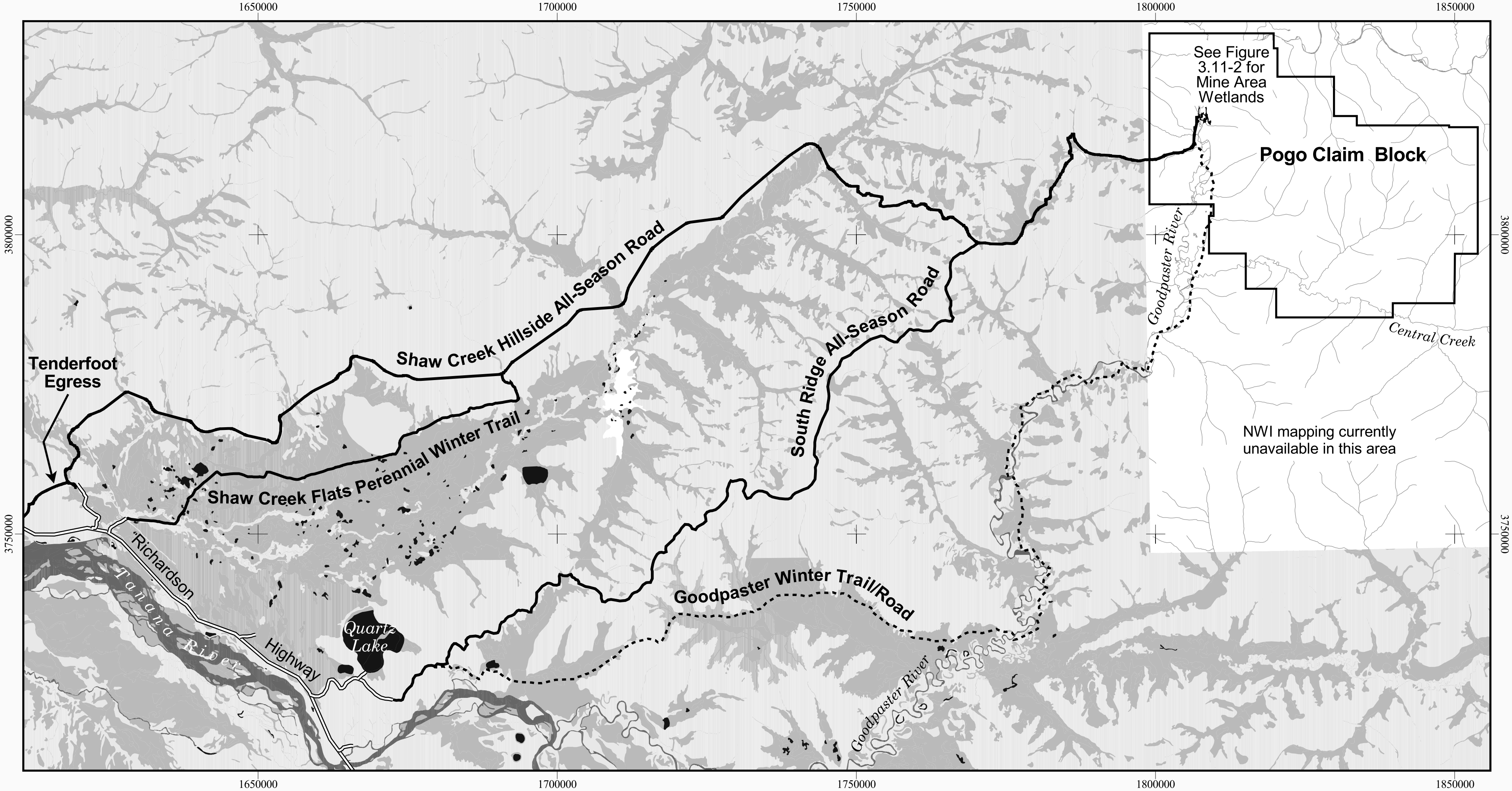
3.11 Wetlands

Wetlands are defined as, "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions..." [33 CFR 328.3(b)]. It is important to note that the wetland sections of this document focus only on wetlands and not all other waters such as ponds, lakes, and rivers. While those other waters are occasionally referenced in the wetland sections to aid federal agencies in considering areas under their jurisdiction, readers should refer to the surface water hydrology section for details. Discussion of wetlands is necessarily multidisciplinary. More detailed discussions of many aspects of wetlands can be found in other sections in this EIS that address hydrology, water quality, biological resources, and human uses of the land.

3.11.1 Wetland Extent and Locations

Detailed wetland mapping has been prepared for part of the Pogo claim block, the two all-season road option corridors, and the Shaw Creek winter road corridor (Three Parameters Plus, 2000a; 2000b; 2001b; 2002b, c, d, e). Some maps may be viewed on the project web site (pogomineeis.com), and more detailed maps may be viewed at the ADNR office in Fairbanks, the COE office in Anchorage, and the Teck-Pogo Inc. office in Fairbanks. Figure 3.11-1 shows a general map of wetlands in the vicinity of the access corridors southwest of the proposed mine site. Figure 3.11-2 shows locations of wetlands in the vicinity of the proposed mine site. The area shown in this figure represents approximately the north half of the Pogo claim block for which wetland mapping was completed.

The detailed mapping of the claim block and all-season access corridors shows that wetlands are widespread in the project area. Many occur in intricate mosaics with uplands. Wetlands predominate on lowlands adjacent to and on the historical floodplain of the Goodpaster River, on foot slopes, valley bottoms, north-facing slopes and bowls, lower parts of watersheds, abandoned channels and oxbows of the Goodpaster River, and some high-elevation plateaus.



Legend

Wetland Type:

(polygons from USFWS 1:63,360 NWI mapping)

River
Lake/Pond
Wetland
Upland
Unknown

Stream (from USGS 1:63,360 DLG)

N W E S

2 0 2 4 6 8 10 Kilometers

1 0 1 2 3 4 5 6 Miles

Streams in claim block area from USGS 1:63,360 dlg
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

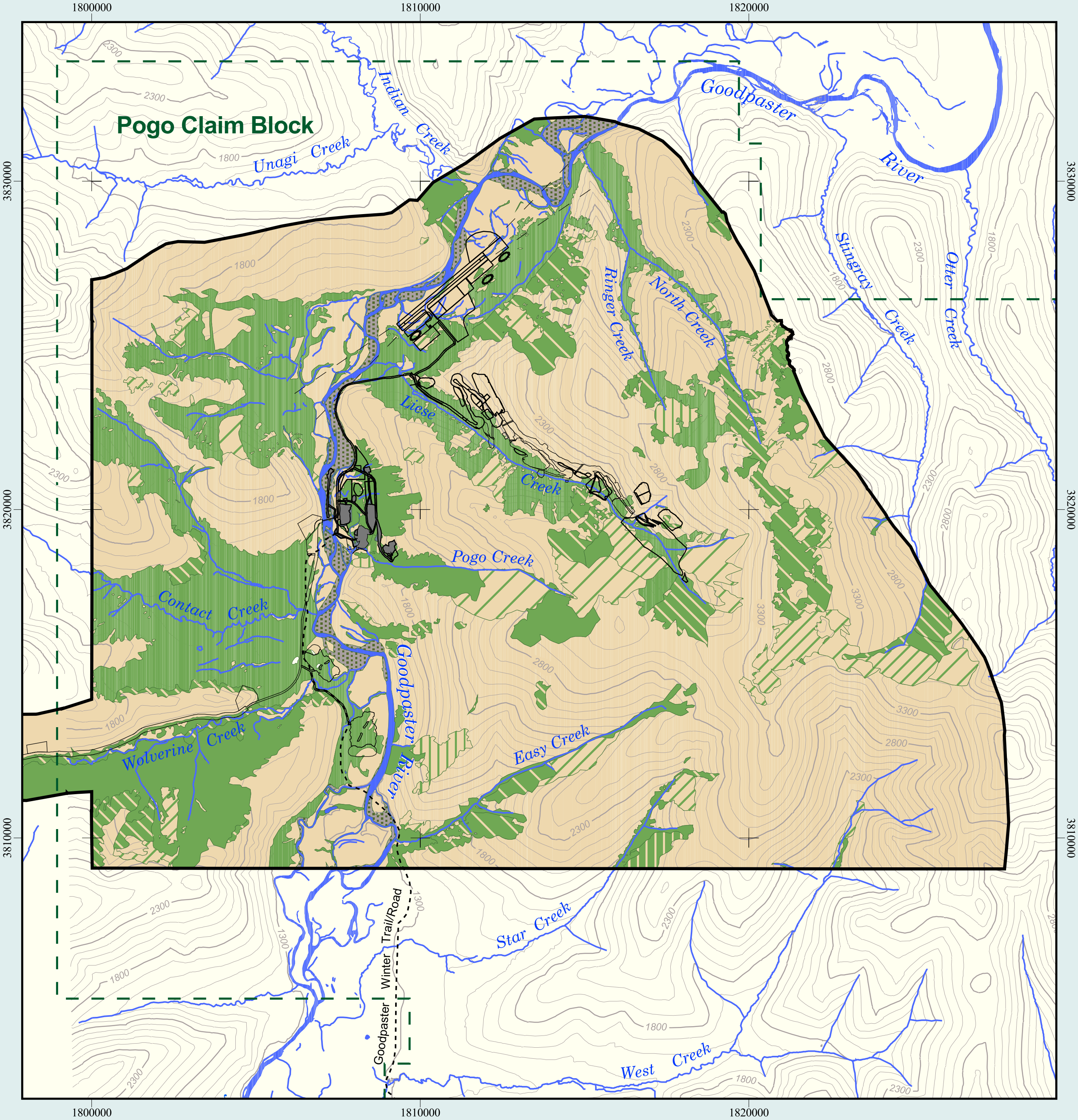
Pogo Mine EIS

Figure 3.11-1
Mapped Project Area Wetlands

map prepared by:
ABR inc
environmental research & services

26 July 2002

ABR File: Pogo_PDEIS_Ch3_Wetlands.apr



0.5 0 0.5 1 1.5 Kilometers

0.25 0 0.25 0.5 0.75 1 Miles

N E S W

Contours and original hydrography by AeroMap U.S., Inc., 1997
Contour interval: 100 feet
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83; Grid: 10,000 feet

Legend

Wetlands

- Upland with up to 10 percent small wetland inclusions
- Upland with up to 25 percent small wetland inclusions
- Upland with up to 40 percent small wetland inclusions
- Wetlands
- Wetland with up to 10 percent small upland inclusions
- Wetland with up to 25 percent small upland inclusions
- Wetland with up to 40 percent small upland inclusions

Other Waterbodies

- Stream, River, Pond
- River Gravel Bar
- Study Area Boundary
- Areas of Proposed Mine Development (Soil Absorption System Option)
- Existing Disturbance
- Uplands

Source: Three Parameters Plus (2002f).

Pogo Mine EIS

Figure 3.11-2
Mine Area Wetlands

map prepared by:
ABR inc. environmental research & services

28 Jan 2003 | ABR File: Pogo_DEIS_Ch3_Wetlands.apr

Table 3-11.1 shows the proportion of the proposed mine vicinity and access corridors that are wetlands (Three Parameters Plus, 2002a). It also includes, under the heading "Other potential waters of the U.S.," the acreage of lakes and ponds, broad rivers, and gravel bars. The area covered by small streams is included within the wetland acreages shown below because they are too narrow to be mapped as distinct polygons. Table 3.5-1 shows the major nonwetland "waters of the U.S." regulated by the federal government. The mapped areas for the various access corridors overlap.

Vegetation types and some landscape positions most often associated with wetlands in the project area include open black spruce forests, medium-height shrub thickets on north-facing slopes or in low-lying or concave areas, open black and white spruce forests on lowlands and alluvial areas, alpine wet sedge meadows, willow thickets, tussock sedge meadows, and depressions supporting emergent aquatic herbs.

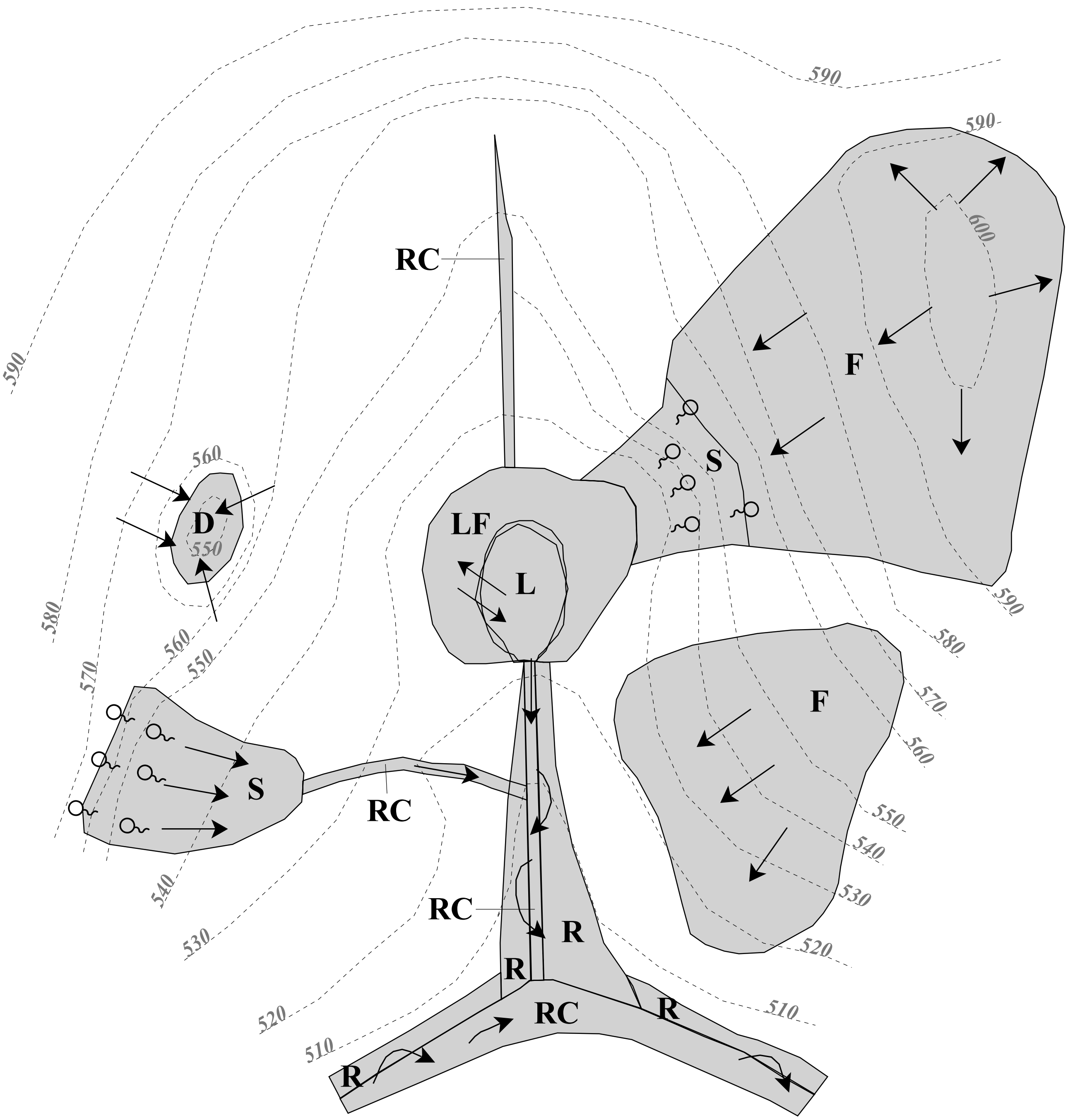
Typical soils found in wetlands include Pergelic Cryaquepts, Histic Pergelic Cryaquepts, Dysic Pergelic Sphagnofibrists, Pergelic Cryohemists, Pergelic Cryofluvents, Aeric Cryaquepts, Typic Cryofluvents, Typic Cryofibrists, Pergelic Cryofibrists, and Lithic Cryaquepts.

Wetland soils were either saturated with water when observed or their physical characteristics indicated saturation or flooding for at least part of the growing season in most years. Other indicators of wetland hydrology were ice-rich permafrost under a thick, moist, or saturated moss mat; seeps; tussocks, hummocks, or swales; and low-lying or depressional topography (Three Parameters Plus 2000a; 2001a).

3.11.2 Wetland Functions

Wetlands perform ecological functions, some of which are unique to wetlands. Some wetlands are valued by human society for the ecological functions they perform. For example, wetlands are recognized as protecting water quality, producing organic matter that supports aquatic and terrestrial food webs, moderating stream flows by maintaining base flows and storing water during storm runoff events, supporting wildlife and human uses of wildlife, and recharging water to aquifers.

For this discussion of wetland functions, terms of the hydrogeomorphic system of wetland classification and assessment are used. The hydrogeomorphic (HGM) approach to wetland assessment assumes that a wetland's functions in the ecosystem are largely dependent on its geomorphic setting and the dynamics of its hydrologic system. That is, wetlands in the same HGM class—in similar landscape positions and with similar characteristics of water movement to, through, and from them—likely have similar ecological functions. HGM wetland types are described by Brinson (1993) and Magee and Hollands (1998). The types potentially affected by the Pogo project are discussed below. One other type—lake fringes—is very limited in the project area, would not be affected by the project, and thus is not discussed further, although its acreage in the study area is presented. Figure 3.11-3 depicts the landform and dominant water movement of the wetland types potentially affected by the project.



Legend

- Topographic Contour
- Direction of Surface Flow
- Site of Groundwater Discharge
- Wetland

S Slope Wetland
D Depressional Wetland
F Flat Wetland
LF Lacustrine Fringe Wetland
L Lacustrine Wetland
R Riverine Wetland
RC River Channel

Source: Adapted from D. Magee and G. Hollands. 1998.
A Rapid Procedure for Assessing Wetland Functional Capacity.

Pogo Mine EIS

Figure 3.11-3
Conceptual Hydrogeomorphic
Wetland Types

HDR Alaska — map prepared by: ABR Inc

18 July 2002 | ABR File: Pogo_PDEIS_Ch3_Wetlands.apr

Table 3.11-1 Percentages of Wetlands Within Mapped Area

Mapped Area	Area Mapped (ac)	Estimated Wetland Area (ac)[1]
Mine Area[2]		
Upland with <10% wetland inclusions	355	35
Upland with 10-25% wetland inclusions	315	79
Upland with 25-40% wetland inclusions	62	25
Wetland with 25-40% upland inclusions	49	30
Wetland with 10-25% upland inclusions	285	213
Wetland with <10% upland inclusions	479	431
Wetland	2,801	2,801
Total Estimated Wetland Area		**3,614**
Other potential waters of the U.S.		
-ponds	5	0
-gravel bars	172	
-broad rivers	118	
Other upland and disturbed areas	7,567	0
Total Area Mapped	**12,208**	**3,614** (30% of mine study area)
Shaw Creek Hillside All-Season Road Corridor[3]		
Upland with <10% wetland inclusions	1,835	184
Upland with 10-25% wetland inclusions	801	200
Upland with 25-40% wetland inclusions	51	20
Wetland with 25-40% upland inclusions	85	51
Wetland with 10-25% upland inclusions	917	688
Wetland with <10% upland inclusions	594	535
Wetland	4,921	4,921
Total Estimated Wetland Area		**6,599**
Other potential waters of the U.S.		
-ponds	111	0
-gravel bars	348	
-broad rivers	312	
Other upland and disturbed areas	13,508	0
Total Area Mapped	**23,484**	**6,599** (28% of road corridor mapped area)
South Ridge All-Season Road Corridor[3]		
Upland with <10% wetland inclusions	2,867	287
Upland with 10-25% wetland inclusions	934	233
Upland with 25-40% wetland inclusions	26	10
Wetland with 25-40% upland inclusions	86	52
Wetland with 10-25% upland inclusions	503	377
Wetland with <10% upland inclusions	453	407
Wetland	1,320	1,320
Total Estimated Wetland Area		**2,686**
Other potential waters of the U.S.		
-ponds	6	0
-gravel bars	0	
-broad rivers	601	
Other upland and disturbed areas	11,054	0
Total Area Mapped	**17,850**	2,686 **(15% of road corridor mapped area)**
Shaw Creek Flats Winter Only Access Corridor[3]		
Upland with <10% wetland inclusions	1,756	176
Upland with 10-25% wetland inclusions	942	236
Upland with 25-40% wetland inclusions	283	113
Wetland with 25-40% upland inclusions	107	64

Table 3.11-1 Percentages of Wetlands Within Mapped Area

Mapped Area	Area Mapped (ac)	Estimated Wetland Area (ac)[1]
Wetland with 10-25% upland inclusions	968	726
Wetland with <10% upland inclusions	1,141	1,027
Wetland	6,798	6,798
Total Estimated Wetland Area		**9,139**
Other potential waters of the U.S.		
-ponds	128	0
-gravel bars	317	
-broad rivers	266	
Other upland and disturbed areas	11,433	0
Total Area Mapped	**24,140**	9,139 **(38% of road corridor mapped area)**

1 Area mapped times maximum estimated percent wetland.
2 The "Mine Area" includes the area shown in Figure 3.11-2 and approximately 2 miles of the access corridor extending westward from the mine area to where the access route option corridors diverge atop the Shaw Creek and Goodpaster River divide.
3 From beginning near Richardson Highway to where all three access corridors meet atop the Shaw Creek and Goodpaster River divide.

- **Flats** Flats are the most common wetlands in the project area. Their dominant water source is precipitation, and evapotranspiration from them approximately equals precipitation (Three Parameters Plus, 2001b). Water flow through them is generally minor and limited to unusual precipitation circumstances. At the Pogo project area, they are usually found on shallow to steep slopes, but also may occur on lowland flats and hilltop plateaus. Their vegetation is typically open or closed black spruce forest, shrub thickets dominated by dwarf birch, open white and black spruce forest, or it is dominated by sedge tussocks. The flats are generally underlain by permafrost.
- **Slope wetlands** The primary water source of slope wetlands is subsurface water moving to the wetland and discharging at its surface. Slope wetlands may also receive water from precipitation and surface flow. These wetlands typically occur on slopes, but at the Pogo project area they are generally located on relatively level toes of slopes and in lowlands adjacent to smaller streams and drainages (Three Parameters Plus, 2001b). The water movement in slope wetlands is unidirectionally downslope. In the Pogo project area, their vegetation is typically sedge tussocks, emergent herbs, shrub thickets dominated by alder or willow, or open black spruce forest.
- **Depressional wetlands** As the name indicates, these wetlands are located lower than the surrounding landscape. Water moves toward the lowest points of depressions by surface and shallow subsurface flow. Water sources are direct precipitation and overland and groundwater flow. Depressional wetlands may or may not have inlet or outlet channels; those in the project area tend to not have outlets (Moody, 2003). These wetlands are characterized by vertical fluctuations in the water table. This wetland type is scarce in the Pogo project area. Depressional wetlands in the project area are typically shallow open water areas with emergent vegetation and also occur as open black spruce forests in the relic dunes along the northwest side of Shaw Creek.
- **Riverine wetlands** Riverine wetlands occur in valleys along streams and are influenced by fluctuations in stream flows. They may receive water from precipitation, surface or shallow subsurface flows, or overbank flooding of the stream. Surface flow is generally unidirectional toward downstream and, at times of flooding, the water has high energy. Water can also flow over the stream banks, into and out of the wetland. At the Pogo project area, riverine wetlands occupy narrow valley bottoms of the smaller streams and abandoned channels and oxbows of the Goodpaster River.

The vegetation of riverine wetlands is typically open black or white spruce forests or shrub thickets dominated by alder or willow. In this document, gravel bars (vegetated and unvegetated), although technically "waters of the U.S." but not always wetlands, are included within the "riverine" wetlands acreage and discussion. They often support small inclusions of wetlands, and they perform many of the same important functions as do the true wetlands along streams (Three Parameters Plus, 2001b).

Wetland functions for the HGM wetland types found in the project area are identified, discussed, and defined by Magee and Hollands (1998), ADEC/COE (1999), and Brinson et al. (1995). These wetland functions are listed in Table 3.11-2, with an indication whether the wetlands of each HGM class in the Pogo project area are likely to perform that function to any substantial degree. This table is excerpted from a table developed by a team of agency staff and other wetland scientists based on best professional judgment and familiarity with the project area.

The area of each HGM wetland type in the project area is shown in Table 3.11-3 and the percent of the wetland area represented by each of these types is shown in Table 3.11-4 (Three Parameters Plus, 2002a). Although they may not be wetlands in the strict sense, the areas of ponds and gravel bars have been included in both of these tables because they are aquatic sites that perform functions similar to the wetlands of the same HGM types. Broad rivers are not included in the acreages below, and the areas of narrow streams are included with the HGM types or uplands that surround them. Acreages for all the mapped areas cannot be totaled because the access corridor study areas overlap.

Table 3.11-2 Expected Functions of Pogo Project Area Wetlands by Hydrogeomorphic Class

Function	Function Definition	Flats	Slope Wetlands	Depressional Wetlands	Riverine Wetlands
Hydrologic Functions					
Modification of Groundwater Discharge	The capacity of a wetland to influence the amount of water moving from ground water to surface water. [1]	No	Yes	No	No
Modification of Groundwater Recharge	The capacity of a wetland to influence the amount of water moving from surface water to ground water. [1]	No	No	No	No
Modification of Stream Flow	The modification of hydrologic inputs (precipitation, surface water, or groundwater) by detention or retention of water on the wetland surface and in its soil.[1]	Yes	Yes	Yes	Yes
Maintenance of Soil Thermal Regime	The capacity of a wetland to maintain or return to characteristic soil thermal conditions. [3]	Yes	Yes	Yes	No
Biogeochemical Functions					
Export of Detritus	Export of organic detritus from the wetland to adjacent and downstream aquatic ecosystems. [1]	No	Yes	No	Yes

Table 3.11-2 Expected Functions of Pogo Project Area Wetlands by Hydrogeomorphic Class

Function	Function Definition	Flats	Slope Wetlands	Depressional Wetlands	Riverine Wetlands
Modification of Water Quality	Removal of suspended and dissolved solids from surface water and dissolved solids from ground water and retention or conversion into other forms, plant or animal biomass, or gases. [1]	No	Yes	Yes	Yes
Habitat Functions					
Contribution to Abundance and Diversity of Wetland Fauna	The capacity of a wetland to support large and/or diverse populations of animal species that spend part or all of their life cycle in wetlands.[1]	Yes	Yes	Yes	Yes[4]
Contribution to Abundance and Diversity of Wetland Vegetation	The capacity of a wetland to produce an abundance and diversity of hydrophytic plant species, including dead plant biomass of all sizes. [1,2]	Yes	Yes	Yes	Yes

[1] Adapted from Magee and Hollands (1998)
[2] Adapted from Brinson et al. (1995)
[3] ADEC/COE (1999)
[4] Riverine wetlands could directly support fish.

Table 3.11-3 Area of Wetland Hydrogeomorphic Type in Mapped Areas (acres) [1]

Mapped Wetland Type	Mine Area[2]	Shaw Creek Hillside Corridor[3]	South Ridge Corridor[3]	Shaw Creek Winter Route Corridor[3]
Flats	1,150	614	476	738
Flat/Upland Mosaics	730	850	990	1,454
Flat/Slope Mosaics	1,109	3,153	345	4,428
Slope Wetlands	420	1,169	449	1,659
Slope/Upland Mosaics	4	395	357	458
Depressional Wetlands	1	47	0	27
Riverine Wetlands	298	529	26	519
Riverine/Upland Mosaics	80	300	20	298
Lake Fringes	0	0	30	3
Total	3,792	7,058	2,693	9,585

[1] Acreages exclude the portion of each mosaic estimated to be upland. Flat/slope mosaics were assumed to be 50 percent flats and 50 percent slopes.
[2] The "Mine Area" includes the area shown on Figure 3.11-2, and approximately 2 miles of the access corridor extending westward from the mine area to where the access route option corridors diverge atop the Shaw Creek and Goodpaster River divide.
[3] From beginning near Richardson Highway to where access route option corridors meet atop the Shaw Creek and Goodpaster River divide.

Table 3.11-4 Percentage of Each Wetland Hydrogeomorphic Type in Mapped Areas

Mapped Wetland Type	Mine Area[1]	Shaw Creek Hillside Corridor[2]	South Ridge Corridor[2]	Shaw Creek Winter Route Corridor[2]
Flats	64	43	61	46
Slope Wetlands	26	44	36	45
Depressional Wetlands	0	1	0	0
Riverine Wetlands	10	12	2	9
Lake Fringes	0	0	1	0
Total	100	100	100	100

1 The "Mine Area" includes the area shown on Figure 3.11-2, and approximately 2 miles of the access corridor extending westward from the mine area to where the access route option corridors diverge atop the Shaw Creek and Goodpaster River divide.
2 From beginning near Richardson Highway to where access route option corridors meet atop the Shaw Creek and Goodpaster River divide.

3.12 Surface Disturbance

There is relatively little existing surface disturbance in the vicinity of the mine site and along the surface access route options. To date, Pogo exploration activities by the Applicant and a previous claims owner have disturbed approximately 30 acres in the vicinity of the mine.

- Three acres related to surface exploration at the Liese Ridge exploration (upper) camp and for surface drill sites (outside of the proposed mine site footprint)
- Seven acres for the advanced exploration (lower) camp below the 1525 Portal
- Four acres for gravel pits
- Four acres for the airstrip and access roads
- Six acres for the 1525 Portal pad and access road
- Six acres for rock storage pads

Table 3.12-1 shows the approximate acreage of existing disturbance along each of the surface access and power line routes.

Table 3.12-1 Approximate Area of Existing Surface Disturbance (Acres) Within the Surface Access and Power Line ROWs for Each Route Option[1]

Route	Surface Access	Power Line	Total
Shaw Creek Hillside	25.5	1.1	26.6
South Ridge	1.9	3.0	4.9
Winter only access perennial winter trail	56.1	N/A	56.1

1 Includes camps, airstrips, and gravel pits

3.13 Fish and Aquatic Habitat

The proposed Pogo Mine project would be developed in the drainages of the Goodpaster River and Shaw Creek, two tributaries of the Tanana River with substantial fish resources. Their aquatic habitats are distinctly different due to their water sources. Water source is a major variable determining stream and river characteristics and the aquatic communities present (Milner *et al.*, 1997). Over the length of the Goodpaster River and Shaw Creek waterways, characteristics of their water sources produce varying habitats, which affect the presence, abundance, and composition of individual fish species. Habitat use, however, is similar between species in both drainages. For the majority of fish, the basic life history strategy involves seasonal movements to those habitat types that best serve the needs of spawning, rearing, feeding, and overwintering. These preferred habitats differ depending on the life stage of the fish. The extent of movement can be small and confined within a section of the river or large, covering 100+ miles and involving one, two, or more rivers and, for salmon, thousands of miles. The net result is that species distribution, abundance, and composition within the Goodpaster and Shaw Creek drainages change over time and place. And just as importantly, the exploitation of some species can extend beyond the two drainages.

Since 1956, numerous studies of the aquatic resources in the Goodpaster River and Shaw Creek have been conducted by USFWS and ADFG. These studies have focused predominantly on game fish, specifically Arctic grayling (*Thymallus arcticus*), in the lower reaches of both rivers (Ridder, 1991). Intermittent aerial surveys for spawning salmon in the Goodpaster have been flown by the USFWS and ADFG since 1954. In 1996, the Applicant initiated a series of aquatic resource studies in the upper Goodpaster River to support the baseline information needs of its proposed Pogo Mine. These baseline studies were the first of their kind in the drainage and included quality of water and fine-grained streambed sediment, ambient toxicity testing, aquatic macroinvertebrates, and fish. For fish, major emphasis was on chinook salmon (*Oncorhynchus tshawytscha*) as the major “indicator” species with delineation of spawning and rearing habitat, tissue analysis, and development of abundance indices for adults and juveniles. The Applicant also funded an ADFG monitoring program for adult Arctic grayling spawning in the river's lower 33 miles. Following is a synopsis of the fish and aquatic habitat of the Goodpaster River and Shaw Creek based on these studies.

3.13.1 Goodpaster River

The Goodpaster River is a typical Alaskan clear water drainage with year-round flow predominantly derived from precipitation and shallow ground water. From its origin in the Tanana Uplands, the river flows approximately 140 miles to the Tanana River, draining an area of approximately 1,600^{+} sq mi (Figure 1.3-1). Its two largest tributaries, both downstream of the proposed mine site, are the South Fork, which enters the river 33 miles above its mouth (river mile 33), and Central Creek, which enters at river mile 61. Below the confluence of the South Fork, the river can be characterized as generally shallow (< 40 in.) but wide (160 ft), slow moving, and meandering. It has a substrate predominantly of sand with isolated riffle areas composed of broad expanses of pea-sized gravel (Van Wyhe, 1964). Upstream of the South Fork confluence, the river is composed of a main stem, side channels, and sloughs and has a moderate and uniform gradient characterized by a classical sequence of riffles, runs, and pools with a predominant substrate of gravel (Morsell, 2000). The Pogo claim block encompasses 11 river miles, with the mine site located adjacent to the river at approximately its mid-point at river mile 70 (Figure 1.3-2).

The aquatic environment in the vicinity of the Pogo claim block is generally pristine, with overall water quality and physical characteristics typical of unpolluted subarctic Alaskan streams (Boggs, 2001a). Aquatic and riparian habitat evaluations of eight sites within the project area from 1998 through 2000 returned “optimal” scores for all parameters (Boggs, 2001b). No major differences in water quality parameters were found between main stem sampling sites above, adjacent to, or below the mine site and Central Creek. There were differences between Central Creek and the smaller tributary sites, especially Liese and Pogo creeks (Boggs, 2001a). Major and trace metal concentrations tended to be higher in the smaller tributaries. No water quality parameters at any site subject to EPA fresh water aquatic life standards for priority pollutants exceeded the CMC (EPA, 1988). However, 6 of 97 samples from the main stem and 2 of 29 samples from Liese Creek did exceed the CCC either for lead, mercury, or both (Section 3.7.1). For nonpriority pollutants, aluminum and iron concentrations exceeded EPA fresh water aquatic life standards in some samples from the main stem and tributaries.

Aquatic organisms can be extremely sensitive to contamination levels. Background toxicity of water samples from the main stem and Liese, Pogo, and West creeks was investigated in 1999 and 2000 on two test species not indigenous to the area. Ambient toxicity tests showed effects on reproduction, survival, and growth in two of seven samples. Effects were dependent both on the test species and source of water (Boggs, 2001c). The 2000 sample from upper West Creek affected the reproduction but not the survival of the freshwater crustacean *Ceriodaphnia dubia*. The 1999 sample from Liese Creek had a deleterious effect on survival and growth of fathead minnows (*Pimephales promelas*). No effects were found from the other samples. Both Liese and West creeks drain the mineralized zone. Liese is ephemerally connected to the main stem, and upper West disappears into a wetland complex before reappearing and entering the main stem.

Fish tissue (whole body) analysis for eight trace metals was conducted on juvenile chinook salmon collected in the main stem above and below the claim block for 3 years, 1998–2000 (Morsell, 2000). Concentrations of antimony, arsenic, and silver were at or below detection limits for all samples. Selenium concentrations were mostly below detection limits in 1999 and just above detection limits in 1998 and 2000. Comparisons of upstream versus downstream samples showed no statistical differences in metal concentrations, with the exception of mercury in 1999 which, while low, was higher in the downstream sample. Copper, lead, and nickel were exceptionally higher in 2000, especially in the upstream sample, than in 1998 and 1999 and suggested contamination of the samples. With the exception of copper in the upstream 2000 sample, metal concentrations were similar to or lower than those found in salmonid tissues (whole body) collected in other areas of the state (Weber-Scannell, 2001).

Three years of baseline studies of the aquatic invertebrate community within the project area found species composition and taxa numbers comparable to those in other pristine streams in the region (Boggs, 2001b). Seven invertebrate orders were found encompassing 24 families and 38 genera. These studies developed eight characteristics, or metrics, of the invertebrate community for use in comparing the project area sample sites and as indicators of habitat change for future bioassessments. Metric values showed no statistical differences between main stem sites upstream and downstream of the claim block and near the proposed mine site. Sites in Liese, Pogo, West, and Indian creeks showed a statistical difference in several metrics compared to the main stem sites. These sites had greater numbers of Chironomidae and Simulidae, which can be indicative of poorer habitat. While population densities of invertebrates in the three main stem sites showed a statistically significant decrease from the most upstream site, it is likely an artifact of sampling from decreased access to habitat at downstream sites due to higher discharge.

Eleven fish species have been found in the Goodpaster River (Roach, 1995). Seven of these species have been found within or directly downstream of the Pogo claim block. The most numerous were chinook salmon, Arctic grayling, slimy sculpin (*Cottus cognatus),* and chum salmon (*Oncorhynchus keta)*, while round whitefish (*Prosopium cylindraceum)*, burbot (*Lota lota)*, and Arctic lamprey (*Lampetra japonic)* appeared least numerous (Morsell, 2000; Parker, 2000a). Humpback whitefish (*Coregonus pidschian)*, least cisco (*Coregonus sardinella)*, longnose sucker (*Catostomus catostomus)*, and northern pike (*Esox lucius)* have been found in the lower 33 miles.

The sport fishery in the Goodpaster River is primarily on Arctic grayling in the lower 33 miles during the open water season, May through September. The fishery also harvests low numbers of northern pike, burbot, and whitefish (Tack, 1974; Parker, 2000a, 2000b). The sport fishery on chinook and chum salmon is closed by regulation. There are presently no subsistence or commercial fisheries in the river. An unknown number of Goodpaster River salmon, however, are taken in such fisheries in the Yukon and Tanana rivers (Barton, 2000). From 1983 through 1998, effort in the sport fishery has ranged from 800 to 3,100 anglers per day and averaged 1,700 (Parker, 2000b). The grayling fishery, which predominantly targets juvenile fish less than 12 in. (Tack, 1974), had an average harvest of 1,200 grayling per year since 1983 and an average total catch (fish harvested plus fish released) of 1,600 since 1990. The trend since 1995 has been a declining harvest but an increasing catch (yearly average of 600 fish harvested from a total of 3,400 grayling caught) (Parker, 2000b). Yearly harvests and total catch of northern pike, burbot, and whitefish (spp.) have been less than 80 fish each (Parker, 2000b, ADFG files).

Following is a synopsis of the biology of the seven fish species found in the Goodpaster River in the vicinity of the Pogo claim block.

Chinook Salmon

The Goodpaster is the uppermost spawning tributary in the Tanana Drainage for chinook salmon. Intermittent aerial surveys by ADFG of spawning escapement between 1954 and 1998 have counted from 18 to 1,400 fish. Escapement counts have averaged 630 fish between 1990 and 1995 (ADFG file data). Aerial surveys, however, are a snapshot of what is in the river at a given time and hence are indices of escapement and do not represent the total escapement. Aerial surveys using fixed wing aircraft have undercounted total chinook escapement by 71 percent in the Chena River and 57 percent in the Salcha River (Stuby, 1999). Surveys using a helicopter or a boat provide a more accurate escapement index and better estimate total escapement in moderate to small-sized waters like the Goodpaster when conducted at peak spawning times (Evenson, 2000). Such helicopter surveys were conducted in the Goodpaster River in 1973 and 1998 through 2000, and a boat survey was conducted in 1974. These surveys show that recent escapements are increasing and are substantially higher than in the 1970s (Table 3.13-1).

For some perspective into the size of the Goodpaster escapement, the average escapement index in 1998 and 1999 was 10 to 27 percent of the total estimated escapement in the Chena and Salcha rivers (Table 3.13-1), two of the largest chinook escapements in the Yukon River drainage (Schultz *et al*., 1994). Since the Goodpaster data are indices and, at best, minimum estimates of total escapement, the river may contribute more to the drainage-wide chinook run than previously thought (Fogels, 2003).

Chinook first enter the Goodpaster in the first weeks of July and choose spawning sites in gravel and gravel/cobble substrates in depths of 1 to 3 ft (Tack, 1975; Morsell, 2000). The run is composed of three to four age groups with 5- and 6-year-old fish representing 80 to 90 percent of the run (ADFG files). Spawning areas are located in 90 miles of the river from approximately river mile 30 to river mile 120. Spawning densities generally decreased with distance upstream due to flow and depth, and thus few fish spawn above Slate Creek at river mile 102. The majority of fish, 95 percent in the 2000 whole river survey, spawn in the 69 miles between the South Fork at river mile 33 and Slate Creek (Morsell, 2000). Sixty-five chinook also were found in the South Fork in 2000 (Morsell, 2000). The only previous survey in the South Fork was by helicopter in 1973, and no salmon were found (ADFG files; Barton, 2000). No chinook have been found spawning in Indian or Central creeks (Morsell, 2000), the largest tributaries surveyed after the South and Eisenmenger forks. Spawning in other tributaries in the mine area is nonexistent due to their small size. In 1999 and 2000, 76 and 67 percent, respectively, of all chinook spawned downstream of the Pogo Mine airstrip at approximately river mile 70 (Morsell, 2000). Twenty-one percent of the 3 river miles encompassing and extending upstream and downstream from the existing airstrip was classified as spawning habitat (Morsell, 2000).

Table 3.13-1 Comparison of Chinook Salmon Escapement Indices in the Goodpaster River to Total Estimated Escapement in the Chena and Salcha Rivers

Year	Goodpaster	Chena	Salcha
1973	18	N/A	N/A
1974	248	N/A	N/A
1998	477	4,745	5,027
1999	1,743	6,485	9,198
2000	2,240	4,462	N/A

Goodpaster data from: ADFG files, 1974; Tack, 1975; and Morsell, 2000.
Chena and Salcha data from Stuby (1999, 2001).

Table 3.13-2 shows that distribution of Goodpaster River chinook salmon spawners from 1998 through 2000 was similar to that found in 1974 (Morsell, 2000; Tack, 1975).

Table 3.13-2 Distribution of Spawning Goodpaster River Chinook Salmon in 1974 and 1998-2000

		1974		1998		1999		2000	
River Reach	**Miles**	n	p	n	p	n	p	n	p
Forks to Central	28	153	0.63	289	0.61	1,051	0.60	979	0.47
Central to Indian	13	41	0.17	107	0.22	348	0.20	501	0.24
Indian to Glacier	12	29	0.12	16	0.03	176	0.10	239	0.12
Glacier to Slate	16	21	0.09	65	0.14	168	0.10	353	0.17
Total	69	244	1.00	477	1.00	1,743	1.00	2,072	1.00

n = number
p = percent

Source: Morsell (2000)

Chinook spawn during an approximately 3-week period beginning the last two weeks of July, with the peak occurring approximately August 1 (Morsell, 2000). With an average water temperature between August and May of 35° F (Boggs, 2000a), the thermal sum model of Healey (1991) predicts 247 days to hatching. Thus, hatching in the proposed mine area likely would occur from the last week in March through mid-April (Table 3.13-3).

After hatching, the alevins spend 3 or more weeks in the gravel absorbing their yolk sac before emerging as fry sometime in May (Morrow, 1980; Table 3.13-3). This timetable is supported by the capture in mid-May within the mine area of small fry (1.2 to 1.6 in.) that appeared to have just emerged (Morsell, 2000). Chinook typically rear for 1 year in the river before outmigrating as smolts in May. Late winter sampling in the mine area captured chinook in the main stem and lower Central Creek, indicating overwintering in the proposed mine area (Morsell, 2000). A few large juveniles, likely in their second year, have been captured in October, suggesting that some fish may spend 2 years in the river. These fish, however, have never been found as adults in the river. In the Chena and Salcha rivers, chinook with 2 years of freshwater residency, when present, comprise less than 1 percent of returning adults (Evenson, 2000).

Juvenile chinook were found in a variety of habitats in the main stem, side channels, and sloughs throughout the Pogo mine area from March through October (Morsell, 2000). The use of the area's tributary streams is much lower than for the main stem areas but appears to be dependent on main stem flows and habitat availability. Of the five tributaries that may be directly affected by the mine proposal – Liese, West, Pogo, Wolverine, and Central creeks – rearing chinook were found only in the lower reaches of the latter two (Morsell, 2000). Liese Creek disappears into a wetland and may be ephemerally connected to the Goodpaster River. No fish have been found in upper Liese Creek, and it is not considered fish habitat (Morsell, 2000). West Creek is similar to Liese Creek in that it disappears into a wetland complex. Unlike Liese Creek, it emerges below the complex and runs for 0.6 mile to the Goodpaster. Fish were found in this lower section, but not in the wetland complex or farther upstream. In Pogo Creek, a beaver dam limited fish to a very short stretch near the mouth. Upstream of the dam, gradient and flow are not hospitable to fish (Morsell, 2000). Wolverine Creek, the drainage in which the all-season or winter access road would be sited, has quality rearing and overwintering habitat in the 3/4 mile upstream of its mouth, and numerous rearing chinook were present. Chinook were found only in the lower reaches of Central Creek, despite excellent upstream habitat. Although index sampling shows that chinook prefer main stem habitats, they seek refuge in tributaries during periods of high flows. In high and fast water during the summer of 2000, chinook were found to be much more abundant in West and Central creeks than under low-flow conditions in 1998 and 1999 (Morsell, 2000).

Chum Salmon

The river has a summer run of chum salmon that lags behind the chinook run (Table 3.13-3). Peak chum spawning in 2000 was estimated to be 9 days behind that of chinook (Parker, 2000a). In the Salcha River, lag time between chum and chinook has been up to 18 days (Stuby, 1999). Because all escapement surveys in the Goodpaster have targeted the earlier chinook run, chums have been observed in only 10 of the 22 surveys conducted since 1954, with counts ranging from 31 to 224 fish (ADFG files). A contributing factor to the absence of chum in these surveys may be the habit of pre-spawning chum to hold in deep water adjacent to steep vegetated banks, making them difficult to see from the air, especially in the river's tannic stained waters (Barton, 2000). On an August 9, 2000, float trip that sampled chinook carcasses, 2,500 chum were counted within a 5-mile reach upstream of Sand Creek, whereas an aerial survey on July 31 counted only 150 chum in the same area (Parker, 2000a; Morsell, 2000).

The spawning area for chum appears to be much more limited than that for chinook. All observations have been in the 28 miles between the South Fork and Central Creek. In the five surveys delineated by river sections, chums have not been observed above Seven Mile Creek, approximately 15 miles downstream of the existing Pogo Mine airstrip. Morsell (2000), however, reported 18 “probable” chum in the middle portion of Central Creek in 1999, but was unable to confirm the sightings from the ground.

Chum spawn in the river during an approximately 6-week period beginning the first week of August. The run is composed of three to four age groups with 4- and 5-year-old fish representing 80 to 90 percent of the run (ADFG files). The peak of spawning, assuming a residency of 11 to 15 days (Sato, 1991), occurs approximately August 12. Assuming 140 days for incubation (Sato, 1991), hatching likely would occur from the last week in December through January (Table 3.13-3). After hatching, the alevins spend 100^{+} days in the gravel absorbing their yolk sac before emerging as fry sometime in April (Sato, 1991; Table 3.13-3). The fry immediately outmigrate starting at ice-out in late April through mid May. Due to distribution, behavior, and limited pre-ice-out sampling, no captures or observations of fry have been made within the Pogo claim block.

Table 3.13-3 Periodicity Chart for Five Fish Species in the Upper Goodpaster River Drainage

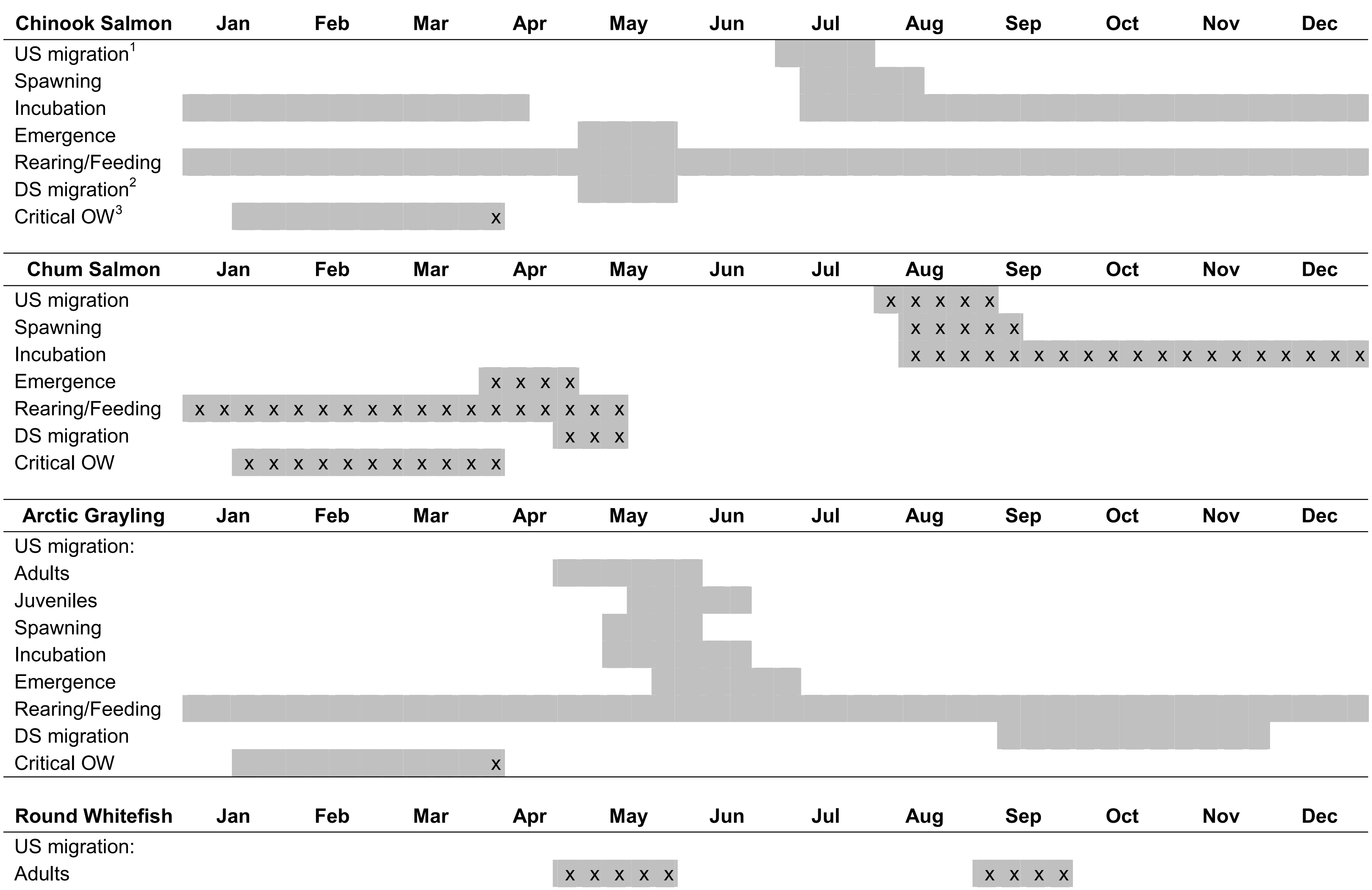


Table 3.13-3 Periodicity Chart for Five Fish Species in the Upper Goodpaster River Drainage

Juveniles																x	x	x	x	x																												
Spawning																																			x	x	x	x										
Incubation	x	x	x	x	x	x	x	x	x	x	x	x	x	x																					x	x	x	x	x	x	x	x	x	x	x	x	x	x
Emergence											x	x	x	x	x	x	x																															
Rearing/Feeding	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	s	s	s	s	s	s	s	s	s	s
DS migration																																					x	x	x	x	x	x						
Critical OW			x	x	x	x	x	x	x	x	x	x	x																																			

Slimy Sculpin	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
US migration																																																
Spawning																		x	x	x	x																											
Incubation																		x	x	x	x																											
Emergence																																																
Rearing/Feeding	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DS migration																																																
Critical OW			x	x	x	x	x	x	x	x	x	x	x																																			

[1] US migration = upstream migration.
[2] DS migration = downstream migration.
[3] Critical OW = critical overwintering. Defined by minimum flows as found in the Goodpaster River by Beckstead (2000).
s = suspected.

Source: Modified from ADFG (2000)

Arctic Grayling

Arctic grayling are found in the majority of the Goodpaster drainage and are perhaps its most important fish resource (Tack, 1974, 1980; Parker, 2000a). The population consists of at least 14 age classes. Grayling begin maturing at Age 4 and attain full maturity by Age 8 (Clark, 1992a). The Goodpaster population, as do others in Alaska, has a life history involving complex migrations between overwintering, spawning, and summer feeding areas that differ between juveniles and adults and can involve different waters (Tack, 1980; Ridder, 1991). Tagging studies have shown the Goodpaster as a spawning area for, and therefore a source of, fish that contribute to five other sport fisheries in the Tanana River drainage (Ridder, 1991). The largest contribution is to the nearby Delta Clearwater River, where 60 percent of its population of adult grayling spawn in the lower Goodpaster (Ridder, 1998a). Movements also significantly affect the abundance and composition of juvenile and adult fish in place and time (Ridder, 1998c). For example, adult fish were 10 times more numerous in the lower 33 miles of the Goodpaster during spawning in May than in July (Ridder, 1998b).

Grayling spawn in the spring shortly after breakup, usually in May, when water temperatures first reach 41° F. River temperatures warm first in the lower reaches; therefore, spawning begins in the lower river and reaches upstream areas weeks later (Tack, 1980; Ridder, 1998c; Table 3.13-3). Preferred spawning areas are in riffle habitats with pea-sized gravel, although a variety of habitats have been used (Tack, 1980). Spawning in the Goodpaster, documented by captures of gravid fish and/or fry, occurs from the mouth through the proposed mine area to at least river mile 115 and at least 26 miles up the South Fork (Tack, 1974; Ridder, 1998b; Morsell, 2000). No spawning has yet been documented in other Goodpaster tributaries. If it does occur, it is likely insignificant to main stem and South Fork spawning. Abundance of adult-sized fish (larger than 12 in.) in 60 river miles from Central Creek downstream to the mouth was 16,600 fish during spawning in 1995 (Ridder, 1998b). Average density was higher in the lower 24 miles (300 fish per mile) than the 23 miles below Central Creek (190 fish per mile). Densities are likely lower above Central Creek as stream size and preferred habitat diminishes. From 1995 through 1999, estimated abundance of adult-sized fish during spawning in the lower 33 miles has ranged from 9,000 to 17,000 fish (Ridder, 1998b; Parker, 2001).

After spawning, eggs develop quickly. At water temperatures of 46° F, hatching occurred in 14 days, after which the alevins remain in the gravel absorbing their yolk sac for 3 to 4 days prior to emergence (Armstrong, 1982; Table 3.13-3). At emergence, fry are poor swimmers and seek out quiet water in shallow riffles at the lower end of gravel bars, sloughs, and backwaters. At this stage of development, flood events displace fry downstream and can cause high mortality either directly from turbulent flows or indirectly by displacing fish into unfavorable habitats. Clark (1992b) found stream flows directly affected recruitment of grayling in the Chena River. Morsell (2000) found fry abundant in preferred habitat throughout the Pogo claim block in 1999, but not within tributaries. However, fry were nearly nonexistent in the same areas in 2000, when several periods of high water occurred in June and July. Flood events may also affect young-of-the-year fish later in the season. Tack (1974) suggested that the Chena River flood of August 1967 caused high mortality among young-of-the-year fish because samples in subsequent years were missing that age group.

After spawning, the majority of grayling, adults and juveniles, disperse upstream to summer feeding areas. In a Chena River study, the extent of the upstream movement of adults was generally dependent on where a fish spawned and where it had spent the previous summer (Ridder, 1998c). Fish spawning in the lower drainage moved the greatest distances to at least mid-drainage locations; fish spawning in mid-drainage moved to the upper drainage; and fish spawning in the upper drainage moved into headwaters. In the Goodpaster, 10 to 15 percent of grayling that spawned in the lower 20 miles migrated to other rivers, principally the Delta Clearwater River, 9 percent remained in the area, and the remainder moved upstream (Ridder, 1998b). For fish 6 in. and longer, Tack (1974) described an upstream post-spawning movement in early June followed by a mid-summer period of little movement but with the greatest dispersal. In mid-summer, he found juveniles and subadults in the lower 33 miles; a mix of these groups, including adults in the middle drainage; and mostly adults above Central Creek. Grayling index sampling in the Pogo mine area in 1999 and 2000 confirmed this pattern, with small May catches of ripe or spawned out adults solely in the main stem and high mid-summer catches of juveniles and adults in the main stem and Central and Wolverine creeks (Morsell, 2000). The mid-summer catch included adults tagged during spawning in the lower river.

Mid-summer density estimates in the river's lower 33 miles have ranged from 215 to 783 Arctic grayling (6 in. and longer) per mile, with adult sized fish (11 in. and longer) at 32 to 115 fish per mile (Roach, 1995). Tack (1974) estimated the mid-summer population (6 in. and longer) from the mouth to river mile 115 at 47,000 fish. Fifty-five percent of the fish were in the lower 33 miles; 28 percent were in the 28 miles between the South Fork and Central Creek; and 17 percent were in the 54 miles upstream of Central Creek.

Grayling in rivers like the Goodpaster move downstream to overwintering areas in a leisurely fashion beginning in late September and extending to December (Tack, 1980; Lubinski, 1995; Ridder, 1998c; Table 3.13-3). Morsell (2000) found lower numbers of fish, mostly adult males, in the proposed mine area during October in 1999 and 2000. Fish had moved out of tributaries and were concentrated in the airstrip area. The extent of this movement to overwintering areas is generally dependent on where the fish spent the summer. Prior to 1990, grayling were thought to move in mass to the lower portions of rivers for overwintering. Several recent studies, however, have shown that some grayling summer feeding in headwater areas move downstream relatively short distances to overwintering areas (Hughes, 2000; Lubinski, 1995; Ridder, 1998c). In the Chena River, grayling in headwater areas moved the least, and contrary to fish from other areas, some also moved downstream to spawning areas (Ridder, 1998c). Grayling in the Chena generally were found to overwinter within 16 miles of their spawning sites. Overwintering grayling have been documented in the lower 33 miles of the Goodpaster (Ridder, 1998a) and upstream of the mine site (Morsell, 2001).

Slimy Sculpin

Slimy sculpin are small, bottom-feeding fish that occur throughout the Goodpaster drainage. The fish, generally unknown to the public, may be the most abundant fish in clear Alaskan streams and hence ecologically important (Sonnichsen, 1981). A solitary, sedentary, bottom-feeding fish, it is likely the only fish resident within the proposed mine area and also the most widely distributed. As with juvenile chinook, however, it was not found in Liese, upper Pogo, or West creeks (Morsell, 2000). Fish sampled in the mine area ranged from 1.8 to 3.8 in. and averaged 2.6 in. (Morsell, 2000). The fish grows slowly and has a maximum age of 7 years in interior Alaska (Morrow, 1980; Sonnichsen, 1981). The fish reach maturity at Ages 3 and 4, and spawn in the spring when water temperatures are between 39° F and 50° (Morrow, 1980; Table 3.13-3). Nests are constructed under rocks, trees, and/or roots in shallow water less than 12 in. deep. Incubation takes approximately 30 days with fry, a quarter inch long, remaining in the nest another week absorbing their yolk sac (Morrow, 1980; Table 3.13-3).

Three other fishes, round whitefish, burbot, and Arctic lamprey, were found in very small numbers within the proposed mine area during 1998 - 2000 surveys (Morsell, 2000). The numbers may reflect incidental use of the area or limited sampling methods and timing.

Round Whitefish

Two young of the year-round whitefish were captured in July 1999, one in the airstrip slough and one in the main stem below Central Creek. Considering that the fish were less than 2 in. long, they were unlikely to have moved upstream but may have been displaced downstream. Thus, spawning likely occurred either instream or upstream of the proposed mine area the previous fall. Movements and biology of the species is not well known in Alaska, but fall movements to spawning areas and spring movements to feeding areas have been noted. Concentrations of pre-spawning round whitefish were found in the 10 miles below Central Creek in mid-September 1973 and included two fish previously tagged in the Delta Clearwater River (Pearse, 1974). The fish are known to spawn in late September to mid-October in shallow gravels, with fry emerging the following spring (Morrow, 1980; Table 3.13-3). Fish are thought to move downstream for overwintering; however, Lubinski (1995) found small numbers of whitefish overwintering with grayling in upper Birch Creek, a large tributary to the Yukon River. One adult fish was observed under the ice in March above the mine site (Morsell, 2001). Large adults are commonly caught in the lower Goodpaster in May (Parker, 2000a). Fish overwintering in the Tanana River move into the Delta Clearwater River for summer feeding and then leave the river in late August with some spawning in the Goodpaster (Pearse, 1974). Tack (1974) captured juvenile and adult round whitefish in the Goodpaster at river mile 33 moving upstream in early May right after ice-out. Thus, some whitefish overwinter, summer feed, and spawn in the main stem within the mine area.

Burbot

Fourteen Burbot were caught in 11 of 417 minnow traps that were fished for over 9,000 hours from 1999 through 2000 (Morsell, 2000). All were captured in main stem sets and were immature fish 4 to 8 in. long representing 1- and 2-year-old fish. Larger-sized burbot are fairly common year-round in the lower Goodpaster. Burbot use of the upper river likely is limited to a juvenile feeding area because spawning would occur only in the lower reaches (Evenson, 2000). McPhail and Lindsey (1970) mention upstream post-spawning runs of young fish, at Ages 1 and 2, that feed on insects and small sculpin. Because minnow traps are an effective capture method (Evenson, 2000; Ott, 2001), the low capture rate indicates few burbot inhabit the mine area.

Arctic Lamprey

Two Arctic lamprey, both less than 6 in., also were caught in the main stem within the proposed mine area, one each in May 1998 and August 1999. The life history of the fish is largely unknown, but is likely quite variable from place to place (McPhail and Lindsey, 1970). Lampreys in interior Alaska are considered to be nonmigratory and also nonparasitic, with adults rarely reaching 12 in. (Morrow, 1980). Lampreys metamorphose from larvae that bury themselves in the soft mud of stream margins and backwaters. Because such habitat is much more prevalent in the lower river, lamprey use of the proposed mine area likely is marginal.

3.13.2 Shaw Creek

Shaw Creek is a 70-mile-long, typical brown water stream where flow is primarily derived from bogs producing tannic-stained water with high concentrations of dissolved organic compounds. Brown water streams have similar, yet gradual, swings in discharge as clear water streams, but generally have lower discharge in winter and usually freeze solid in their lower reaches (Reynolds, 1997). In late winter, the lower 28 miles of Shaw Creek has been found to be anoxic. Lower Caribou Creek, tributary to Shaw Creek and located 6 miles above its mouth, freezes solid (Ridder, pers. obs.). Open water areas are present during winter, however, in the drainage upstream of Gilles Creek approximately 40 miles above the mouth of Shaw Creek (Windsor, 1999). Although quality evaluations have not been done, aquatic habitat can be considered pristine for its type. The drainage is undisturbed, except for two winter roads with three stream crossings that access timber sales near Caribou and Rapids creeks.

Fish investigations by ADFG have involved limited surveys in Shaw Creek's lower 6 miles and the tributaries of Rosa, Keystone, Rapids, and Gilles creeks; annual harvest surveys; and an 8-year study of post-spawning grayling outmigrating from Caribou Creek. Other investigations by Teck-Pogo involved short ground or aerial surveys at proposed road crossings at the major Shaw Creek tributaries of Keystone, Caribou, and Gilles creeks, and of upper Shaw Creek. Most of the other tributaries crossed are either ephemeral or disappear into the bog surrounding the main stem (Hanneman, 2000f).

Ten fish species have been found in the lower 6 miles of Shaw Creek: grayling, slimy sculpin, round whitefish, burbot, humpback whitefish, least cisco, longnose sucker, northern pike, lake chub (*Couesius plumbeus)*, and juvenile silver salmon (*Oncorhynchus kisutch)* (Ridder, 1983). Because of a general lack of overwintering habitat, the majority of fish in the drainage likely overwinter in the Tanana River, although some may overwinter in the upper drainage. Grayling tagged in Caribou Creek and 28 miles upstream in Rapids Creek have been routinely recovered in the Tanana River in April prior to breakup of Shaw Creek (Ridder, 1991). At that time, the abundance of adult-sized grayling off Shaw Creek's mouth has been estimated to range from 6,000 to 21,000, and averaged 13,000 for the years 1981 through 1987 (Ridder, 1989; ADFG files). All ten species have been caught in Caribou Creek migrating upstream in mid- to late May (Ridder, 1984). Fish distribution and habitat use in the drainage, with the possible exception of grayling, are largely unknown.

Arctic Grayling

Grayling use of Shaw Creek parallels that of the Goodpaster with the exception of overwintering. Grayling enter Shaw Creek during breakup, which typically occurs the last week in April. They have been observed migrating up Caribou Creek, with burbot, the first of May in overflow over bottom-fast ice (Ridder, pers. obs.). Known spawning areas include the main stem up to river mile 20 and Caribou, Rapids, and Gilles creeks (Ridder, 1984, 1998a; Morsell, 2000). Estimated spawning abundance in Caribou Creek has ranged from 5,000 to 10,000, and averaged 7,000 fish from 1981 through 1987, making it the major spawning site in the drainage (Ridder, 1994).

After spawning, adult grayling migrate to feeding areas upstream in Shaw Creek and to other drainages. Shaw Creek grayling contribute to nine other Tanana River tributary fisheries stretching from the Delta Clearwater River to the Little Salcha River 60 miles downstream of Shaw Creek (Ridder, 1991). Grayling spawning in Caribou Creek contribute 70 percent to the fish found in the nearby Richardson Clearwater (Ridder, 1994). Tagged fish from Caribou Creek also have been recovered in Gilles Creek above the proposed all-season road crossing, and juveniles and young of the year have been recovered at the road crossing (ADFG field notes, 1983; Morsell, 2000). No grayling have been found in upper Caribou Creek, although juveniles and subadults have been captured at the proposed road crossing (ADFG field notes, 1983; Morsell, 2000).

The extent of upstream dispersal of post-spawning grayling may be limited in Keystone Creek and Shaw Creek by beaver dams. Extensive beaver activity was noted below the road crossings at Keystone and upper Shaw creeks (Morsell, 2000). No fish were captured or observed at the upper Shaw Creek site, despite favorable habitat. No ground survey was conducted at the Keystone Creek crossing, although habitat looked poor from the air. Grayling, burbot, sculpin, lake chub, and juvenile silver salmon have been found in lower Keystone Creek (ADFG field notes, 1982).

Fishing effort and harvest in Shaw Creek are largely restricted to its lower 3 miles due to the creek's small size and numerous log jams. From 1990 to 1999, effort has averaged 612 person-days with an average harvest of 519 fish, principally grayling (n = 328) and burbot (n = 154), but including northern pike and whitefish (Parker, 2000a). Prior to a spring fishing closure begun in 1987, grayling harvests averaged 2,000 fish.

3.14 Wildlife

This section describes the affected environment for nonthreatened, endangered, and sensitive species. Threatened, endangered, and sensitive species are discussed separately in the following section (3.15).

3.14.1 Habitat Values

Jorgenson *et al*. (2000) used a method based on a geographic information system (GIS) for integrating habitat information for a large group of key species to assess wildlife habitat in the proposed project area, covering approximately 695,000 acres from the confluence of Shaw Creek with the Tanana River in the southwest to the upper Goodpaster River north of Shawnee Peak in the northeast. In the methodology, habitat use by 32 key species and groups (21 birds species, 9 mammals, and 2 groups of small mammal species, microtine rodents, and shrews) was selected to represent the broader range of species that occur within the project area. The methodology accounted for rare or sensitive species, harvested species, overall use of habitats by different species, and habitat rareness. It also computed a Conservation Priority Index intended to identify habitats that are in themselves rare and also important to wildlife, particularly for rare or sensitive species.

This habitat assessment methodology yielded a detailed map of 23 wildlife habitat classes in the project area (Figure 3.10-1). The most abundant habitats were lowland needleleaf forest (16.4 percent of total area), upland broadleaf forest (10.0 percent), upland mixed forest (25.4 percent), and upland needleleaf forest (11.8 percent), accounting in total for approximately 64 percent of the area. Nine habitats each composed less than 1 percent of total area: riverine barrens, riverine scrub, riverine broadleaf forest, lakes and ponds, lowland wet meadow, bluff meadow, cliff, alpine meadow, and human-modified habitats (predominantly farmland on the southern edge of the study area). Two habitats, bluff meadow and cliff, were exceedingly rare, composing less than 0.1 percent of total area (Jorgenson *et al*., 2000).

Six integrated habitat value indices that may be of use for land management decision-making purposes were developed. Because of the nature of the indices, depending on the management issue, the use of one or more of these indices to determine "high-value" wildlife habitat becomes very much an issue of which species are being considered and what value judgments or management imperatives are placed on them. For the purposes of this EIS, the Conservation Priority Index appeared to be the most useful metric for identifying priority habitats for protection from habitat-altering activities. A detailed explanation of the methodology is beyond the scope of this EIS; however, a description of the Conservation Priority Index is contained in Appendix A.3.

Jorgenson *et al.* (2000) developed a priority index of habitat conservation that combined habitat rareness with habitat use, with emphasis on use by rare species. High-priority rankings were calculated for cliff, riverine broadleaf forest, riverine mixed forest, lowland meadow, lowland broadleaf forest, and lakes and ponds, because these habitats were uncommon, important to rare species, or had overall high value for wildlife. In contrast, low-priority rankings were calculated for alpine dwarf scrub, subalpine needleleaf woodland, upland tall scrub, and lowland low scrub because these habitats had either low use or were relatively abundant habitats. When values of the Conservation Priority Index were categorized into high, medium, and low, high-priority areas covered 5 percent of the Pogo project area, medium-priority areas covered 70 percent, and low-priority areas covered 25 percent. Figure 3.14-1 presents a graphic representation of the habitat Conservation Priority Index.

3.14.2 Birds

Many species of birds are found in the Pogo project area, including loons and grebes, waterfowl, raptors, grouse and ptarmigan, shorebirds, woodpeckers, and passerines. Burgess *et al.* (2000) lists 122 bird species that are confirmed or likely to occur in the project area. Most bird species that breed in interior Alaska are migratory and are present only during the spring and summer months; a relatively small number are permanent residents that occur year-round. Before and after the breeding season, the Tanana River Valley (including the project area) is an important spring and fall migration corridor, and more than 200,000 birds pass through the region each spring and fall (Kessel, 1984; Cooper *et al.,* 1991; Anderson *et al*., 2000). The following discussion has been taken from a more detailed description of birds in the project area by Burgess *et al.* (2000).

Waterbirds

The Shaw Creek Flats are important for both migrating and breeding waterbirds (Ritchie, 1980; Ritchie and Hawkings, 1981). Species of waterbirds that probably breed in the Shaw Creek Flats and Quartz Lake areas include Common and Pacific loons, Horned and Red-necked grebes, Trumpeter Swans, Canada Goose, Green-winged Teal, Mallard, Northern Pintail, Northern Shoveler, American Wigeon, Canvasback, Greater and Lesser scaup, Surf and White-winged scoter, Common Goldeneye, Bufflehead, Common and Red-breasted mergansers, Lesser Yellowlegs, Solitary and Spotted sandpipers, Common Snipe, Bonaparte's and Mew gulls, and Arctic Terns.

The Goodpaster River and its major tributaries also are used by breeding waterbirds, including Harlequin Ducks, Trumpeter Swans (a pair regularly occupies wetlands in the southwestern corner of the Pogo claim block), Common and Red-breasted mergansers, and other dabbling and diving ducks (Burgess *et al.,* 2000).

- **Ducks** Dabbler as well as diving ducks frequent the lakes, ponds, and sloughs of Shaw Creek Flats and the Goodpaster River Valley. A May 2000 project-related survey showed that overall densities of ducks in the Goodpaster Flats (17.9 ducks/sq mi) were approximately a quarter of the densities found in the Shaw Creek Flats (70.7 ducks/sq mi). From a regional perspective, the Shaw Creek Flats area generally was characterized by somewhat lower densities of dabbling ducks and large diving ducks (scoters, Ring-necked ducks, and mergansers) compared to USFWS surveys across the Tanana and upper Kuskokwim basins, and higher densities of small diving ducks (Bufflehead and goldeneyes).

- **Trumpeter Swans** Trumpeter Swans nest primarily in open meadows in or near wetlands and rear their broods on open water in lakes and medium-sized ponds, typically with some amount of emergent vegetation on shorelines, especially when the cygnets are small.

  From a habitat perspective, lakes and ponds were considered essential for swans because of their use as brood-rearing habitats. Lowland meadows were considered high-use areas because of their use as nesting habitat, while rivers and streams and lowland low scrub were considered as low use areas. All other habitats were considered to be of negligible importance for swans.

  Figure 3.14-2 presents Trumpeter Swan sightings during surveys in 1995 and 2000. Eighty-two adults and 9 young in 5 broods were counted at 42 locations in the project area in 2000. All but seven sightings and one brood that were seen in the Goodpaster River Valley were located in the Shaw Creek Flats. Historical survey data indicate an expanding population of swans in the project area for both number of breeding pairs and number of flocks (nonbreeders). The number of broods observed in the area, however, has increased only slightly, from 2 in 1985 to 7 in 1995 and 5 in 2000 (Burgess *et al*., 2000).

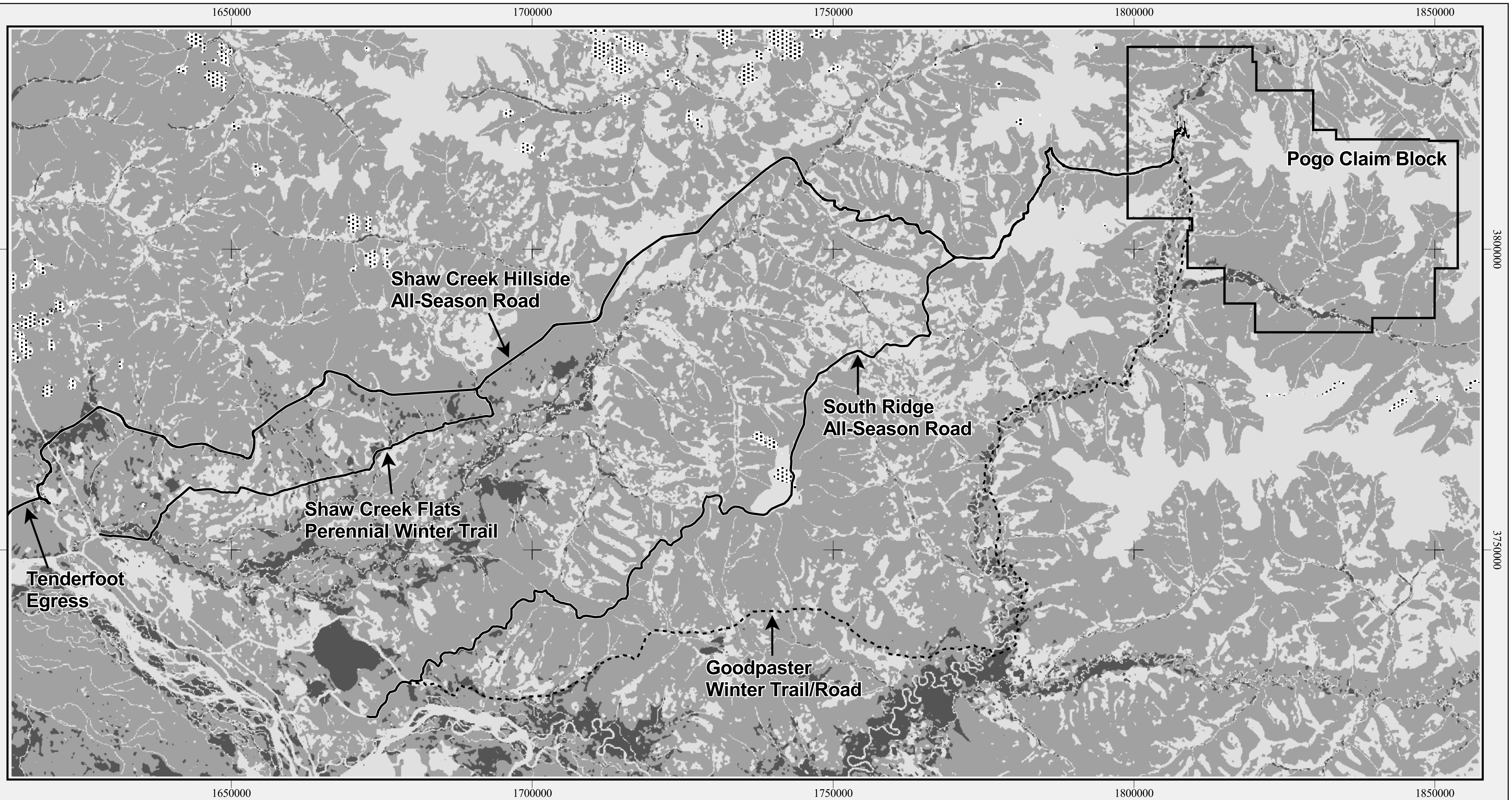
Raptors

Sixteen species of raptors probably occur in the project area (Bald and Golden eagles, Northern Harrier, Sharp-shinned Hawk, Northern Goshawk, Red-tailed Hawk, Rough-legged Hawk, American Kestrel, Merlin, Peregrine Falcon, Gyrfalcon, Great-horned Owl, Northern Hawk Owl, Great Gray Owl, Short-eared Owl, and Boreal Owl), and all of these species, except the Rough-legged Hawk, are likely to breed in the area (Burgess *et al*., 2000). Most of these raptors migrate south during the winter, but some are resident year-round. Important habitats for raptors include specific cliffs traditionally used for nesting (used by Golden Eagles, Peregrine Falcons, and Gyrfalcons) and traditionally used tree nests (used by Bald Eagles, Northern Goshawks, Red-tailed Hawks, and Great-horned Owls).

Some species are highly adapted to and dependent on forested habitats (e.g., Sharp-shinned Hawk, Northern Goshawk, Great Gray Owl, and Boreal Owl), others prefer open habitats of tundra, marsh, or grassland (e.g., Northern Harrier, Rough-legged Hawk, Short-eared Owl). The Gyrfalcon, Great Gray Owl, and Boreal Owl have been identified as priority species in central Alaska by the Boreal Partners in Flight Working Group primarily because of their biogeographic regional importance (i.e., they are restricted to boreal habitats). Eagles, Northern Goshawks, and Peregrine Falcons are discussed in greater detail under species of concern in Section 3.15 (Threatened, Endangered, and Sensitive Species).

Other Species

There are many passerine and other non-waterbird or raptor species found in the Pogo project area. Generally, these species occur in appropriate habitats throughout the project area. A more detailed description of these species may be found in Burgess *et al.* (2000). Species considered threatened, endangered, or sensitive are discussed in the following section (3.15).



Habitat Value Index
Conservation Priority

- Low
- Medium
- High
- Cloud and Shadow

2 0 2 4 6 8 Kilometers
1 0 1 2 3 4 5 Miles

N W E S

Map derived from supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-1
Habitat Conservation
Priority Index

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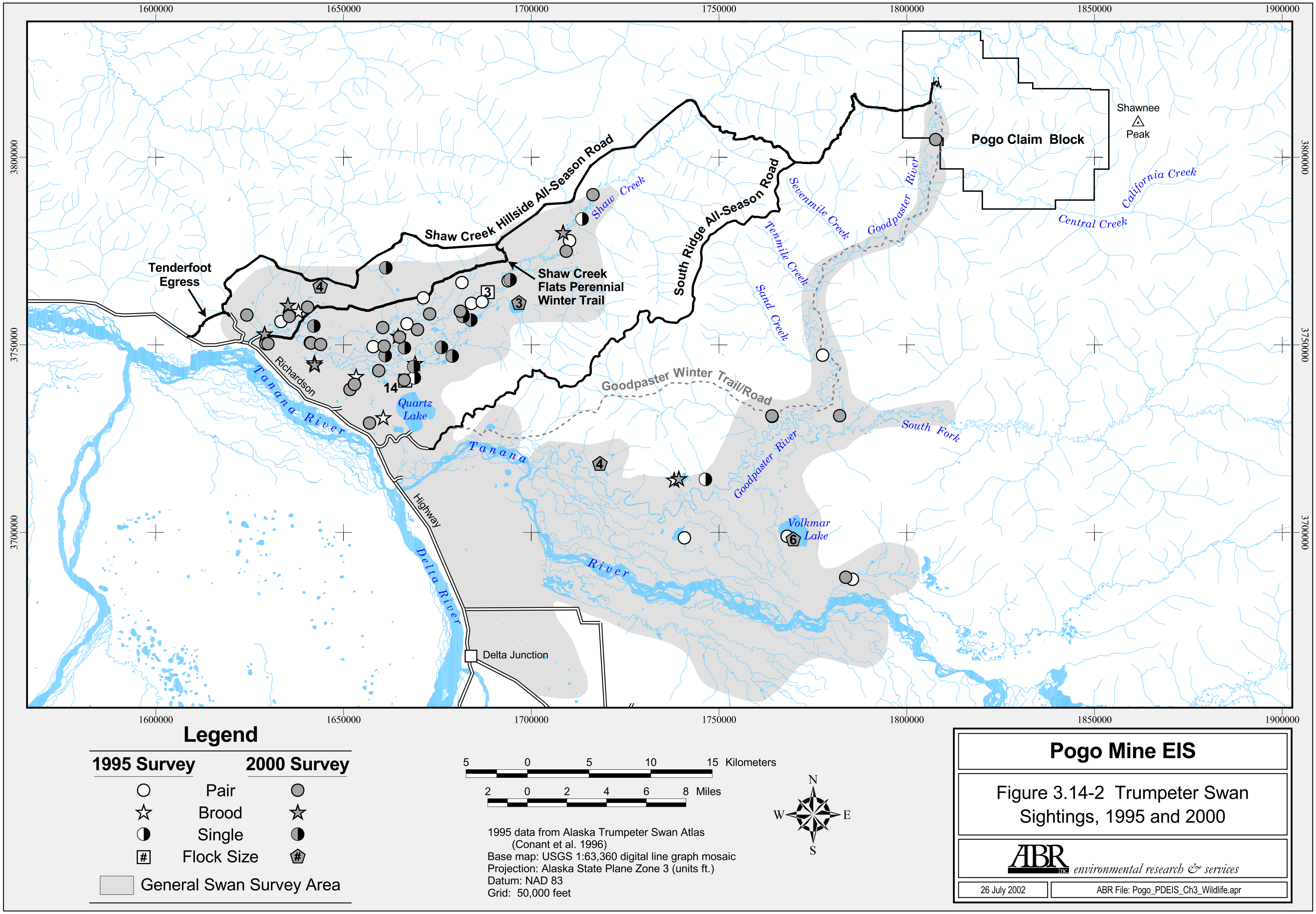


Figure 3.14-2 Trumpeter Swan Sightings, 1995 and 2000

3.14.3 Mammals

Jorgenson *et al.* (2000) list 47 species of mammals that are confirmed or likely to occur in the vicinity of the project area. Many of these species are important to local residents, subsistence users, and recreationists. The project area is within the northern portion of Game Management Unit (GMU) 20D. The following discussion of major species has been taken from a more detailed description of mammals in the project area by Burgess and Lawhead (2000).

Moose

Moose occur throughout the project area. Moose populations in interior Alaska generally are not limited by habitat availability or quality, but rather by winter weather and predation (Gasaway *et al*., 1983; Boertje *et al*., 1996). During the course of a year, moose may be found at all altitudes, including high elevations which contain some of the highest quality moose habitat in the project area. Burned areas are important moose habitats from several years following the burn (after willows have colonized) until shrub cover begins to be replaced by taller trees (about 25 years following most burns in interior Alaska). Lakes and ponds with emergent or submergent vegetation are important spring and summer habitats, and higher elevation woodlands and tall scrub are important during late summer and winter.

Hunting, accidental mortalities (e.g., vehicle collisions), and habitat quality also influence moose populations to varying degrees. Because much of GMU 20D is relatively remote, hunting pressure is concentrated in the unit's more easily accessible southern portion in the vicinity of Delta Junction and the Richardson Highway (DuBois, 1996); however, the Goodpaster River Valley downstream of Tibbs Creek is a major hunting area (Fogels, 2003). In 1995, the state legislature mandated intensive management of moose for human consumption in large areas of the state, and GMU 20D was one of the areas in which this became the primary management goal. A wolf control program was approved to assist in reaching the population target, but has not yet been implemented. The moose population in GMU 20D in fall 1999 was estimated at 4,900 to 7,200 animals. Calf survival and yearling recruitment into the breeding segment of the population remain relatively low in northern GMU 20D.

From a habitat perspective, high use habitats for moose were considered to be riverine scrub, riverine broadleaf forest, lakes and ponds, lowland broadleaf forest, and upland tall scrub (Figure 3.10-1). Other habitats were ranked as medium or low use. Figure 3.14-3 presents moose habitat values in the project area. Moose concentration areas in the project area include calving habitats in the Shaw Creek Flats and wintering areas in the Central Creek burn area, which covers much of the Pogo claim block. The Salcha River drainage, north and west of the project area, contains much more extensive moose concentration areas used for calving, rutting, and wintering.

Within the project area are two locations where ADFG has historically conducted population surveys. The Central Creek trend area encompasses approximately the southeastern two-thirds of the Pogo claim block north of Central Creek. The purpose of this count is to provide information on long-term changes in moose population status. The Shaw Creek survey area encompasses almost all of the Shaw Creek Valley. The purpose of this count is to calculate a population estimate for the survey area.

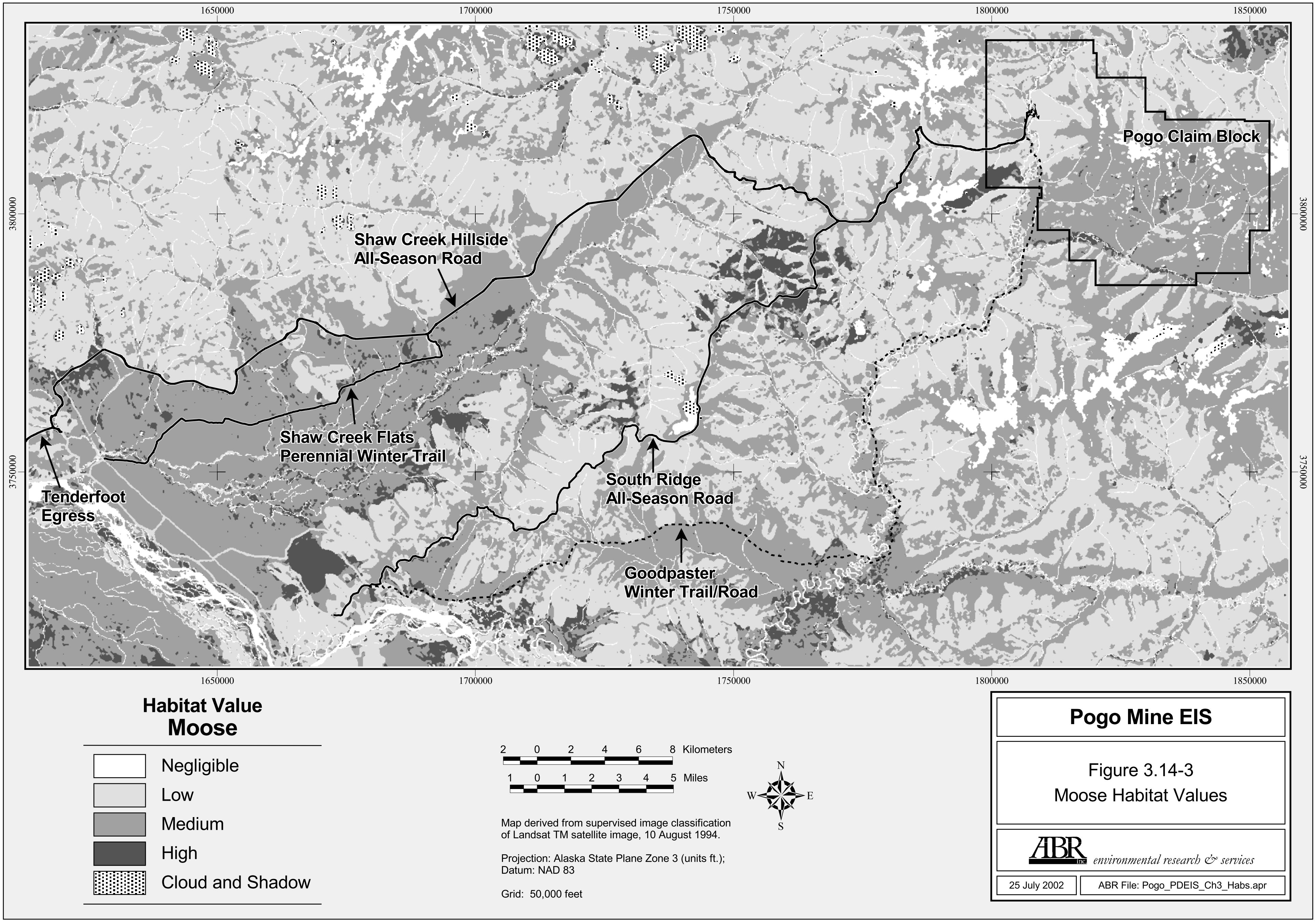


Figure 3.14-3
Moose Habitat Values

In the Central Creek trend area, the 1998 survey found 29 moose and the 1999 survey found 61 moose. These findings compared with 118 to 139 animals per year in 1992–1994 (Burgess and Lawhead, 2000). In both 1998 and 1999, the numbers of moose counted were substantially lower than were recorded by ADFG in the Central Creek burn in the early 1990s. The mean density for the count area was 0.7 and 1.5 moose/sq mi in 1998 and 1999, respectively. These densities, although higher than average across all of GMU 20D, suggest a decline either in use of the area or in the moose population from the early 1990s. It is likely that the Central Creek area is less attractive to wintering moose because of declining habitat quality in the burn.

In general, moose density declines in burns more than 15 to 20 years old (Peek, 1997) as foraging opportunities decrease.

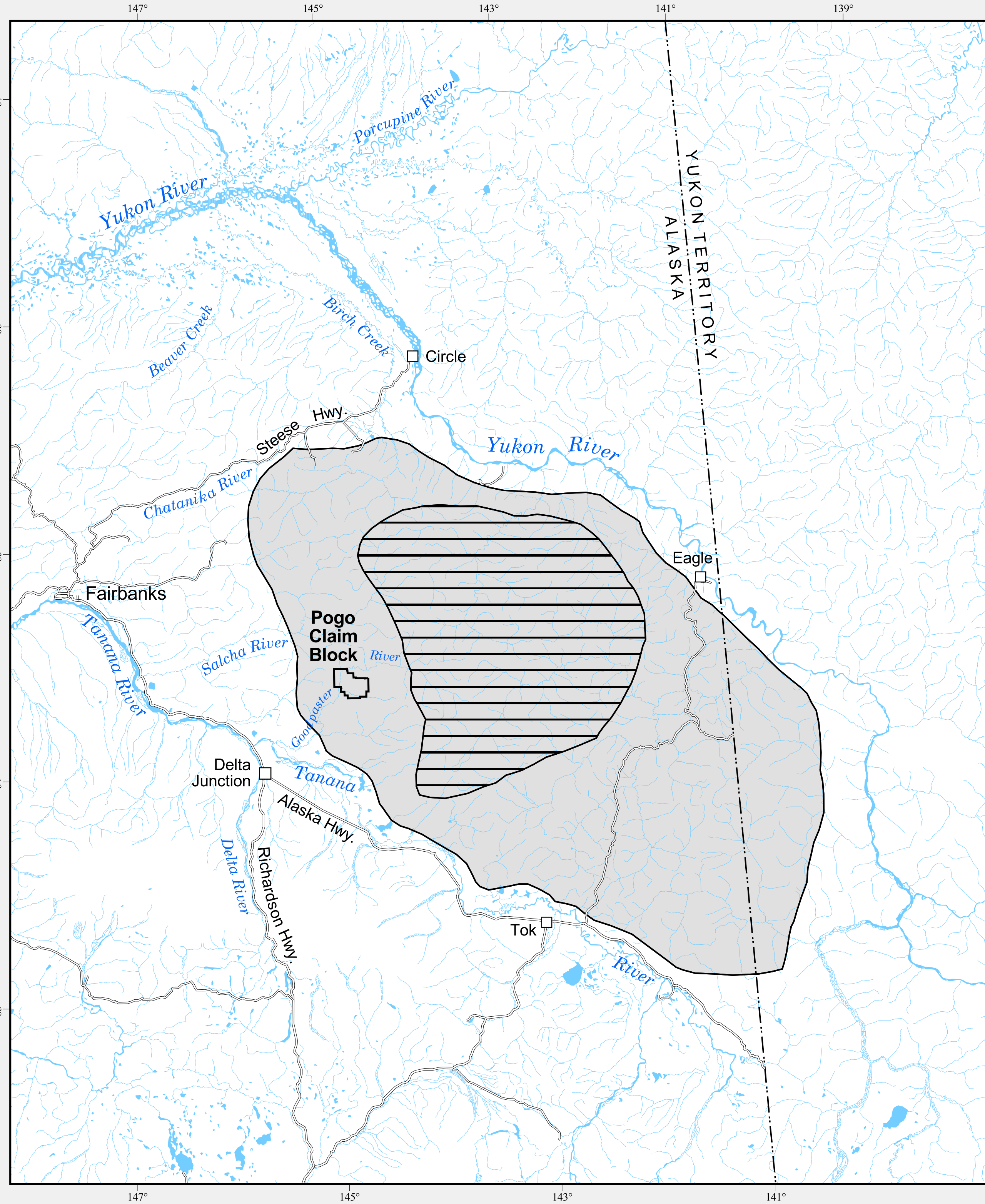
In the Shaw Creek Valley, moose were distributed throughout the survey area at relatively low density. The population estimate was 119 moose, which equated to a density of 0.4 moose/sq mi over the entire area. In interior Alaska, ≤0.6 moose/sq mi is considered low density, and >1.2 moose/sq mi is considered high density (DuBois and VerHoef, 1999). The highest densities of moose in the Shaw Creek survey area occurred in subalpine habitats and in areas burned by the Rapids Creek wildfire in 1986. The lowest densities occurred on the Shaw Creek Flats and in spruce forest habitats, whereas hillsides with birch and aspen forests had intermediate moose densities.

In northern GMU 20D, the number of moose harvested has remained relatively constant since 1984, averaging approximately 48 for all units annually (Burgess and Lawhead, 2000). More than 68 percent of that annual harvest occurred in the Shaw Creek drainage (approximately 18 moose per year), in the lower Goodpaster River (approximately 9), and in the upper Goodpaster River (approximately 6 per year). Goodpaster River Valley moose harvests have increased since 1992, however; harvests in uniform coding units (UCU) 300 (nonspecific Goodpaster River), 301 (lower Goodpaster River), 302 (upper Goodpaster River), and 303 (Eisenmenger Fork) have averaged 28 moose/year by an average of 114 hunters/year (Fogels, 2003).

Caribou

Caribou in the vicinity of the project area are considered members of the Fortymile Caribou Herd. The herd's range is bounded on the north by the Yukon River and Steese Highway, on the south by the Tanana River, on the west by Chena Hot Springs, and on the east by Dawson, Yukon Territories, Canada (Figure 3.14-4). The Pogo claim block and the northeastern half of the project's potential access corridors are located within the southwestern portion of the current annual range of the Fortymile Herd. The project area is southwest of the herd's current summer range, and calving concentration areas lie well to the north and east of the Pogo claim block in higher elevation areas. The project area is classified primarily as winter range (ADFG, 1986; U.S. Air Force [USAF], 1995).

Marked historical declines in the size and range of the herd have stimulated great interest in its welfare in recent years, culminating in the formation of the Fortymile Caribou Herd Planning Team (FCHPT), a diverse group of Alaska and Yukon residents and agency representatives who have shaped management actions on both sides of the border. During the early 1900s, the Fortymile Caribou Herd was thought to be the largest herd in Alaska and among the largest in the world. In 1920, Olaus Murie estimated the herd size at 568,000 caribou (FCHPT, 1995), with a range from Whitehorse in the Yukon Territory to the White Mountains north of Fairbanks.



Fortymile Caribou Herd

Total Range

Summer Range

Pogo Mine EIS

Figure 3.14-4
Fortymile Caribou Herd Range

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19 August 2002 | ABR File: Pogo_PDEIS_Ch3_Wildlife.apr

By the 1930s, the herd had declined to 10,000 to 20,000 caribou. Following this decline, the herd has rarely used the eastern part of its range in the Yukon Territory. By the mid-1950s, the Fortymile Herd had increased to near 60,000 and remained between 40,000 and 60,000 into the early 1960s (FCHPT, 1995). The herd often used areas east of Dawson and, in some years, the entire herd wintered in the Yukon Territory.

Between 1963 and 1973, the herd declined precipitously, from 50,000 to 6,500 animals. A combination of factors contributed to this crash and prevented recovery including, over harvesting by humans in 1964–1967 and 1971–1972, unfavorable winter weather (1966–1969 and 1971), and high wolf numbers (1963–1975). In 1967, Fortymile caribou ceased crossing the Steese Highway, and after 1973 rarely moved into the Yukon Territory (FCHPT, 1995).

Between 1976 and 1990, the herd grew to approximately 22,000, but by 1990 herd growth had ceased. Public concern over the condition of the herd stimulated development of a joint management plan to focus the cooperative efforts of agencies and citizens of both the Yukon Territory and Alaska (FCHPT, 1995). The goal of the plan is to stimulate further growth of the herd and to restore the herd to its previous range in both Alaska and the Yukon. The management plan and related research have received a high degree of public scrutiny, and the research was reviewed favorably by 10 independent, international scientists familiar with wolf biology and predator–prey relationships.

From 1990 to 1995, herd size remained stable at approximately 22,000 caribou. After that period of relative stability, implementation of the management plan coincided with an increase in herd size, estimated at 31,029 caribou in June 1998 (Boertje and Gardner, 1999) and approximately 33,000 by spring 2000. In the fall of 2002 the herd numbered approximately 45,000 (Fogels, 2003). Increases have resulted from a rise in pregnancy rates and improved calf and adult survival. They have been attributed to both reduced predation and favorable environmental conditions.

ADFG has monitored the locations of radio collared female caribou of the Fortymile Herd since late 1991. Radio locations confirm that the Pogo claim block lies southwest of areas used by radio collared female caribou of the Fortymile Herd during the six-month period April through September period. During the autumn and winter seasons, however, range use by the Fortymile Herd is at its maximum and the Pogo claim block lies in an area that has been used by a portion of the herd during 4 to 5 of the last 8 years. Use of the project area probably will increase as herd size increases because the area contains a mosaic of habitat types offering preferred forage species throught out the year (Fogels, 2003). During all other seasons since 1992, radio-collared female caribou were not observed in the Pogo claim block. During calving and post-calving, radio collared female caribou were concentrated in areas more than 25 miles east and northeast of the Pogo claim block (Burgess and Lawhead, 2000).

Incidental observations of caribou by the Applicant's personnel and contractors, as well as tracks seen by ADFG during aerial surveys, tend to confirm that the project area receives light use by small numbers of caribou throughout the year. There has been little indication of any substantial use of the Pogo project area by the herd, however.

Because of their prodigious migrations, caribou can be located in a wide range of habitat types, but the most used habitats in interior Alaska tend to be located at higher elevations in open alpine habitats, particularly during calving, and in open woodlands. From a habitat perspective, alpine meadow, subalpine needleleaf woodland, and alpine dwarf scrub were perceived as areas receiving high use by caribou. Lowland needleleaf forest, upland needleleaf woodland, upland needleleaf forest, and upland north-facing needleleaf forest (all of which tend to have a large component of open canopy) were ranked as medium use, and most other non-aquatic habitats were ranked as low use. Figure 3.14-5 presents caribou habitat value in the project area.

Since 1993, all caribou harvest in the Pogo project area has occurred in the upper Goodpaster River and Eisenmenger Fork UCU. The Pogo claim block lies within the upper Goodpaster UCU, and Eisenmenger Fork UCU lies approximately 15 miles due east of the Pogo claim block. From 1993 to 1998, inclusive, an average of four caribou were taken annually in each of the upper Goodpaster and Eisenmenger Fork UCUs (Burgess and Lawhead, 2000).

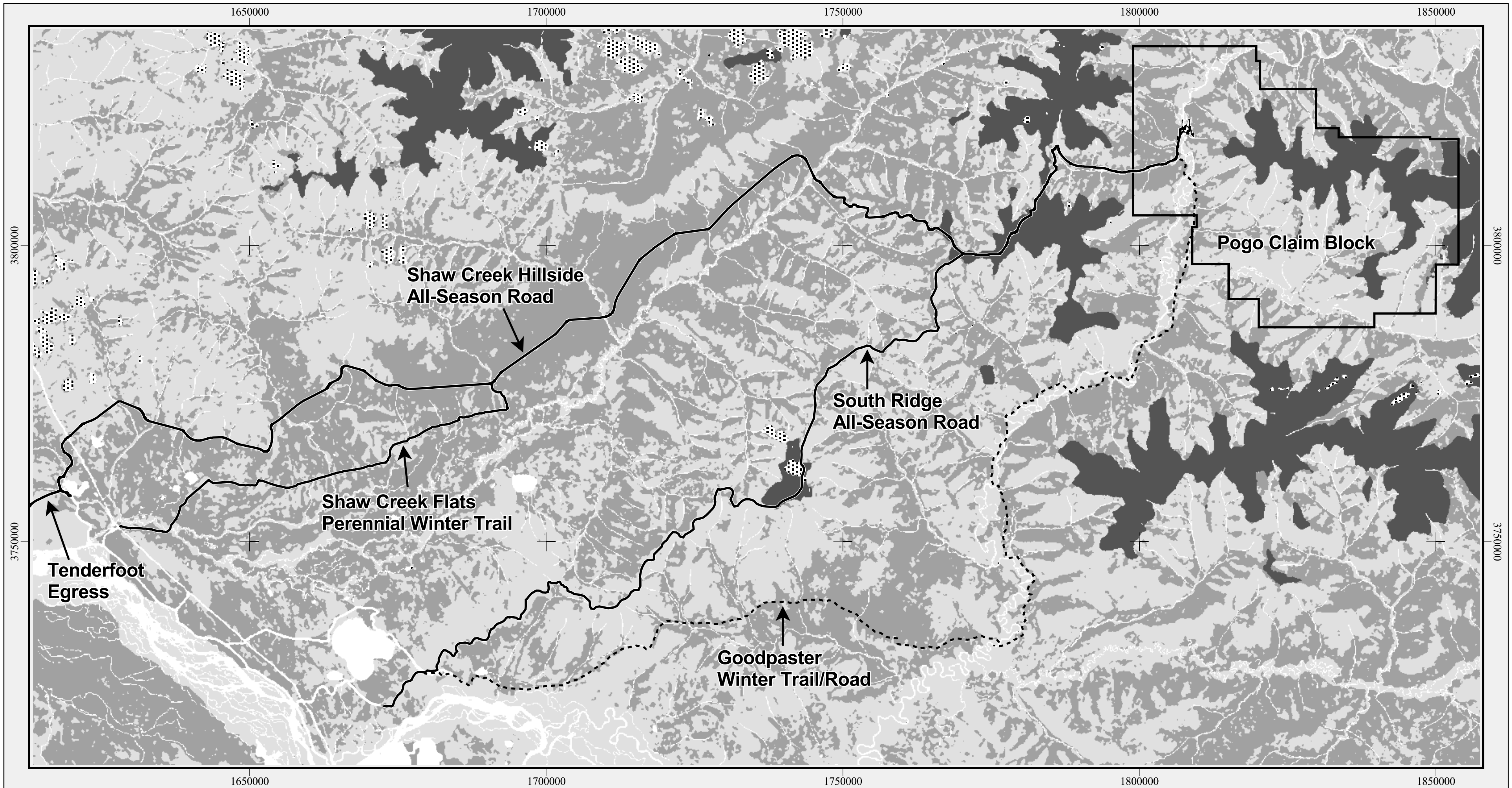
Brown Bear

Brown bears, as well as black bears, are present in the Pogo project area and both have been observed occasionally by project workers around both the surface and advanced exploration camps during summer. Bear populations north of the Tanana River in GMU 20D are considered to be naturally regulated because of low human-induced mortality (Hicks, 1995b). Brown bear habitat in northern GMU 20D comprises the terrain at both lower and higher elevations in the Shaw Creek and Goodpaster River headwaters, where hunter access is more limited.

Brown bears can be found in a variety of habitats, and they tend to exhibit strong seasonal habitat preferences, which often are specific to localized food sources in different regions. In general, brown bears in interior Alaska prefer high-elevation, open alpine habitats in most seasons and they tend to avoid low-elevation closed forests. The following habitats in the project area were considered as high use for brown bears: upland north-facing needleleaf forest, alpine meadow, subalpine needleleaf woodland, and alpine dwarf scrub. Other upland habitats were considered as medium use and non-aquatic lowland and riverine habitats are ranked as low use. Figure 3.14-6 presents brown bear habitat values in the project area.

There are no brown bear concentration areas in the Pogo claim block or in the larger Pogo project area (ADFG, 1986). Spring concentration areas and berry use concentration areas occur at high elevations in the headwaters of the Salcha River to the north and in the South Fork and Volkmar River tributaries to the east. Brown bears, however, have been observed feeding on chinook salmon in the Goodpaster River. Salmon streams are important to interior brown bears, and as the chinook salmon run increases in size this resource will become increasingly important to the bears (Fogels, 2003).

The earliest brown bear population estimate in 1991 was 92 to 109 bears 2 years of age or older in northern GMU 20D (Abbott, 1991). The most recent estimate, in 1992–1994, was 105 to 124 total bears in GMU 20D north of the Tanana River (Hicks, 1995b).



Habitat Value
Caribou

(white)	Negligible
(light gray)	Low
(medium gray)	Medium
(dark gray)	High
(stippled)	Cloud and Shadow

2 0 2 4 6 8 Kilometers

1 0 1 2 3 4 5 Miles

N W E S

Map derived from supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-5
Caribou Habitat Values

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25 July 2002 | ABR File: Pogo_PDEIS_Ch3_Habs.apr

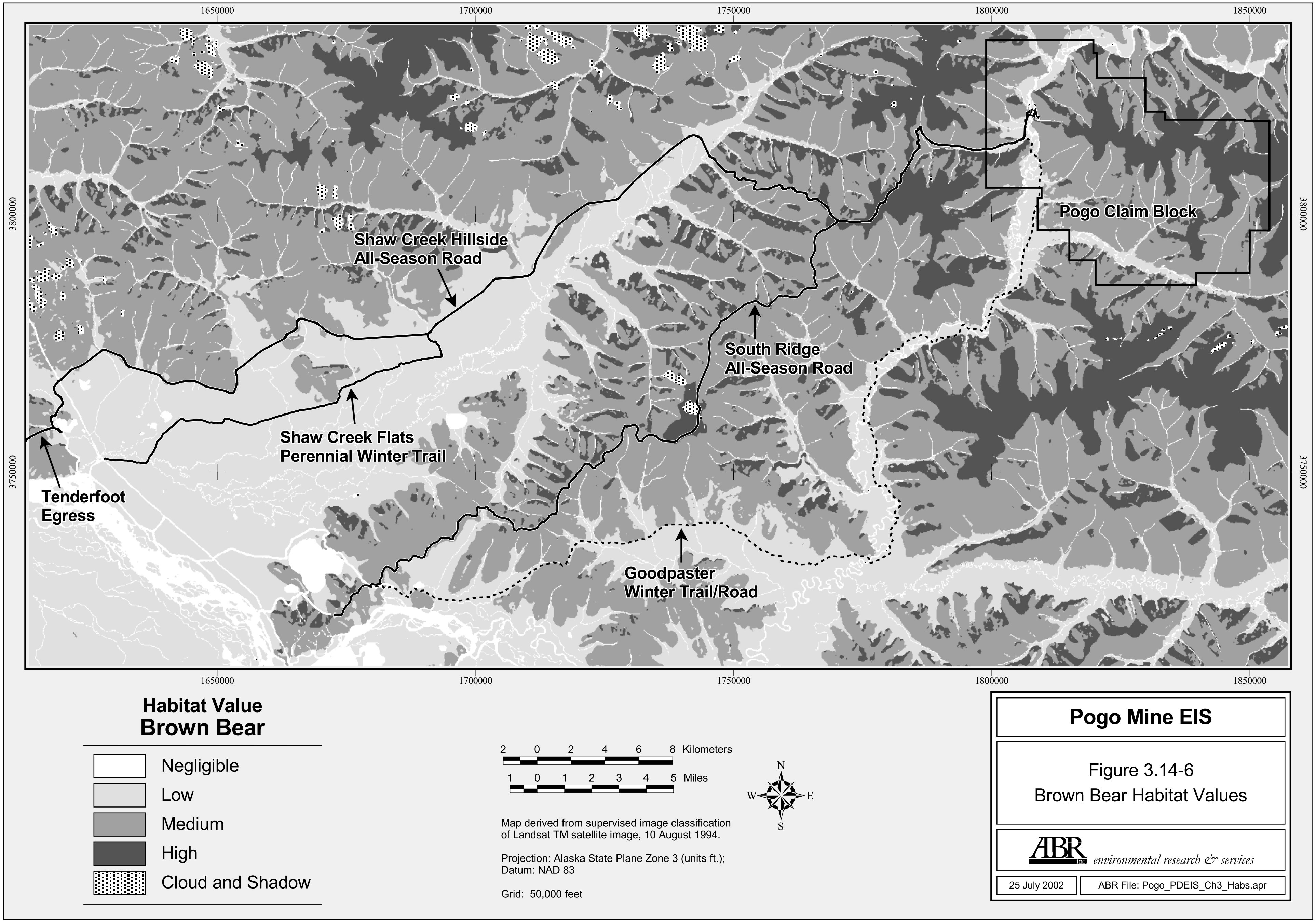


Figure 3.14-6
Brown Bear Habitat Values

Between 1981 and the early 1990s, the management objective in GMU 20D was to provide a stable population with a mean annual harvest of 30 bears. In the early 1990s, harvest was liberalized in northern GMU 20D in an attempt to increase moose productivity (Abbott, 1993a). North of the Tanana River, the management objective was to increase the mean annual harvest to 3 to 10 percent of the bear population until moose calf survival increased to greater than 30 calves per 100 cows for 3 consecutive years. Since 1996, the objective has been to manage bears to maintain an annual harvest of 5 to 15 bears, with 60 percent of the harvest comprising males. Attempts to increase harvest in northern GMU 20D have been moderately successful with mean annual harvest increasing from 1 bear per year to 3 bears per year and the range of annual harvest increasing from 0–2 bears per year to 1–7 bears per year in the last 7 years with more liberal hunting regulations. Harvest was probably not high enough to cause a population reduction, but as the number of hunters increase, bear harvest is also expected to increase and could exceed sustainable yield (Fogels, 2002).

Between 1989 and 1998, annual harvests north of the Tanana River in GMU 20D have ranged from none to seven. During that 10-year period a total of seven bears was harvested in the lower Goodpaster UCU, while eight bears were taken from the upper Goodpaster UCU, with only three bears taken in the Shaw Creek UCU. Thus, an average of less than one bear was harvested annually in each of these UCUs. Approximately 40 percent of the total harvest north of the Tanana came from the Tanana River lowlands UCU accessible from the river, which undoubtedly reflects the distribution of the human population more than that of the bear population. Because of the low reproductive rate for bears, bear populations are sensitive to overharvest and mortality from hunting generally limits population size in accessible areas (Burgess and Lawhead, 2000).

Two characteristics make bears a particular concern in project planning and management: their very low reproductive rate, which makes populations vulnerable to depletion, and their attraction to and ready habituation to human activities, primarily when a food source is accidentally or deliberately made available (Milke, 1977; Follmann *et al*., 1980).

Black Bear

Black bears are distributed throughout the project area, except in treeless alpine habitat favored by brown bears (Hicks, 1996). In GMU 20D black bears are near the northern limit of their range in Alaska.

During spring, black bears in the Pogo project area use moist lowlands where early growing vegetation forms the bulk of their diet (Hatler, 1967). In the fall, they feed primarily on berries found in open meadows or alpine areas. The following habitats in the Pogo project area were considered as high use for black bears: riverine scrub, lowland broadleaf forest, lowland needleleaf forest, and upland broadleaf forest. Aquatic habitats, bluff meadows, cliffs, and alpine habitats were considered to have negligible use, and other habitats were considered as low or medium use by black bears.

Accurate estimates of black bear population size are not available for GMU 20D. However, Hechtel (1991) reported 17.5 adult black bears/100 sq mi in the Tanana Valley. Extrapolation of this density estimate to other portions of GMU 20 resulted in a population estimate of 525 bears north of the Tanana River in GMU 20D (Abbott, 1993b; Hicks, 1996). In the last two decades, black bear populations have been considered stable at moderate densities in GMU 20D (Townsend, 1986). Black bear mortality in this area results from human harvest (legal, illegal, and defense of life and property kills), predation by brown bears, food shortages that affect cub and yearling survival, and flooding of winter dens (Alt, 1984; Hicks, 1996).

Seasons and bag limits for black bear in GMU 20D have not changed since the late 1970s: There is no closed season and the bag limit is three per year. Between 1990 and 1995, the management objective north of the Tanana in GMU 20D was for a harvest of 15 black bears (Abbott, 1993b; Hicks, 1996). In 1995, this objective was changed to allow 35 black bears to be harvested annually (Hicks, 1997c, 1999b).

Most bear harvests in GMU 20D occurs near the road system south of the Tanana River along the Richardson Highway and along major river systems (Hicks, 1996). Total hunter take of black bear in GMU 20D north of the Tanana River has ranged from 2 to 12 between 1987 and 1996, and averaged 5.5 annually, well below the management goal.

During the 9-year period from 1989 through 1998, a total of 11 bears was harvested in the lower Goodpaster UCU, 6 bears were taken from the upper Goodpaster UCU, and 34 bears were taken in the Shaw Creek UCU. Thus, only in the Shaw Creek UCU, with an annual average harvest of four black bears, was an average of more than one bear harvested per year.

Wolf

Gray wolves are present in the Pogo project area and throughout GMU 20D at all times of year, where their primary prey are moose, caribou, and Dall sheep. Wolves have been observed occasionally by the Applicant's personnel and contractors, as reported on wildlife observation forms. One or two packs have been known to range in the project area in the past (Valkenburg and Davis, 1989), and the area now includes two or three permanent packs, with the possibility of additional single or paired wolves (Fogels, 2003). An active den was located in the vicinity of Indian Creek in summer 1998, and as many as 17 wolves were associated with that pack, presumably including pups produced that year at the den (Burgess and Lawhead, 2000).

Wolves are habitat generalists, having few habitat requirements, except that their ranges support adequate populations of prey. For denning, wolves do require well-drained sites with soils suitable for excavation of dens. Adequate sites are unlikely to be limiting to wolves in any area of their range.

Since the early 1900s, wolf populations in the region have fluctuated widely, largely in response to wolf control programs. In the late 1940s and early 1950s, wolves in interior Alaska, as in most other parts of the state, were numerous, but by the late 1950s were reduced to low numbers due to federal wolf control programs (Gasaway *et al*., 1983).

Wolf control ended in 1960, and the population in GMU 20D increased to 200 to 250 animals, (Hicks, 1997a). Because these numbers were considered to be high, a wolf control program was authorized in 1979 in response to decreases in moose abundance that began in the mid-1960s (ADFG, 1984). This control program included aerial shooting permits issued to the public by ADFG. From fall 1979 to spring 1983, 105 wolves were removed from GMU 20D by trappers, ADFG staff, and aerial hunters. The wolf control program ended in 1983, and all harvest since has been conducted by hunting and trapping.

In March 1995, the Alaska Board of Game established the still-current population goal of 15 to 125 wolves for GMU 20D, in view of the low caribou and moose populations and the state legislature's mandate for intensive management of ungulates for human consumption as a priority management goal. The broad population range of the objective was intended to allow temporary reduction of the wolf population to low levels, if needed, to stimulate prey population increases. Also in 1995, the trapping season was extended and a wolf control implementation plan was adopted but never implemented (Burgess and Lawhead, 2000).

Efforts at wolf control in GMUs 20E and 20D during the late 1990s were stimulated in large part by public interest in growing the Fortymile Caribou Herd through intensive management action, as recommended by the FCHPT. These efforts included attempts to increase harvest by trappers within the range of the Fortymile Caribou Herd and a program to sterilize the alpha male and female and translocate other members of those packs believed to have the strongest effect on Fortymile caribou. Wolf harvest increased in the late 1990s as a result of renewed interest in wolf trapping, stimulated by a privately sponsored wolf harvest incentive program in 1995–1997 (the “Fortymile Caribou Calf Protection Program,” which paid $400 per pelt for wolves from the Fortymile Herd’s range). Since 1997, attempts to further reduce wolf numbers have included wolf relocation and sterilization programs. Since the mid-1990s, the distribution of harvest has shifted, largely as a result of interest in increasing the abundance of caribou in northern GMU 20D.Before that time, harvest was 70 to 80 percent from the southern portion of GMU 20D, south of the Tanana River. Since the mid-1990s, harvest has been more evenly divided between southern and northern GMU 20D (Burgess and Lawhead, 2000).

Despite efforts to increase wolf harvest, no substantial reduction in the autumn wolf densities has been detected (Boertje and Gardner, 1999). Autumn wolf densities in the annual range of the Fortymile Caribou Herd (including primarily GMU 20E and northern GMU 20D) have remained relatively stable at six to eight wolves/390 mi^2, although a slight decline was observed after winter 1995–1996, when 57 percent of wolves in those two units were harvested (Boertje and Gardner, 1999).

The most recent population estimate for GMU 20D was 116 to 128 wolves (Hicks, 1995a). The total harvest of wolves from GMU 20D, as estimated from sealing of pelts, was 15 wolves between 1 July 1998 and 30 June 1999 for north and south GMU 20D combined (Hicks, 1999a), down from 38 wolves harvested in 1997–1998 (16 from northern GMU 20D) (Hicks, 1998) and 28 in 1996–1997 (10 from northern GMU 20D) (Hicks, 1997b). Harvest of wolves in the Pogo project area from 1994 through 1998 was concentrated in the upper Goodpaster River UCU (40 wolves) and the Shaw Creek UCU (22) (Burgess and Lawhead, 2000). This concentration undoubtedly reflects the distribution of trapping effort more than the distribution of population size of wolves. In 1997–1998, six wolves from two packs in northern GMU 20D were relocated out of the unit as part of the Fortymile Caribou Management Plan (Hicks, 1998).

Furbearers

Twelve species of furbearers in the project area, excluding wolf, are regularly harvested by humans: wolf, lynx, beaver, muskrat, coyote, red fox, marten, short-tailed weasel, least weasel, mink, wolverine, and river otter. General information on abundance, from ADFG survey and inventory reports, and harvest statistics are available for the six species of furbearers, including wolves and lynx, whose harvested furs must be sealed. Population information is generally lacking for the other species.

ADFG manages the harvest of furbearers under both trapping and hunting regulations, and a representative must seal pelts of species considered sensitive to overharvest: lynx, beaver, river otter, wolverine, and wolf taken anywhere in Alaska and marten trapped in certain GMUs or subunits (not including GMU 20D). The primary purpose of sealing is to gather more detailed information about the harvest. ADFG manages harvest through adjustments to bag limits and seasons for each species in each GMU or subunit. The following descriptions have been taken from more detailed descriptions of furbearers in the project area by Burgess and Lawhead (2000).

Wolverine

Wolverines are wide-ranging carnivores that occupy forests and tundra throughout Alaska (Manville and Young, 1965; Pasitschniak-Arts and Larivière, 1995). Prey include small and large mammals, carrion, birds, eggs, and insects (Magoun, 1985; Pasitschniak-Arts and Larivière, 1995). Population densities of wolverines generally are low and home ranges between 190 and 230 sq mi (500 and 600 km^2) have been reported for males in Alaska (Magoun, 1985; Whitman *et al*., 1986). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), wolverines were considered by trappers to be scarce in GMU 20D. The number of wolverines harvested annually from GMU 20D ranged from 2 to 15 between 1986 and 1999. Wolverine pelts are prized for parka trim and cold-weather clothing. Wolverines tend to inhabit remote areas; habitat loss and human predation are the principal threats to their population (Hornocker and Hash, 1981).

Marten

Marten are restricted to forested areas throughout Alaska (Clark *et al*., 1987). Marten generally require coarse woody debris or trees to provide shelter and pathways under snow (Buskirk, 1983; Paragi *et al*., 1996). Marten diets are composed primarily of small mammals, but they use birds, fish, carrion, insects, fruits, and human food when available (Buskirk and MacDonald, 1984; Ben-David *et al*., 1997). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), marten were considered by trappers to be increasing from scarce to common in GMU 20D. Marten are relatively easy to trap and, depending on pelt prices, they are heavily exploited by trappers.

Mink

Mink inhabit the shores of streams, lakes, and coastlines of the boreal forest in Alaska (Larivière, 1999). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), mink were considered by trappers to be scarce in GMU 20D. Mink prey primarily on animals associated with water, including fish, terrestrial invertebrates, birds, and, to a lesser degree, small mammals (Harbo, 1958; Johnson, 1985).

River Otter

River otters are restricted to aquatic and shoreline habitats. They are not endangered, but are listed in Appendix II of the Convention on International Trade in Endangered Species (CITES), which requires permits for international sale of pelts, principally because of low populations in the contiguous 48 states. River otters feed on a variety of fish, marine invertebrates, and, less commonly, small mammals, birds, and eggs (Larsen, 1983). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), otters were considered by trappers to be scarce in GMU 20D. The number of river otters harvested in GMU 20D ranged from zero to six between 1986 and 1999.

Red Fox

Red foxes occur throughout Alaska, except south of the Chugach Mountains in the Prince William Sound area (Hall, 1981). Small mammals, birds, berries, and insects compose the bulk of the diet of the red fox (Samuel and Nelson, 1982; Eberhardt, 1977). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), red foxes were considered by trappers to be common in GMU 20D.

Beaver

Beavers occur exclusively in association with woody vegetation and fresh water, including streams and large rivers, impoundments and lakes, and even the alpine zone where aspen is available. In the project area, from a habitat perspective, lakes and ponds were identified as essential for beavers. Rivers and streams and lowland meadows were considered as medium use, and all other habitats were ranked as low or negligible use. In most areas, trapping is the main factor limiting the number of beavers per colony (Hill, 1982).

Muskrat

Muskrats are associated with aquatic environments, typically standing or slowly flowing waters containing vegetation, including fresh water marshes near lakes, sloughs, streams, and rivers (Perry, 1982). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), muskrat were considered by trappers to be common in GMU 20D.

Coyote

In general, coyotes are not abundant in Alaska and occur mainly in the southern portions of the state, especially in areas where wolves have been reduced or eliminated (Bee and Hall, 1956; Manville and Young, 1965; Hall, 1981). Coyotes are highly adaptable, denning in a variety of habitats and eating a wide variety of animal and plant foods (Bekoff, 1982). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), coyotes were considered by trappers to be increasing from common to abundant in GMU 20D where they are more common south than north of the Tanana River.

Weasels

Ermine (short-tailed weasels) and least weasels are common throughout Alaska, from arctic tundra to coastal forest (Hall, 1981), but generally are not sought by trappers because of their small size and low commercial demand. They are predators primarily of voles and lemmings, although other small vertebrates and insects may also be consumed. At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), weasels were considered by trappers to be increasing from common to abundant in GMU 20D.

3.15 Threatened, Endangered, and Sensitive Species

American Peregrine Falcon

The American Peregrine Falcon was removed from the endangered species list in August 1999, but it is still treated as a species of concern during the Section 7 consultation process under the ESA by the USFWS, and recovery will continue to be monitored closely for 5 years. This subspecies originally was listed as endangered after experiencing significant declines in population size and productivity, primarily due to pesticide contamination. Since the late 1970s, however, it has recovered over much of its range in Alaska (Ambrose *et al.*, 1988).

This species has recently begun to reoccupy areas after pesticide-induced, continent-wide declines in the 1960s and 1970s depleted their numbers on all rivers in interior Alaska (Ambrose *et. al.,* 1988). Since monitoring surveys in the vicinity of the proposed project were initiated by the USAF in 1994, the number of occupied sites in the Pogo project area has increased from two to six. Five cliff-nesting habitats were identified in the Pogo project area (Figure 3.15-1): Shaw Creek Bluff, Sevenmile Creek and the Goodpaster River, lower Central Creek, Indian Creek, and Glacier-Rock Creek (Burgess and Ritchie, 2000). During the 4-year period (1997-2000) during which Peregrine Falcon nesting surveys were conducted by the Applicant, occupied nests were observed in each of these habitats at least once, and all five are therefore considered to be Peregrine Falcon nesting habitat. This species is present in interior Alaska from late April until late September.

Northern Goshawk

The Northern Goshawk is considered a sensitive species across its range in Alaska. Although not protected under the ESA, resource management agencies encourage surveys for this species and their nest sites. In addition, goshawks have been surveyed during environmental assessment studies for other development projects in interior Alaska (Ritchie, 1981; Roseneau and Bente, 1981; Anderson *et al*., 1997).

The Northern Goshawk is a year-round resident of interior Alaska forests, preferring to nest and forage in deciduous and mixed forests. This species' abundance varies with population cycles of its principal prey species – snowshoe hare and grouse. Because hare abundance has increased over large areas of interior Alaska in the last few years, goshawk numbers are expected to increase accordingly. When prey numbers are low, suitable habitats and territories can go unoccupied for long periods. Therefore, nest surveys often identify many inactive nests. Figure 3.15-1 presents the results of Northern Goshawk surveys in 1999 and 2000 along potential access corridors and at the mine site (Burgess and Ritchie, 2000).

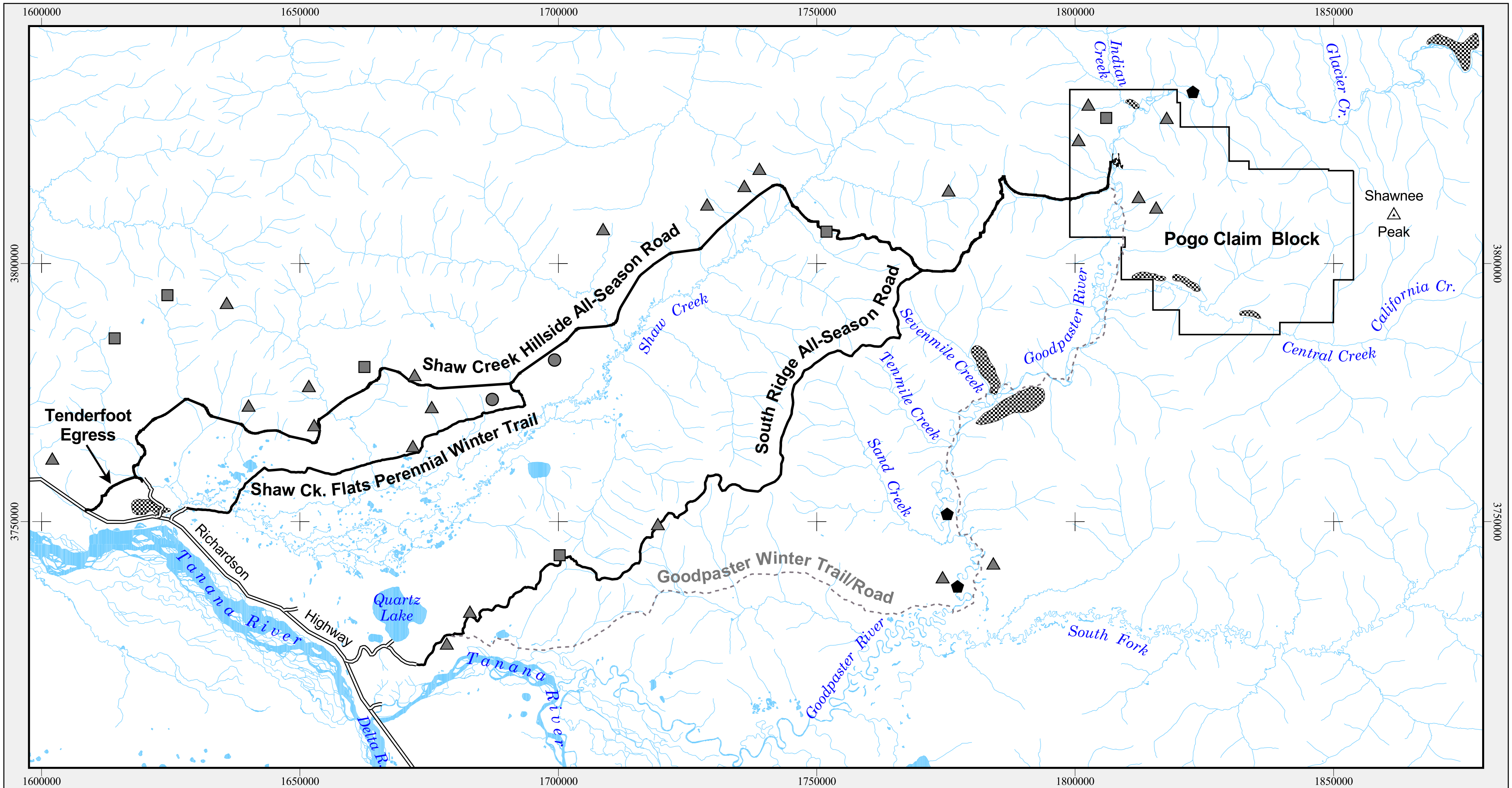
Bald Eagle

The Bald Eagle receives special protection under the Bald Eagle Protection Act, as does the Golden Eagle, because of its similarity of appearance. The Bald Eagle Protection Act prohibits the taking, harassment, or disturbance of eagles.

Bald eagles are present in interior Alaska, primarily during summer months, although they occasionally winter near open water areas in the Interior. The number of breeding pairs has increased along interior Alaska rivers in recent years (Ritchie and Ambrose, 1996), and there appears to be additional unoccupied, suitable habitat along the Goodpaster River and Shaw Creek. Only three nests, however, are known in the Pogo project area (Figure 3.15-1). One is approximately 2.5 miles northeast of the exploration camp, and the other two are located at least 12 miles away along the Goodpaster River near or below Sand Creek. No nests were identified along any of the potential surface access routes or in the Shaw Creek Flats (Burgess and Ritchie, 2000).

Harlequin Duck

The Harlequin Duck is considered a species of concern because it was formerly a Category 2 candidate species. Although the Harlequin Duck is not formally protected under the ESA, resource management agencies continue to encourage research and implementation of management practices that would stop population loss and alleviate threats to preclude the possible future need for listing.



Legend

Northern Goshawk Sites:
(may represent > 1 nest)

- ▲ Inactive 1999–2000
- ■ Active 1999
- ● Active 2000

⬟ Bald Eagle Nests

Cliff habitat

Note: 1997–2000 survey areas were based on conceptual access alternatives. Due to the sensitive nature of raptor cliff nest locations, nests are not shown. Specific site information can be obtained from the author.

N, S, E, W

5 0 5 10 Kilometers

2 0 2 4 6 Miles

Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

Pogo Mine EIS

Figure 3.15-1 Project Area Cliff-nesting Habitat, and Northern Goshawk and Bald Eagle Nest Sites

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26 July 2002 | ABR File: Pogo_PDEIS_Ch3_Wildlife.apr

This species breeds along swiftly flowing mountain streams in interior Alaska. It is present in the Interior from late spring until late summer. Although uncommon, they are likely to be found along suitable steam habitats undisturbed by human activities. A number of these habitats occur along the Goodpaster River and its tributaries, including Central and Indian creeks (Burgess and Ritchie, 2000).

Pairs of Harlequin Ducks were found at three locations in the Pogo claim block in 1997–2000: on the Goodpaster River between Indian and Liese creeks (1999), between Liese and Pogo creeks (1999, 2000), and on Central Creek near the mouth of Sonora Creek (1998, 1999) (Burgess and Ritchie, 2000). A single male was observed on the Goodpaster River near the mouth of Indian Creek in 1997. The consistent presence of Harlequin Duck pairs at the end of May strongly suggests that breeding occurs in the claim block vicinity. Other sightings outside the claim block occurred on the Goodpaster upstream of Indian Creek, between West and Central creeks, and near the junction with the South Fork (Burgess and Ritchie, 2000).

Olive-Sided Flycatcher

The Olive-sided Flycatcher is similarly a species of concern, formerly listed as a Category 2 candidate species. Little is known of its population status in Alaska, but evidence suggests declining numbers across its range, similar to declines for several other neotropical migrant songbirds. Resource management agencies encourage research and management practices that may protect the species.

This species is present in interior Alaska only during late spring and summer months. Open black spruce woodland comprises the preferred breeding habitat for this species in the Pogo project area. During four annual surveys near the mine site from 1997 through 2000, five territorial males were recorded at four locations. Two of these locations were west of the Goodpaster River; one was south of the existing 1525 Mine Portal on the south side of Pogo Creek; and the fourth was in Liese Creek Valley, south of the creek on the north side of Pogo Ridge, in the vicinity of the proposed entrance to the 1875 Portal (Burgess and Ritchie, 2000).

Lynx

The lynx is a species of concern that has been proposed for listing as threatened in the Lower 48 states because of shrinking range and decreasing abundance. The species has been listed on Appendix II of CITES since 1977, and ADFG closely manages trapping harvests during periods of low abundance (e.g., during snowshoe hare declines). Populations in Alaska are considered healthy, but management agencies encourage monitoring and research to prevent future problems (Burgess and Ritchie, 2000).

Lynx occur throughout most of the boreal forests of Alaska (Tumlison, 1987), including mixed spruce–hardwood forests, open spruce muskegs, and aspen–spruce woodlands, but they use shrub habitats as well (Berrie, 1973; Stephenson, 1986). All of these habitat types are present in the project area, and lynx have been sighted there where suitable habitats and prey species occur. Currently, snowshoe hares are relatively abundant in interior Alaska, and lynx numbers have been rising in the last several years, judging from the increasing proportion of young animals taken by trappers (Taylor 1993, 1994, 1995; James 1996).

Rare Plants

Five rare plants are also species of concern due to rarity in their present-day ranges, including Alaska. They, too, were formerly listed as Category 2 candidate species, and surveys for their presence are encouraged to prevent significant impacts.

None of these five species was found in surveys of favorable habitat in the project area. *Aster yukonensis* typically is found on riverbanks, dry streambeds, and river deltas (Murray and Lipkin, 1987), but a search of riverine sand and gravel bars along the Goodpaster River in the vicinity of the claim block found none (Burgess and Ritchie, 2000). The other four species (*Cryptantha shackletteana, Draba murrayi, Eriogonum flavum* var*. aquilinum, and Podistera yukonensis*) generally are restricted to south-facing bluffs (characterized by remnant steppe vegetation) and low-elevation rubble slopes along interior rivers (Murray and Lipkin, 1987). These species have been found primarily along river bluffs (rubble slopes and steppe remnants) in the Tanana and upper Yukon River drainages. Although some suitable habitats (south-facing rubble slopes) are present in the project area, these sites are in upland areas away from the Goodpaster River, not in the typical river bluff habitats in which these rare plants have been found elsewhere (Burgess and Ritchie, 2000).

3.16 Socioeconomics

3.16.1 Socioeconomic Project Area

Most of the socioeconomic effects stemming from development and operation of the Pogo Mine project are expected to occur in the Delta Junction area which lies within the Southeast Fairbanks Census Area and in the Fairbanks North Star Borough (FNSB). The Southeast Fairbanks Census Area encompasses 25,934 sq mi, and straddles the Alaska Highway between the Alaska/Canada border and the FNSB. The census area's population of approximately 6,200 residents is sparsely distributed in 18 small communities that range in population from approximately 25 in Alcan to approximately 1,400 in Tok.

The Delta Junction vicinity is an unorganized area that includes the communities of Delta Junction, Big Delta, Fort Greely, and Healy Lake, as well as residents widely dispersed throughout the northwestern portion of the Southeast Fairbanks Census Area.

Delta Junction is located approximately 38 miles from the project site and could be linked to the mine by either an all-season road or a winter road. A portion of the mine's workforce could be drawn from Delta Junction and its surrounding population, depending on access to the mine. Also, nonresident miners might choose to reside in the community, again depending on how access to the mine is developed.

Employment and income effects in the Delta area could include the small and isolated Native village of Healy Lake. Healy Lake is located 31 miles from the proposed mine site. The village is accessible only by air, snowmachine in winter, boat in summer, and vehicle in the winter when an ice bridge is constructed across the Tanana River.

The FNSB boundary is only 7 miles from the Pogo Mine project site. A large component of the mine workforce could be drawn from Fairbanks, 85 miles northwest of the project site. In addition, Fairbanks would serve as the service and supply center for the mine. However, because the effects in Fairbanks of mine development on employment, income, and public services would be very small relative to the community's large economy and well-developed infrastructure, only general (rather than detailed) baseline data is provided for Fairbanks.

It is important to note that relatively little socioeconomic data is available for the Delta area specifically. Many economic and population data sources combine the Delta area with all other communities in the Southeast Fairbanks Census Area. In the following analysis, data is presented for Delta Junction (where available), the Delta area (including the communities of Big Delta, Delta Junction, Fort Greely, and Healy Lake), and the Southeast Fairbanks Census Area (in addition to the FNSB). Baseline data is included for Fort Greely, a military base that has been the economic backbone for the Delta area. Approximately one-quarter of the civilian and uniformed personnel stationed at Fort Greely live off the base (Alaska Department of Community and Economic Development [ADCED], 2000).

This socioeconomic analysis focuses on the communities in the Delta Junction area. Other communities in the Southeast Fairbanks Census Area, such as Tok (population 1,393, according to the 2000 Census), Northway (274), Tanacross (140), and Dot Lake (57), also play a role in the regional economy, although they would be unlikely to experience direct socioeconomic effects associated with development of the Pogo Mine. Northway, a predominately Alaska Native community situated 7 miles off the Alaska Highway and 165 miles from Delta Junction, is the most distant from the mine. Northway actually includes three settlements: Northway Junction, Northway (on the airport spur road), and the Native village (2 miles north of the airport).

Tok, located at the junction of the Alaska and Glenn highways, is about 100 miles southeast of Delta Junction. Considered the "Gateway to Alaska," Tok is the first major community upon entering Alaska on the Alaska Highway. Tanacross is a community with a population that is 90 percent Alaska Native. It is located just off the Alaska Highway on the south bank of the Tanana River, about 95 miles from Delta Junction. Dot Lake comprises two small communities, Dot Lake and Dot Lake Village, located on the Alaska Highway about 60 miles southeast of Delta Junction.

3.16.2 Delta Area

Population

Over the past decade the population of the Delta area declined from approximately 2,300 residents to approximately 1,700 residents in 2002 as a result of closure of Fort Greely (ADOL, 2000a).

Within the Delta area, however, some locales have experienced growth while others have declined. For example, Delta Junction, the community closest to the Pogo Mine project, experienced a 23 percent increase in population between 1991 and 2000, from 681 to 840 residents during the 10-year period (ADOL). Meanwhile, Fort Greely's population dropped by 62 percent (the result of a military base phase-out). Table 3.16-1 presents Delta area population estimates from 1991 to 2000. The increase in population in Big Delta in 2000 is likely the result of methodological changes in reporting rather than actual growth.

Table 3.16-1 Delta Area Population Estimates, 1991 – 2000

Locale	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Big Delta CDP	455	482	496	492	500	515	511	749	808	829
Delta Junction City	746	783	807	843	838	877	889	840	890	856
Fort Greely CDP	1,133	960	915	809	721	684	635	461	23	0
Healy Lake CDP	54	57	59	58	59	61	61	37	34	31
Delta Area Totals	2,388	2,282	2,277	2,202	2,118	2,137	2,096	2,087	1,755	1,716

Source: Alaska Department of Labor and Workforce Development, Research and Analysis, Demographics Unit, for 1993 through 1999 and 2001-2000 data.

CDP = Census Designated Place.

2000 data is from the U.S. Census Bureau.

The most recent data on the racial composition of Delta Junction and the Delta area population is from the 2000 census. Based on 2000 data, Big Delta and Delta Junction were predominantly White (89 percent or more); Fort Greely was approximately two-thirds White; and Healy Lake was 73 percent Alaska Native. Table 3.16-2 presents a breakdown by race and ethnicity of the Delta area.

Table 3.16-2 Population Distribution by Race and Ethnicity (Percent), Delta Area, 2000

	Race					Ethnicity
Locale	White	American Ind., Eskimo, Aleut	African American	Asian	Other	Hispanic Origin
Big Delta CDP	95.5	1.5	0.1	0.5	2.4	2.5
Delta Junction City	91.4	4.0	1.1	1.0	2.5	0.8
Fort Greely CDP	65.7	1.3	19.7	1.3	11.9	15.4
Healy Lake CDP	27.0	73.0	0.0	0.0	0.0	0.0
Delta Area Totals	86.1	3.7	4.8	0.9	4.5	4.6

Source: U.S. Bureau of the Census. Published by Alaska Department of Labor and Workforce Development, Research and Analysis, Demographics Unit.

CDP = Census Designated Place

Recent data on the racial and ethnic composition of the Southeast Fairbanks Census Area shows the Delta area (as defined above) accounts for approximately one-third of the population of the Southeast Fairbanks Census Area. This data indicates that the White component of the census area's population has not increased since 1990. During the same period, the African American component of the population dropped from 4.9 percent to 2.0 percent. As a percentage of total population, all other minority populations, except "all other," declined during the 1990-to-2000 period. This decline is an expected effect of military base closure. Russian speakers, including those mostly Russian or Ukrainian, account for 25 percent of the population in the Delta region (Korvola, 2000b). Table 3.16-3 presents the percent distribution and population, by race and ethnicity, of the Southeast Fairbanks Census area from 1990 to 2000.

According to ADOL data, the population of Healy Lake was 61 in 1999. However, others have estimated that about 40 people live in Healy Lake, with perhaps as few as 25 permanent residents (Korvola, 2000b). The community of Healy Lake was disbanded almost entirely in the mid-1940s, and the 1970 census reported no residents at all. In 1980 there were 33 residents, according to the census. All families involved in the re-establishment of Healy Lake are related to families documented to have resided there since at least 1910. At the time of the 2000 census, the population of Healy Lake was 37 people, including 10 family and 3 nonfamily households. Of the 37 people residing in the community, 27 classified themselves as Alaskan Native.

Table 3.16-3 Percent Distribution and Population Estimate, by Race and Ethnicity, in the Southeast Fairbanks Census Area, 1990 and 2000

	April 1, 1990		April 1, 2000		Change 1990 - 2000	
	Percent	Population	Percent	Population	Percent	Population
Race						
White	79.0	4,670	79.0	4,877	0.0	207
Native American	13.0	770	12.7	785	-0.3	15
African American	4.9	290	2.0	122	-2.9	-168
Asian/Pacific Islander	1.4	82	0.8	51	-0.6	-31
Other	1.7	101	5.5	339	3.8	238
Total	**100.0**	**5,913**	**100.0**	**6,174**	**0.0**	**261**
Ethnicity						
Hispanic Origin	3.0	177	2.9	167	0.0	-10

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section, Demographics Unit

Employment

Table 3.16-4 summarizes the latest available employment data for the Delta area. The table includes annual average employment for the Delta census subarea, which includes Big Delta, Delta Junction, Fort Greely, and Healy Lake, as well as the sparsely populated areas of Gerstle River, Donnelly, Delta Camp, Johnson River, and Shaw Creek. The table includes only nonagricultural wage and salary employment. It does not include uniformed military or self-employed workers.

The federal government was the largest single employer in 2001 in the Delta area, with 143 civilian personnel. Another 22 active duty military were stationed at Fort Greely in 2001 (ADOL). Including the federal government, the Delta Greely School District (DGSD), the State of Alaska, and the City of Delta Junction, government accounted for about 40 percent of the civilian employment in the Delta area.

Table 3.16-4 Delta Area Civilian Employment, 2001, Annual Average, by Employer

Business/Agency Name	Annual Average Employment
Federal Government	143
Delta Greely School District	93
State of Alaska	39
IGA Food Cache	38
Alyeska Pipeline Service Company	36
Schooley Group	25
Whitestone Farms, Inc.	20
Alaskan Steakhouse and Motel	16
Family Medical Center	15
Total All Others	373
Grand Total Employment	**720**

Source: Alaska Department of Labor and Workforce Development, Annual Alaska Population Overview

In 1990, Fort Greely's population was nearly twice that of Delta Junction. However, the 1995 Base Realignment and Closure Act called for closure of the army base. By 2001, Fort Greely's population totaled only 23 residents (the number of personnel stationed at Fort Greely actually began declining in 1992 after peaking at 489 active duty personnel). In addition to the loss of more than 450 active military personnel, the area has also lost 230 civilian jobs since employment peaked in 1993 at 948 jobs.

The loss of the area's largest employer (and about half of the region's economic base) has prompted local residents to look for other economic development opportunities. The Fort Greely Re-Use Plan includes, among other projects, use of the base as a NMDS site. Construction work is currently under way on a $325 million facility to test technology for destroying missiles in mid-course (ADOL, 2002). The facility is expected to be completed in 2004. Approximately 500 workers would be employed during the peak of the construction effort.

Other basic industries (those that draw new money into the Delta area) include state government, tourism, TAPS pipeline maintenance, mining, and agriculture. The DGSD is the second largest employer in the Delta area. In 2001, the district had 93 employees. School district employment has declined by about 30 percent since 1999. The DGSD is supported entirely by state and federal government funds. Other state government-related jobs in the Delta area include ADOT/PF positions.

Each year approximately 120,000 highway travelers pass through the Delta area, traveling to or from Fairbanks (McDowell Group, 2000). Many of these travelers pass through without spending much (if any) in the area; however, some spend money on fuel, food, lodging, and other miscellaneous services.

The Alyeska Pipeline Service Company is an important provider of high-paying, year-round jobs in the Delta area. As shown in Table 3.16-4, Alyeska's pipeline operations and maintenance activity in the area accounted for an annual average of 36 jobs. Annual payroll for these jobs likely totals between $1.5 million and $2 million.

Mineral exploration activity, coupled with the training opportunities made available through the Delta Mine Training Center (DMTC), has created mining industry employment opportunities for local residents. No data is available on the number of local residents employed in the mining industry. However, data from the training center indicates that 46 students have secured employment in the mining industry throughout Alaska.

Because agricultural employment is not reported by ADOL, there is no current data available on the role of agriculture in the local economy. It has been reported that in 1997 there were 71 farms covering 64,660 acres of land in the postal zip code area 99737. Farmers spent $2.98 million, and assuming that they at least broke even that year, the gross income from agriculture is estimated at about $3 million. In 1997 there were 5,900 acres in barley, 1,200 acres in oats, and 8,000 acres in hay and silage, and 1,400 cattle, 40 sheep, and an undisclosed number of hogs were raised. The four commercial greenhouses in the zip code area produced approximately $100,000 of income from plant sales. According to Korvola (2000b), agricultural activities in the Delta area have been severely hampered by adverse weather conditions in recent years. Anecdotal information suggests that farmers in the region generally supplement their incomes with other jobs in the community.

The Healy Lake economy is based on subsistence fishing and hunting in the summer and fall and trapping in the winter. Some residents work outside the village in Fairbanks, on the North Slope, or on the Pogo Mine project and seasonally at Harding Lake. At least two individuals have full-time employment with the local tribal government. During the last 5 years, there have been some federally funded building and infrastructure improvements at Healy Lake. Local hire at Davis-Bacon wages has been an important component of these projects (Korvola, 2000b). As in most villages in Alaska, public assistance provides an important source of cash for village residents.

Unemployment

According to the 2000 census in Delta Junction, 6.8 percent of potential workers were unemployed and 40.9 percent were not in the labor force in 2000. It is important to note that the Bureau of the Census and ADOL do not define unemployment in the same way. Census data reflects employment status at a specific point in time (in 2000) while ADOL data reflects an annual average, based on unemployment insurance claims. Table 3.16-5 presents unemployment rates for the Delta area in 2000.

Table 3.16-5 Unemployment Rates, Delta Area, 2000

Locale	Percent Unemployed	Percent of Adults Not in Labor Force
Big Delta	12.8	48.4
Delta Junction	6.8	40.9
Fort Greely	0.7	23.8
Healy Lake	11.6	34.9

Source: U.S. Bureau of the Census.

In 2001, unemployment in the Southeast Fairbanks Census Area averaged 10.7 percent, ranging from a high of 15.5 percent in January to a low of 8.0 percent in July. Annual employment rates for the Southeast Fairbanks Census Area are presented in Table 3.16-6. This data highlights the seasonal nature of the local economy.

Table 3.16-6 Unemployment Rates, Southeast Fairbanks Census Area, 1992 to 2001

Income	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Monthly Peak	19.0	17.8	18.6	18.4	20.5	20.3	14.5	14.8	16.5	15.5
Monthly Low	8.3	7.3	8.0	8.1	7.7	7.8	5.7	6.4	9.0	8.0
Annual Average	13.4	12.9	13.2	12.6	13.7	12.6	9.2	10.1	11.6	10.7

Source: Alaska Department of Labor and Workforce Development.

Income

The most recent income data available for the Delta area specifically is from the 2000 census. In 1999, median household income in Delta Junction was $43,500, 19 percent below the Alaska average of $51,571. Median family income in Delta Junction was $58,250, about 1 percent below the statewide average of $59,036. Delta Junction per capita income was $19,171, the highest level in the Delta area, but below the Alaska statewide average of $22,660. In the Delta area, income levels were lowest in Fort Greely, where 10.4 percent of the residents lived below the federal poverty level. Table 3.16-7 presents Delta area household, family, and per capita income in 1999.

Table 3.16-7 Delta Area Household, Family, and Per Capita Income, 1999

Income Category	Delta Junction	Big Delta	Fort Greely	Healy Lake
Median Household Income	$43,500	$49,000	$33,750	$51,250
Median Family Income	$58,250	$53,125	$32,969	$53,750
Per Capita Income	$19,171	$14,803	$12,368	$18,128
Percent Below Poverty	19.4	30.0	10.4	9.1
Persons in Poverty	163	197	45	5

Source: U.S. Census Bureau.

Between 1996 and 2000, per capita income in the Southeast Fairbanks Census Area increased at an annual rate of 3.3 percent, slightly below the statewide average growth rate of 3.4 percent and well below the national average of 5.0 percent. Table 3.16-8 presents per capita income for the Southeast Fairbanks Census Area from 1996 to 2000.

Table 3.16-8 Southeast Fairbanks Census Area Per Capita Income, 1996 to 2000

Census Area	1996	1997	1998	1999	2000	Average Annual Change
S.E. Fairbanks Census Area	$19,676	$20,669	$20,724	$21,580	$22,376	3.3%
State of Alaska	$25,901	$26,898	$27,645	$27,994	$29,642	3.4%
United States	$24,270	$25,412	$26,893	$27,843	$29,469	5.0%

Source: U.S. Department of Commerce, Bureau of Economic Analysis (ADOL, 2000b)

Wage and salary employment and payroll data can serve as a good indicator of the earning opportunities available in an area. Wage and salary data is not available for the Delta area because of confidentiality restrictions; however, data for the Southeast Fairbanks Census Area is informative.

Table 3.16-9 provides average annual employment, total payroll, and average monthly wages by industry. This data further highlights the importance of government employment and payroll in the area. Monthly wages paid by federal, state, and local governments combined are 70 percent above the private-sector average for the census area.

Other analysts have noted the importance of supplemental income sources such as retirement incomes and public assistance payments. Public assistance payments paid to residents in zip code 99737 (which encompasses Delta Junction, Fort Greely, Dot Lake, and Paxson), totaled approximately $1.6 million in Fiscal Year (FY) 2000 (Korvola, 2000b). Korvola also notes that public assistance payments to the Russian-speaking immigrant population may be playing an increasingly important role in the area’s economy. Table 3.16-10 presents the number of households and individuals receiving public assistance payments in zip code 99737 in FY 2000.

Table 3.16-9 Employment, Total Wages, and Annual Average Monthly Wage by Industry, Southeast Fairbanks Census Area, 2001

Industry	Average Annual Employment	Total Annual Wages ($)	Average Monthly Wage ($)
Private Sector Totals	917	22,612,599	2,055
Mining	6	392,923	-
Construction	44	1,615,675	3,060
Manufacturing	19	343,355	1,506
Transportation, Communications, Utilities	225	10,507,160	3,892
Trade	343	5,372,436	1,305
FIRE	11	170,638	1,293
Services	266	4,210,412	1,319
Government Total	593	24,944,001	3,505
Federal	203	10,514,300	4,316
State	125	5,810,423	3,874
Local	265	8,619,278	2,710
All Industries Average/Total	1,510	47,556,600	2,625

Source: Alaska Department of Labor and Workforce Development.

Table 3.16-10 Public Assistance Payments to Residents in zip code 99737 in FY 2000

Program	# of Households	# of Individuals	Amount
Temporary Assistance Program	79	381	$795,159
Food Stamps	437	437	$433,878
Adult Assistance	89	89	$339,573
Medicare/Medicaid	435	852	NA

Source: Korvola (2000b), from Alaska Department of Health and Social Services.
NA = Not applicable because paid directly to health provider who might not be in the same zip code area.

Local Government Organization, Powers, and Finance

The City of Delta Junction was incorporated as a second-class city in 1960. It is governed by a seven-member city council. The city operates under a strong mayoral form of government. The city administers grants from the State of Alaska and federal sources, including state revenue sharing funds, roads and highway funds, grants from the Office of Economic Adjustment, U.S. Department of Defense, and ADCED (Hegarty, 2000). As a second class city, Delta Junction may, by referendum, levy property taxes. However, the city does not currently levy a property tax. It also does not levy a sales tax. The city's FY 2001 budget totaled approximately $400,000. Table 3.16-11 presents the City of Delta Junction budgets for the years 1998 to 2001.

The City of Delta Junction provides road maintenance services, which are limited to snow plowing on main roads in the city in winter. The city maintains and staffs part-time a community center and a library, which are in the same building as the City Hall. Households have individual wells and septic systems. Refuse is collected by a private firm, Delta Sanitation, and is deposited in the city-owned permitted landfill. Electricity is provided by GVEA, and residents and businesses generally heat with fuel oil (Korvola, 2000b).

Other local governing organizations in the Delta area include the Deltana Community Corporation and the Delta Greely Community Coalition. The Deltana Community Corporation is a nonprofit organization that acts as the fiscal agent for funding improvements outside the City of Delta Junction. The corporation's purpose is to encourage infrastructure and economic development, as well as coordinate emergency planning (Hegarty, 2000).

The Delta Greely Community Coalition was formed in 1995 to coordinate recovery efforts related to the closure of Fort Greely. The coalition has a 13-member board of directors and a professional staff of three. The board includes representatives of the Delta City Council, Deltana Community Corporation, Delta Chamber of Commerce, Delta Chapter of the Farm Bureau, DGSD, retired military and civil service employees, and active civil service employees (Hegarty, 2000).

The village of Healy Lake is an unincorporated community that is governed by the federally recognized Healy Lake Tribal Council. Residents are shareholders in the for-profit Doyon Regional Corporation and the Mendas Cha-ag Native Corporation, that are the Alaska Natives Claims Settlement Act (ANCSA) regional and village corporations for the area, respectively. The nonprofit Tanana Chiefs Conference (TCC), based in Fairbanks, provides a range of health care, social, and economic services to the residents of Healy Lake.

Table 3.16-11 City of Delta Junction Budgets, FY 1998 to FY 2001

Revenues	FY 98	FY 99	FY 00	FY 01
State Municipal Assistance	52,457	49,894	33,696	30,145
Transfer in from Permanent Fund	0	52,234	32,000	32,000
Transfer from General Fund	0	0	31,000	0
Revenue Sharing	28,310	28,105	25,923	25,027
Payment in Lieu of Taxes	0	230,264	220,000	235,434
Correction Facility	0	62,500	187,500	0
Fire and Ambulance Services	5,910	69,145	40,000	50,000
Community Center and Library	13,855	21,613	18,500	13,500
Electric & Telephone Coop Tax	5,512	4,850	4,800	5,200
Sanitary Landfill Revenue	4,700	4,800	4,700	4,700
Airport Tie-Downs	0	4,690	5,000	5,000
Other[1]	9,324	6,739	27,898	3,198
Miscellaneous Revenue	204,933	6,818	3,500	3,500
Total	325,001	541,652	634,517	407,704
Expenditures				
Administration	74,323	122,564	126,245	161,284
Correction Facility/FG Reuse	0	20,909	187,500	0
Community Center and Library	15,216	33,139	54,855	52,680
Fire Department & Rescue Squad	17,787	36,709	51,127	42,966
Sanitary Landfill	1,654	1,173	2,910	NA
Street, Facility/Runway Maintenance	20,881	28,371	21,691	33,749
911 Activity	11,281	45,743	88,415	NA
Other	2,488	22,931	29,574	8,882
Total	**143,630**	**311,539**	**562,317**	**399,111**

Source: The City of Delta Junction

1 Includes revenues from and expenditures for hockey, land sales, the park, cemetery, games & amusement, and alcohol tax sharing.

Health Care and Public Safety

The Delta area's nearest public hospital is in Fairbanks. Providers listed below offer limited heath care services locally, some on a "visiting clinic" basis:

- Delta Junction Family Medical Center
- Crossroads Family Dentistry
- Delta Public Health Office
- Fairbanks Community Mental Health
- Deaf Community Services
- Alaska Department of Health and Social Services

Police, rescue, and fire-suppression services are provided by the following organizations.

- Alaska State Troopers
- Delta Rescue Squad
- Rural Deltana Fire Protection District

In the village of Healy lake, a clinic was built with federal funding through the TCC and completed in February 1998. The clinic has a full-time health aide through the TCC Health Aide program and Indian Health Service (Korvola, 2000b).

Education

Educational institutions active in the Delta area include the DGSD and DMTC. Whitestone Farms also operates a private school with a total enrollment of approximately 65 students (Korvola, 2000b).

The DGSD provides kindergarten through grade 12 public education. In FY 2001, the district's enrollment totaled approximately 630 students. Another 129 students are enrolled in the Delta/Greely Charter Cyber School, which was started in FY 1999 and whose students cyber commute from across the state. The DGSD operating budget has been declining in recent years in response to declining enrollment and is now approximately $5.3 million annually. Until 2001, local school facilities had included Delta Greely Elementary (grades pre-K through 6), Delta Junction High School (8-12), Fort Greely Elementary (PK-6), Fort Greely Junior High (7-8) and Healy Lake School (K-9). Because of declining enrollment, however, the schools at Fort Greely and Healy Lake have been closed (Korvola, 2000b).

Table 3.16-12 presents the DGSD enrollment from 1995 to 2001. Table 3.16-13 presents the DGSD operating budgets from 1995 to 2001.

Table 3.16-12 Delta Greely School District Enrollment, FY1995 to FY2001

Fiscal Year	K-6	7-12	Healy Lake K-9	Total	
95	523	441	10	974	
96	480	393	12	885	
97	443	391	8	842	
98	445	519	NA	964	
99	490	609	NA	1099	(771 + 324[1])
00	371[2]	391[2]	11	762	(593[2] + 169[2])
01	365	435	0	800	(629 + 171[1])

Source: DGSD. Taken from Korvola (2000b).

[1] Nonresident students enrolled in Charter Cyber School
[2] Includes students at Healy Lake
NA = not available

Table 3.16-13 Delta Greely School District Operating Budgets, FY 1995 to FY 2001

Fiscal Year	Operating Budget ($)
1995	7,076,270
1996	6,856,555
1997	5,656,878
1998	6,313,944
1999	6,993,877
2000	6,186,531
2001	5,295,618

Source: DGSD. Taken from Korvola (2000b).

Table 3.16-14 shows DGSD enrollments in bilingual, English proficiency, and Indian Education programs in FY 2001. As shown in the table, the DGSD has a high proportion of students coming from homes in which English is not the primary language. Apparently, most of the students enrolled in these programs are from Russian-speaking homes. Other non-English speaking students come from homes where Korean, Spanish, or German are spoken. Indian Education students may be American Indian or Alaska Native children. (This data does not include students who are enrolled in correspondence courses that are from sources other than the DGSD.) The data supports the community perception that the Russian-speaking population constitutes about one-quarter of the area's total population (Korvola, 2000b).

Table 3.16-14 Delta Greely School District Enrollments in Bilingual, English Proficiency, and Indian Education Programs, FY 2001

Grade	Bilingual	Limited English Proficiency	Indian Education	Total Students[1]
Elementary	78	69	8	302
High School	56	33	11	268
Preschool	4	4	1	17
Correspondence	30	27	2	56
Grand Total	168	133	22	643

Source: DGSD. Taken from Korvola (2000b).

[1] Total student numbers differ from those of the DGSD Central Office; they are based on different dates in the new school year.

A new school was constructed in Healy Lake in 1999 with $1.5 million in federal funds. The school was built because the DGSD was no longer able to use the Tribal Hall. The new school opened in December 1999 and was used until the end of the school year in May 2000. Today the school is closed because enrollment fell below the State of Alaska's required minimum of 10 students. Some of the students are attending boarding schools outside of the community and three are enrolled in home schooling programs (Korvola, 2000b).

The DMTC is a nonprofit organization whose membership includes the Alaska Miners Association, University of Alaska, TCC, Alaska Cooperative Extension, and DGSD. It is funded exclusively by grants. The DMTC was established to stimulate local hire for mineral industry jobs. Programs include an Associate degree in Applied Mining Technology, MSHA Certification, Hazardous Work Operations and Emergency Response Certification, Dislocated Worker Education, School to Work, and English Language Development. The English Language program is an important avenue for non-English speaking people to participate in the mineral industry. An estimated 20 percent of the DMTC students are from the Russian-speaking segment of the Delta community (Korvola, 2000b). Korvola provided a summary of the DMTC activities during 1998 to 2000:

- 23 total classes for 363 students from 1998 to 2000
- 295 credit hours earned through the University of Alaska Fairbanks (UAF) as of July 1, 2000
- 46 students employed by companies working in Alaska (Dynatec, Equity Engineering, Major Alaska Drilling, Procon, and Teck Resources Inc.) as of September 20, 2000
- $32,432 local purchases as of July 1, 2000
- $65,119 interior purchases as of July 1, 2000
- $200,738 total payroll as of July 1, 2000
- 12 local residents hired as of July 1, 2000

Housing

Because Delta is an unorganized, unincorporated area, very little recent detailed data on the housing inventory exists for the area. According to census data, the Delta area included approximately 1,888 housing units in 1990, including 688 unoccupied units. It should be noted that census housing data makes no distinction between primary residences and recreational or subsistence activity-related housing. Presumably, most of these unoccupied units are secondary residences that are not available units. Since 1990, the housing inventory in the Delta area may have increased by 100 units in response to population growth. Most recently, housing vacancy rates are probably increasing as a result of closure of Fort Greely.

Table 3.16-15 presents Delta area housing by occupancy status, and Table 3.16-16 presents Delta area housing by type. Data from the 2000 census is not yet available in the same level of detail as for the 1990 census. The housing inventory for Big Delta, Delta Junction City, Fort Greely, and Healy Lake combined totaled 1,029 units, including 616 occupied units, in 2000. However, this total excludes a large number of housing in outlying areas. Among the 413 unoccupied housing units in the area, more than half were at Fort Greely.

Table 3.16-15 Delta Area Housing by Occupancy Status, 1990

Occupancy Status	Delta Area	Tract 9559	Tract 9560[1]
Total Housing Units	1,888	1,508	380
Occupied	1,200	859	341
Owner	642	638	4
Renter	558	221	337
Vacant	688	649	39

Source: 1990 Census. Tract 9559 includes Healy Lake, Big Delta, and Delta Junction.
[1] Tract 9560 includes Fort Greely.

Table 3.16-16 Delta Area Housing by Housing Type, 1990

Units per Structure	Delta Area	Tract 9559	Tract 9560[1]
1, Detached	1,029	999	30
1, Attached	99	21	78
2	24	24	0
3-4	82	72	10
5-9	286	28	258
10-19	60	58	2
20 or More	0	0	0
Mobile Home	224	222	2
Other	87	87	0

Source: 1990 Census. Tract 9559 includes Healy Lake, Bug Delta, and Delta Junction.
[1] Tract 9560 includes Fort Greely.

The housing situation has changed since construction of the NMDS facility began; however, no data is available. Anecdotal evidence indicates that the NMDS construction program has consumed most of the available housing in the area. Part of the issue is that military housing is generally not available to civilian workers (although apparently some civilian construction workers are living on base temporarily). Therefore, although there is vacant housing in the Delta area, it is military and therefore not available to the general public.

Residential sales data provides an indication of the value, and perhaps quality, of homes on the market in the Delta area in recent years. Through the first 9 months of 2000, ten homes had sold in the Delta area, with an average sales value of $72,300 (Korvola, 2000b). Table 3.16-17 presents the average residential sales prices in the Delta area from 1991 until mid-2000.

In Healy Lake, according to the 2000 census, there was a total of 21 housing units in 2000. Thirteen of those units were permanently occupied; seven of these were owner-occupied, and six were renter-occupied.

Table 3.16-17 Average Residential Sales Prices in the Delta Area, 1991 to Mid-2000

Year	Average Price ($)	Number of Sales
1991	45,403	24
1992	41,728	17
1993	73,668	29
1994	79,595	39
1995	38,579	5
1996	50,628	9
1997	60,128	17
1998	59,750	17
1999	67,083	16
Through 9/00	72,300	10

Source: Mt. Hayes Inc., Realtors. Taken from Korvola (2000b).

3.16.3 Fairbanks North Star Borough

Population

The FNSB would serve as the service and supply center for the Pogo Mine project. Fairbanks is interior Alaska's largest urban and commercial center. The borough might also be home to some portion of the mine labor force. Fairbanks is located approximately 85 miles northwest of Delta via the Richardson Highway.

The population of the FNSB increased between 1992 and 1994, rising from 82,506 to 83,512, a 1.2 percent increase. After dropping to 81,941 in 1995, the population climbed back to 84,791 in 2002. Table 3.16-18 presents population counts and estimates for the City of Fairbanks and the FNSB from 1992 to 2001.

Table 3.16-18 Population Counts and Estimates, City of Fairbanks and FNSB, 1992 to 2001

Year	Fairbanks	FNSB
1992	32,959	82,506
1993	33,335	82,979
1994	33,249	83,512
1995	32,702	81,941
1996	32,960	82,880
1997	31,850	82,483
1998	31,601	83,299
2000	30,224	82,840
2001	26,558	83,530
2002	29,670	84,791

Source: U.S. Department of Commerce, Bureau of the Census, and ADOL. U.S. Census Bureau estimates are for April 1, and ADOL estimates are for July 1.

Approximately 82 percent of the FNSB population is White, 7 percent is Native American, 7 percent is African American, 2.6 percent is Asian and Pacific Islander, and 1.4 percent is of other race. The racial composition of the FNSB has not changed substantially during the past decade. Table 3.16-19 presents the percent distribution and population estimate, by race and ethnicity, for the FNSB in 1990 and 2000.

Table 3.16-19 Percent Distribution and Population Estimate, by Race and Ethnicity, FNSB, 1990 and 2000

		April 1, 1990		April 1, 2000		Change 1990 - 2000	
Race or Ethnicity		Percent	Population	Percent	Population	Percent	Population
Race	White	82.0	63,751	77.8	64,439	-4.2	688
	Native American	6.9	5,330	6.9	5,714	0.0	384
	African American	7.1	5,553	5.8	4,843	-1.3	-710
	Asian & Pacific Islander	2.6	1,998	2.4	1,965	-0.2	-33
	Other	1.4	1,088	7.1	5,879	5.7	4,791
	Total	100.0	77,720	100.0	82,840		5,120
Ethnicity	Hispanic	3.7	2,889	4.2	3,440	0.4	541

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section, Demographics Unit.

Employment

The FNSB economy is the second largest local economy in Alaska, with average annual employment of 34,303 and more than $1.1 billion in total annual payroll in 2001 . The Fairbanks economy has been growing steadily during the past 5 years, with employment increasing at an annual rate of 2.3 percent. Table 3.16-20 presents FNSB employment and payroll figures from 1997 to 2001.

Table 3.16-20 FNSB Employment and Payroll, 1997 to 2001

Category	1997	1998	1999	2000	2001
Average Annual Employment	31,376	32,336	32,538	33,475	34,303
Total Annual Payroll ($ millions)	952.7	993.4	1,017.4	1,087.1	1,146.5

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section.

The local economy is based on a large military presence (with 16,200 uniformed military and dependents), the University of Alaska (3,200 employees), tourism, and oil industry activity (Alyeska Pipeline Service Company is headquartered in Fairbanks). Other basic economic activities include mining (Fort Knox Mine employs 260 workers; plus most of interior Alaska mining exploration activity is staged out of Fairbanks), transportation services (Fairbanks is the supply center for interior and northern Alaska), regional health care, and state and federal government.

Unemployment

Unemployment rates in the FNSB averaged 5.7 percent in 2001. Unemployment rates typically increase during the winter months, and in January and February of 2001, unemployment stood at 7.6 percent, compared with the summer low of 4.5 percent. Table 3.16-21 presents FNSB unemployment rates from 1992 to 2001.

Table 3.16-21 FNSB Unemployment Rates, 1992 to 2001

Category	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Monthly Peak	13.0	10.4	10.8	9.7	9.7	10.9	7.6	8.2	8.1	7.6
Monthly Low	7.3	6.4	6.2	5.6	6.0	5.4	4.0	4.6	4.7	4.5
Annual Average	9.8	8.4	8.2	7.5	7.6	7.6	5.6	5.9	6.1	5.7

Source: Alaska Department of Labor and Workforce Development.

Income

Personal income for the FNSB totaled $2.3 billion in 2000, with per capita income averaging $28,260 (ADOL, 2000b). Table 3.16-22 presents FNSB personal and per capita incomes from 1996 to 2000.

Table 3.16-22 FNSB Personal and Per Capita Personal Income, 1996 to 2000

Category	1996	1997	1998	1999	2000
Personal Income (in $ millions)	1,949	2,049	2,135	$2,189	$2,338
Per Capita Personal Income (in $)	23,325	24,605	25,341	$26,245	$28,260

Source: ADOL, Research and Analysis Section.

Local Government Organization, Powers, and Finance

The 7,361 sq-mi FNSB is a second-class borough governed by a borough mayor and an 11-member assembly. The certified assessed valuation for purposes of local property taxes is approximately $4 billion. The FNSB includes two incorporated cities, the City of Fairbanks (population 31,000) and the City of North Pole, 12 miles southeast of Fairbanks (population of approximately 1,600 residents).

FNSB expenditures totaled $218.7 million in 1999, including $123.5 million for schools, $10.3 million on general government, $10.2 million on public works, $3.4 million on parks and recreation, $3.0 million on mass transit, $2.8 million on public safety, and $2.4 million on library/museum, plus additional expenditures on other services. FNSB 1999 revenues totaled $214.6 million, including $109.4 million in operating revenues from nonlocal sources (public school funding, shared revenue, other state revenue, and federal revenue), $74.3 million in operating revenues from local sources (property taxes, service charges, enterprise revenues and other local revenue), and $30.8 million in capital project revenue.

City of Fairbanks expenditures totaled $59.9 million in 1999, including $47.9 million on public utilities (electric, phone, water/sewer, and others), $8.7 million on police and fire services, and $2.3 million on general government, plus additional expenditures on other services. City of Fairbanks revenues totaled $67.9 million, including $62.3 million from local sources (property taxes, service charges, enterprise revenues, and other local revenue), $5.2 million from non-local sources (shared state revenue, other state revenue, and federal revenue) and $0.4 million in capital project revenue.

City of North Pole expenditures totaled $2.9 million in 1999, including $1.5 million on police and fire services, $0.6 million on public utilities (water/sewer and other public works), and $0.7 million on general government. City of North Pole revenues totaled $2.9 million, including $2.6 million from local sources (property taxes, service charges, enterprise revenues, and other local revenue) and $0.3 million from nonlocal sources.

Health Care and Public Safety

Fairbanks is interior Alaska's health care center. Denali Center Fairbanks Memorial Hospital is a 169-bed acute care facility that is owned by a nonprofit community foundation. It is co-located with the Denali Center, a 92-bed long-term care facility (Fairbanks Memorial Hospital, 2000). Approximately 1,900 professional health care providers and staff are employed in Fairbanks' health care sector.

Education

The FNSB School District operates 32 schools throughout the borough on an annual budget of approximately $107 million (Alaska Department of Education, 2000). Enrollment in 1999 totaled approximately 16,000 students.

Public education opportunities available in Fairbanks include UAF. UAF is a land, sea and space grant institution classified as a "doctoral II institution" by the Carnegie Foundation. Enrollment in the Fall of 1999 was 8,250 students. UAF is the borough's largest civilian employer with 3,200 full- and part-time employees (UAF, 2000). The FNSB also includes several private primary and secondary schools as well as trade schools.

Housing Inventory

The number of housing units in the Fairbanks area is very large compared to any potential demand due to mine development. With a population of approximately 84,000 residents, the FNSB has a housing stock of 30,000 units. Table 3.16-23 and 3.16-24 present rental vacancy data and rental rates, respectively, for the borough for 1999 and the first half of 2000. Table 3.16-25 provides housing sales data for the same period.

Table 3.16-23 Vacant Rental Housing Units, FNSB, 1999 to 2000

		Apartments				Houses				Mobile Homes	Cabins	Total Rentals
		Eff	1 BR	2 BR	3+ BR	1BR	2 BR	3 BR	4 BR			
1999	March	45	179	156	34	4	10	7	5	12	11	463
	June	13	73	135	43	4	13	16	4	11	14	326
	Sept.	51	133	187	57	8	16	23	7	19	22	523
	Dec.	55	201	153	52	11	18	9	3	8	21	531
2000	March	56	134	119	40	3	6	10	3	11	17	399
	June	32	69	92	37	6	8	16	3	12	22	297

Source: FNSB (2001)

Table 3.16-24 FNSB Average Monthly Rents for Available Housing Units, 1999 to 2000

		Apartments				Houses				Mobile Homes	Cabins
		Eff	1 BR	2 BR	3+ BR	1BR	2 BR	3 BR	4 BR		
1999	March	$409	$552	$697	$890	$627	$799	$973	$1,270	$632	$451
	June	442	547	706	959	712	967	1,005	1,343	691	343
	Sept.	479	545	714	921	593	834	1,246	1,292	634	442
	Dec.	461	541	699	921	684	856	1,148	1,306	650	391
2000	March	422	529	677	885	706	928	1,015	1,716	584	347
	June	422	540	719	889	758	668	1,139	1,400	687	380

Source: FNSB (2001)

Table 3.16-25 FNSB Residential Housing Sales Volume and Average Prices, 1998 to 2000

Yr/ Qtr	1 Bedroom Number Avg. Price	2 Bedroom Number Avg. Price	3 Bedroom Number Avg. Price	4 Bedroom Number Avg. Price	5+ Bedroom Number Avg. Price	Total Sold Number Avg. Price
1999						
1st Qtr.	5	28	47	16	8	104
	$54,300	$90,343	$132,853	$175,609	$169,238	$127,008
2nd Qtr.	12	54	101	40	7	214
	81,782	87,115	131,574	157,750	157,143	123,292
3rd Qtr.	12	57	111	46	7	233
	69,192	101,427	145,050	163,492	183,629	135,271
4th Qtr.	17	41	91	28	5	182
	66,841	88,319	137,139	171,791	156,260	125,431
Total	**46**	**180**	**350**	**130**	**27**	**733**
	69,989	**92,424**	**137,466**	**165,004**	**167,430**	**128,158**
2000						
1st Qtr.	14	30	76	32	132	165
	63,000	96,622	147,932	190,466	40,508	146,939
2nd Qtr.	11	49	116	41	10	227
	45,582	76,694	140,000	169,132	172,840	128,468

Source: Greater Fairbanks Board of Realtors and Alaska Multiple Listing Service, Inc. Taken from Korvola (2000b).

3.17 Land Use

Land status within the greater Pogo project area is shown in Figure 1.3-2. Ownership includes non-Native private parcels; private Native allotments; Doyon, Ltd. selected and conveyed private lands; Mental Health Trust lands; and Tanana Valley State Forest (TVSF) lands including TVSF research natural areas. Other land status includes the Goodpaster River Trail and Trail 53-Black Mountain (Teck-Pogo Inc., 2000d). In addition, as shown in Figure 3.17-1, there are approximately 10,000 mining claims in the area, covering approximately 387,000 acres. These claims include 1,281 covering 41,800 acres that are controlled by the Applicant (Hanneman, 2000). All of the Applicant's claims are on state-owned lands, including all proposed project facilities and alternative transportation and power transmission corridors (Teck-Pogo Inc., 2000a).

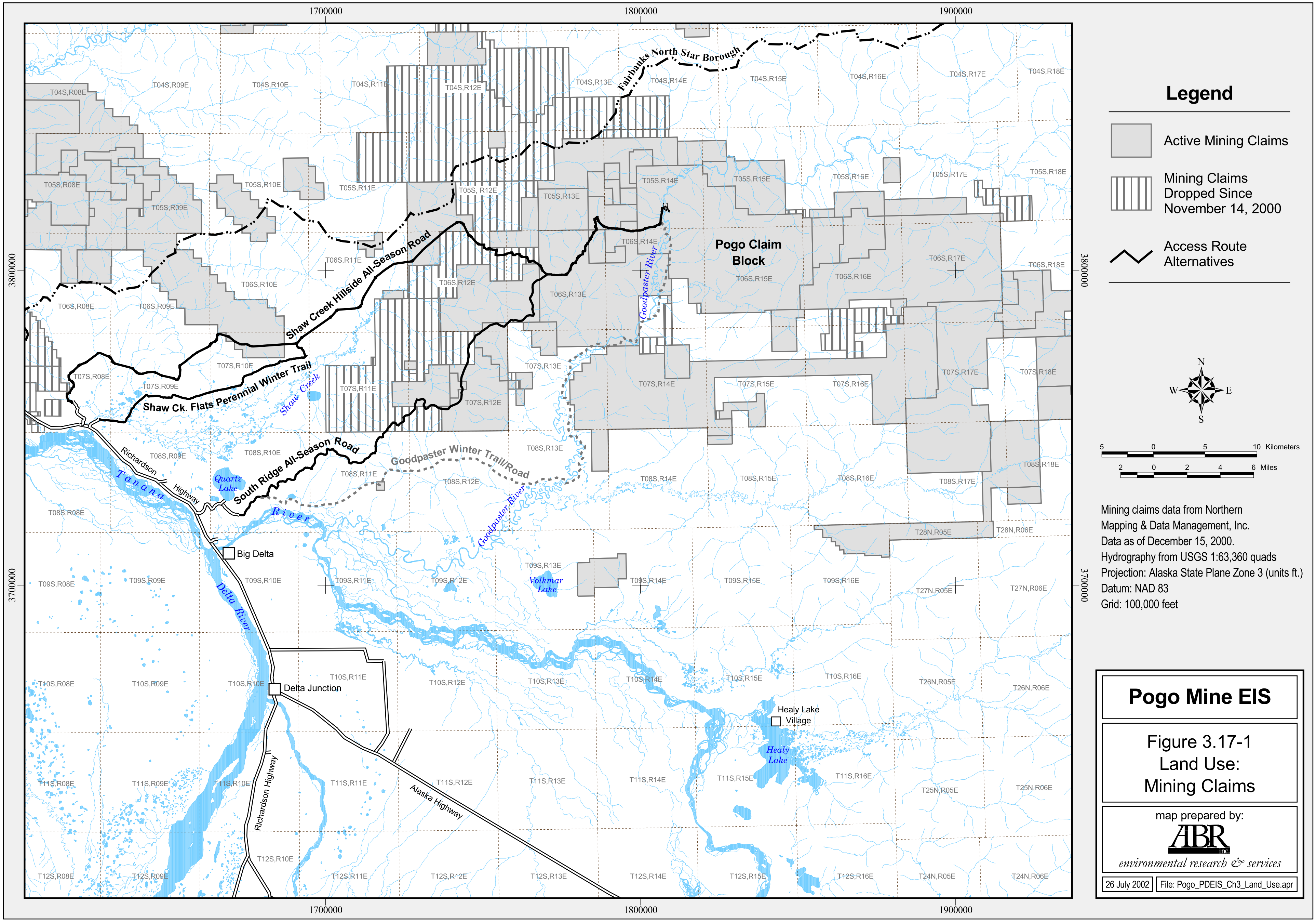
3.17.1 Land Management Plans

Land use in Alaska is regulated by federal and state agencies and local governments. In the vicinity of the Pogo project area, there are two State of Alaska land management plans and one local borough plan that affect land uses. The two state plans are the TBAP (ADNR,1991), and the TVSF Management Plan (ADNR, 2001b). Lands immediately to the west of the project area are subject to the FNSB Comprehensive Plan (FNSB, 1990).

- **Tanana Basin Area Plan** TBAP was adopted in 1985 and updated in 1991, and addresses state lands outside the TVSF. TBAP classified the land within the Pogo project area (Delta-Salcha Subregion) into four units: Shaw Creek, Quartz Lake, Tanana Uplands, and Goodpaster River (ADNR, 1991). Primary surface land uses within these four units include: public recreation, wildlife habitat, forestry, and minerals. The TBAP provides that state lands in these management units are to be retained in public ownership. Table 3.17-1 presents a land use designation summary for the four TBAP project area management units. Figure 3.17-2 shows the boundaries of those management units.

  TBAP recognizes that a variety of resources on state lands in the project area will require access prior to development or extraction of the resource. The plan specifies forest areas, recreation lands, and mineralized terrain areas as examples of such resources. State lands in the project area also are subject to the Areawide Land Management Guidelines for Subsurface Resources in TBAP, which include goals for the management of mineral resources in the planning area. These goals include contributing to Alaska's economy by making subsurface resources available for development, protecting integrity of the environment and affected cultures, and to aid in development of infrastructure, including roads, to support the mining industry.

  TBAP also recognizes the lower Goodpaster River Corridor for its recreational and scenic values. The plan specifies that any development activities in this area be designed to minimize the visual impacts to the lower Goodpaster River Corridor (where most private recreational cabins are located).



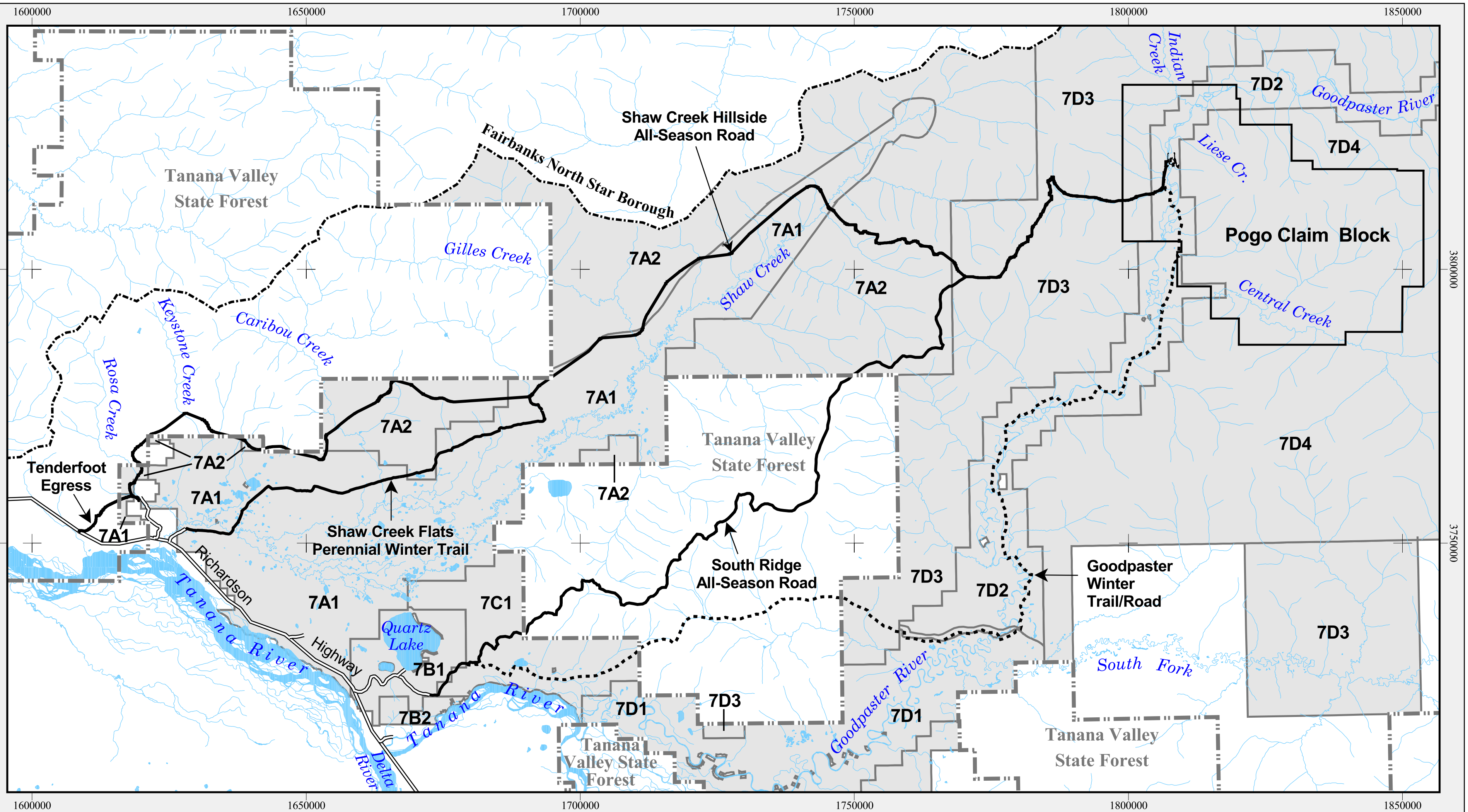
Pogo Mine EIS

Figure 3.17-1
Land Use:
Mining Claims

Table 3.17-1 TBAP Land Use Designation Summary for the Four Project Area Management Units.

Subunit	Primary Surface Uses	Secondary Surface Uses	Subsurface[1]	Prohibited Surface Uses[2]
Management Unit 7-A Shaw Creek Drainage				
Management Intent – Unit will be retained in public ownership and managed for its forest resources and protection of water quality, wildlife habitat, and public recreational values. This unit is open to mineral entry.				
7A1	Public recreation, wildlife habitat		Open	Land sales, remote cabins
7A2	Forestry, public recreation, wildlife habitat		Open	Land sales, remote cabins
Management Unit 7-B Quartz Lake				
Management Intent –Unit will be retained in public ownership and managed primarily for public recreation. Unit will remain open for mineral entry. Recreation opportunities should be enhanced; timber harvest activities should complement recreation activities.				
7B1	Public recreation	Wildlife habitat, forestry	Open	Land disposals
7B2	Forestry, public recreation	Wildlife habitat	Open	Land disposals
Management Unit 7-C Tanana Uplands				
Management Intent – Unit will be retained in public ownership for multiple use with an emphasis on public recreation and forestry values. Unit is open to mineral entry.				
7C1	Forestry, public recreation	Wildlife habitat	Open	Land disposals
Management Unit 7-D Goodpaster River Drainage				
Management Intent – Unit will be retained in public ownership and managed for multiple use, with an emphasis on recreation and fish and wildlife values. Unit will remain open to mineral entry. Lower Goodpaster corridor will be managed to maintain and enhance the river's recreational and scenic values. The upper Goodpaster corridor will be managed to maintain and enhance the habitat values of the river.				
7D1 Lower River	Public recreation, wildlife habitat		Open	Land disposals, all-season roads, timber harvest greater than 10 mbf, permanent commercial facilities
7D2 Upper River	Public recreation, wildlife habitat		Open	Land disposals, timber harvest within 100-year floodplain
7D3	Forestry, public recreation, wildlife habitat		Open	Land disposals
7D4	Public recreation, wildlife habitat		Open	Land disposals

[1] Locatable minerals. All areas are available for leasing for leasable minerals, except as noted for coal.
[2] Other uses such as material sales, land leases, or permits that are not specifically prohibited may be allowed if consistent with the management-intent statement.



Legend

7A1	Tanana Basin Area Plan Region 7 Project Area Management Subunit Boundary
	State Forest Boundary

5 0 5 10 Kilometers

2 0 2 4 6 Miles

N E S W

TBAP management unit boundaries from Alaska DNR Tanana Basin Area Plan, 1991

Base map: USGS 1:63,360 digital line graph mosaic

Projection: Alaska State Plane Zone 3 (units ft.)

Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.17-2 TBAP Project Area Management Unit Boundaries

map prepared by: ABR Inc. *environmental research & services*

14 January 2003 | ABR File: Pogo_DEIS_Ch3_Land_Use2.apr

- **Tanana Valley State Forest Management Plan** The TVSF Management Plan was adopted in 1988, with a revision formally adopted in September 2001 (ADNR, 2001b). The TVSF Management Plan sets policy for how ADNR should review proposals for use of state land by the public, industry, and other governmental agencies. The management plan states that the primary purpose in establishment of state forests was “multiple use management that provides for the production, utilization, and replenishment of timber resources while perpetuating personal, commercial, and other beneficial uses of resources.” It also clarifies that the state forest “shall be retained in state ownership.”

  The management plan contemplates that where feasible and within the limits of available funding, full public rights of access should be provided when roads are constructed by state or local governments for purposes other than forest operations. Perpetual exclusive easements should be acquired and recorded when the state acquires access rights across property in other ownerships adjacent to the state forest.

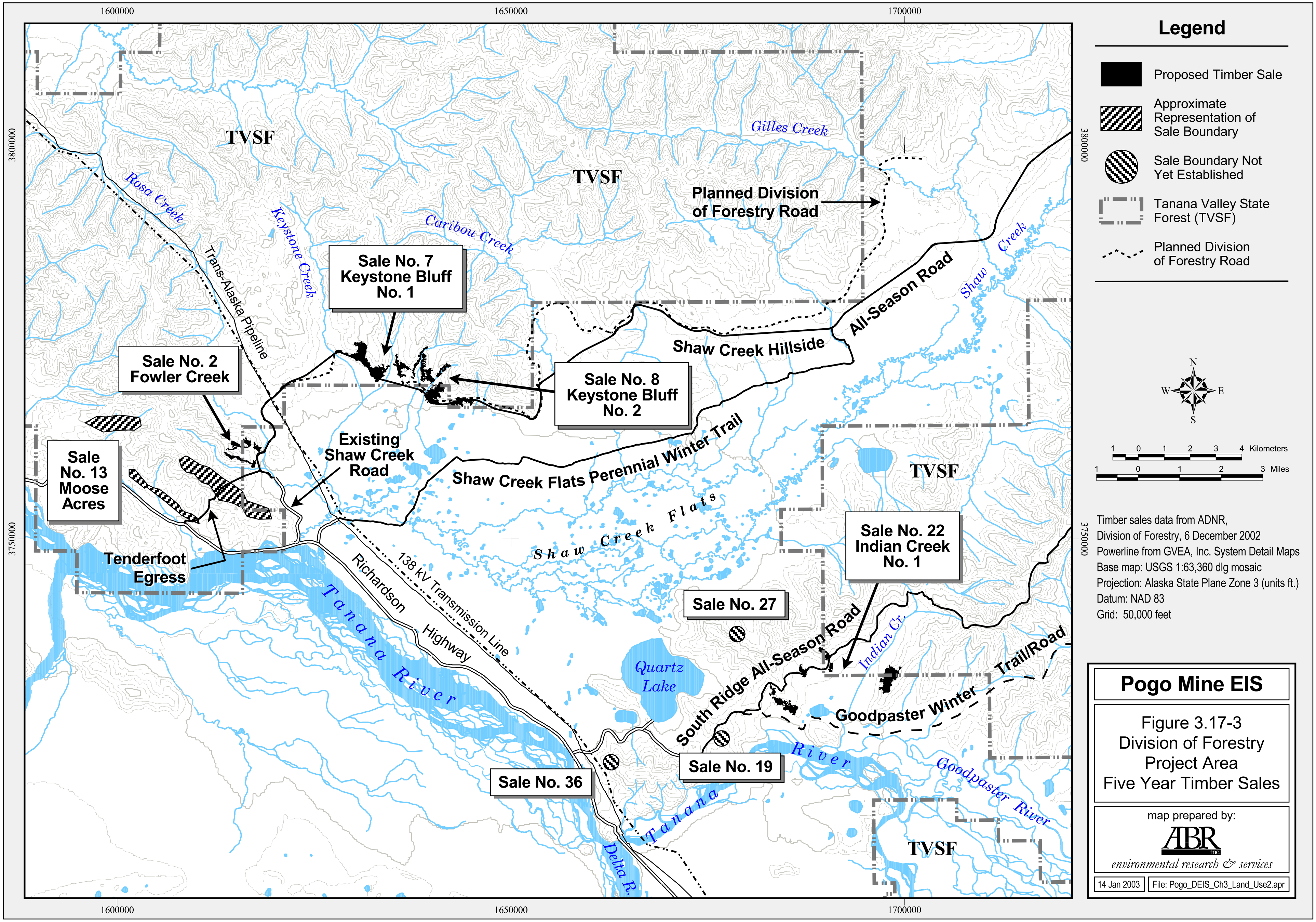
  The TVSF Management Plan designates lands within the Pogo project area for potential long-term timber sales, including areas within Rapid, Indian, and Progressive Creek drainages; and areas on the north side of Shaw Creek Flats, including Caribou Creek and Gilles Creek drainages. Areas on the south side of Shaw Creek Flats, and near Rosa Creek, have been designated natural research areas and closed to timber harvest. Timber has been harvested from the TVSF in the Pogo project vicinity during the last 15 years (Teck-Pogo Inc., 2000b).

  The management plan for the state forest in the project area recognizes the high mineral resource values in this unit, and states that it will be managed for commercial timber production and mineral exploration and production. These and other activities in these subunits will be managed to protect fish and wildlife values near the Tanana River and Shaw and Caribou creeks. The state has developed a portion of the winter trail on the north margin of Shaw Creek Flats to a primary winter road for timber access, and additional development of this winter access route will occur to access other timber sales. Primary all-season access is planned from the existing Shaw Creek Road to proposed timber harvest sales in the Keystone and Rosa Creek drainages.

  The 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). The locations of these proposed timber sales are shown in Figure 3.17-3. Table 3.17-2 presents a description of each sale, including acreage, volume, and an estimate of the number of round trip-truck trips necessary to harvest the timber. The eight sales during the 5-year period would total approximately 2,765,000 cubic feet of timber and affect approximately 1,313 acres.

  The Shaw Creek area sales at Fowler Creek and the two in the Keystone Bluff area are to be accessed by a new DOF all-season road in the Rosa Creek and Keystone Creek drainages. The Moose Acres sale in the Tenderfoot area would be accessed by new roads from the Richardson Highway.

  The four sales in the Quartz Lake / Indian Creek area would be south and east of Quartz Lake between the lake and the Tanana River (Quartz Lake #1 and Bert Mountain # 1), and northeast of Quartz Lake (Indian Creek # 1 and Shaw Creek # 6). The Indian Creek # 1 sale would be accessed by a new all-season road to and across Indian Creek, while the Shaw Creek No. 6 sale would be accessed by winter road in the Shaw Creek Flats.



1600000
1650000
1700000
3800000
3750000
TVSF
Rosa Creek
Keystone Creek
Caribou Creek
Gilles Creek
Planned Division of Forestry Road
Trans-Alaska Pipeline
Sale No. 7 Keystone Bluff No. 1
Sale No. 2 Fowler Creek
Sale No. 8 Keystone Bluff No. 2
Shaw Creek Hillside
All-Season Road
Shaw Creek
Existing Shaw Creek Road
Sale No. 13 Moose Acres
Shaw Creek Flats Perennial Winter Trail
Shaw Creek Flats
Tenderfoot Egress
Richardson Highway
138 kV Transmission Line
Tanana River
Sale No. 22 Indian Creek No. 1
Sale No. 27
Quartz Lake
South Ridge All-Season Road
Indian Cr.
Goodpaster Winter Trail/Road
Sale No. 36
Sale No. 19
River
Goodpaster River
Tanana
Delta R.
Legend
Proposed Timber Sale
Approximate Representation of Sale Boundary
Sale Boundary Not Yet Established
Tanana Valley State Forest (TVSF)
Planned Division of Forestry Road
N
W
E
S
1 0 1 2 3 4 Kilometers
1 0 1 2 3 Miles
Timber sales data from ADNR, Division of Forestry, 6 December 2002
Powerline from GVEA, Inc. System Detail Maps
Base map: USGS 1:63,360 dlg mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet
Pogo Mine EIS
Figure 3.17-3
Division of Forestry
Project Area
Five Year Timber Sales
map prepared by:
ABR Inc.
environmental research & services
14 Jan 2003
File: Pogo_DEIS_Ch3_Land_Use2.apr

Table 3.17-2 Division of Forestry Project Area Five Year Timber Sale Schedule

Sale No.	Fiscal Year	Sale Name	Legal Description	Acres	Species	Volume in cubic feet	Access	Area Plan	Estimated Truck Round Trips (Entire Sale / Average Per Day)
2 NC-652	02 - 03	Fowler Creek	Sec. 21, W1/2 Sec 22, T7S, R8E	69	Spruce Sawlogs	100,000	All-season	TVSF 8A TBAP 7A2	142/2
7 NC-995	02 - 03	Keystone Bluff # 1	Sec. 4, 7, 8, 15, 16, 17, T7S, R9E.	134	Spruce Sawlogs	300,000	All-season	TVSF 8C TBAP 7A1	285/3
8 NC-1173	02 - 03	Keystone Bluff # 2	Sec. 4, 5, 6, 7, 8, 15 16, & 17,T7S, R9E.	230	Spruce Sawlogs	400,000	All-season	TVSF 8C TBAP 7A2	485/3
13	03 - 04	Moose Acres NC-673 NC-984	Tenderfoot Sec. 13, 23, 24, T7S, R7E Sec. 17-21, 27-30, 33 T7S, R8E	270 30	Birch/Aspen Spruce Saw	600,000 50,000	All-season	TVSF 8A	943/3
19	04 - 05	Quartz Lake # 1	Sec. 14-16, 21-23, 28-30, 32 T8S, R10E	70 150	Spruce Saw Birch/Aspen	120,000 160,000	All-season	TBAP 7B1 & 7C1	266/2
22	04 - 05	Indian Creek # 1	Sec. 13, 14, 22 & 23, T8S, R10E Sec. 18, 19, T8S, R11E.	200 50	Spruce Saw Birch	600,000 75,000	All-season	TBAP 7C1 TVSF 9A	950/3
27	05 - 06	Shaw Creek # 6	Sec. 2, 10, 11, & 15 T8S, R10E.	50 30	Spruce Saw Birch	150,000 40,000	Winter	TBAP 7C1 TVSF 9A	188/3
36	06 - 07	Bert Mnt. # 1	Sec. 25 & 36, T8E, R9E. Sec. 31 & 32, T8S,R10E. Sec. 4, 5, & 6, T9S, R10E.	60	Spruce Sawlogs	170,000	All-season	TBAP 7B1 & 7B2	162/2
Total				1,313		2,765,000			

Source: ADNR (2002) and Joslin (2002)

- **Fairbanks North Star Borough Comprehensive Plan** The FNSB Comprehensive Plan was adopted in 1984 and updated in 1990 (FNSB, 1990). The plan provides a framework for citizens and officials to make decisions related to the use of land and forms the basis for other land use ordinances and programs guiding land development and preservation. The borough also has a borough-wide zoning ordinance that was revised in 1988 (FNSB, 1988). The following land use designations from the FNSB Comprehensive Plan are applicable to parts of the greater Pogo project area: industrial, military, open space, reserve, and rural settlement land uses, including residential, agricultural, forest, and high mineral potential lands. While portions of the proposed project are near its boundary, neither the mine site area nor any of the surface access option routes are within the FNSB.

3.17.2 Federally Designated Military Lands

Federally designated military lands within the greater Pogo project area include Fort Greely, Eielson Air Force Base, and the Yukon 1 Military Operation Area. The Yukon 1 Military Operation Area, as designated by the FAA, is routinely used by the USAF to conduct military flight training exercises. Most routine military training missions originate from Eielson Air Force Base, located approximately 35 miles west of the Pogo project area.

Within the Yukon 1 Military Operation Area, the Air Force has established a military flight restriction zone in the Pogo area that is closed to all high-speed military aircraft. This restricted zone includes portions of Shaw Creek, the communities of Big Delta and Delta Junction, and additional areas on both sides of the Richardson Highway in the vicinity of Big Delta and Delta Junction (U.S. National Park Service [NPS] and ADFG, 1998).

In August 1999, to minimize risk of collision between military aircraft and civilian fixed-wing and helicopter aircraft flying in support of the Pogo project, the current flight restriction zone was enlarged to encompass a circular area with a 5-mile radius centered on Peak 4021, which is located 3 miles southeast of the Pogo deposit. This restricted area includes a corridor 4 miles wide centered on the Goodpaster River, extending from the Pogo airstrip to the southern edge of the Yukon 1 Military Operation Area, approximately 10 miles to the southwest. The restriction zone extends from the surface up to an altitude of 4,500 feet above mean sea level (Teck-Pogo Inc., 2000d).

3.17.3 Existing Land Use

The following existing types of land uses occur in the Pogo project area: commercial, industrial, military, recreational, residential; private parcels and cabins, transportation, and infrastructure (Teck-Pogo Inc., 2000d).

Commercial, Industrial, and Military

Commercial, industrial, and military activities in the project area include agriculture, timber harvest, backcountry expeditions, trapping, mineral exploration, and military installations and overflights (Figure 3.17-4).

Three agricultural tracts, totaling approximately 266 acres, are located near the end of the existing Shaw Creek Road; however, only two are active. One recently ceased its dairy operations but leases its hay fields. Two types of commercial backcountry expeditions operate in the project area: guided dog mushing tours in the Shaw Creek drainage and backcountry guided and nonguided hunting and fishing trips in the Goodpaster drainage that involve riverboat travel or a combination of aircraft and raft float trips. There are a number of trapping operators in the project area, covering all of the Shaw Creek, Salcha, and Goodpaster drainages (Ridder, 2002).

Figure 3.17-1 shows the mining claims in the project area. There are no currently producing placer or hardrock mines; however, several mining claim owners have conducted extensive mineral exploration on their properties (Figure 3.17-4). Other commercial and industrial activities in the project area include a year-round recreational lodge at Quartz Lake, a Quartz Lake boat livery, and two rock quarries: one along the Richardson Highway north of the Tanana River Bridge and the other adjacent to Shaw Creek Road. In addition, a military communications site is located west of the Pogo property and supports military exercises within the airspace designated Yukon 1 Military Operation Area (Ridder, 2002).

Residential, Recreational Cabins, and Other Private Parcels

Other land uses in the project area include residential, recreational cabins, and other private parcels (Figure 3.17-5). Within the Delta-Salcha subregion, 6,664 acres of state land were sold for residential use through 1989 (ADNR, 1991). In general, year-round residences are located near Shaw Creek, along the Richardson Highway near the Tanana River, along the Richardson Highway between the Tanana River crossing and Delta Junction, near the community of Delta Junction, and dispersed in a broad rural area among private land and agricultural parcels to the north and east of Delta Junction. There are six year-round residences on the existing, state-maintained, 2.1-mile-long Shaw Creek Road near Shaw Creek, four of which are presently occupied. Year-round residences consist of one north of Shaw Creek on the east side of the pipeline that uses the pipeline work pad for access and two residences within 2 miles northeast of Shaw Creek Road (Ridder, 2002).

In general, recreational cabin sites and other private parcels in the project area are near river or lake access. Most of these cabin sites and other private parcels were acquired by individuals from the federal government prior to statehood in 1959 or from the State of Alaska during state-sponsored home site, open-to-entry, or other land disposal programs. There are approximately 63 Goodpaster River property households, 60 households at Quartz Lake and vicinity, and 10 Shaw Creek vicinity households, including the 6 accessed from Shaw Creek Road (Ridder, 2002).

Transportation and Infrastructure

Roads, trails, and infrastructure are shown in Figure 3.17-6. Both the state-maintained Richardson and Alaska highways border the greater Pogo project area. Two state-maintained spur roads are located near Shaw Creek and Quartz Lake, respectively, providing local access. Both roads were raised, received new culverts, and were chip sealed in 2001. Two gravel roads maintained by Alyeska Pipeline Service Company provide access from the Richardson Highway to the Trans-Alaska Pipeline. The pipeline traverses the project area for several miles, both underground and aboveground.

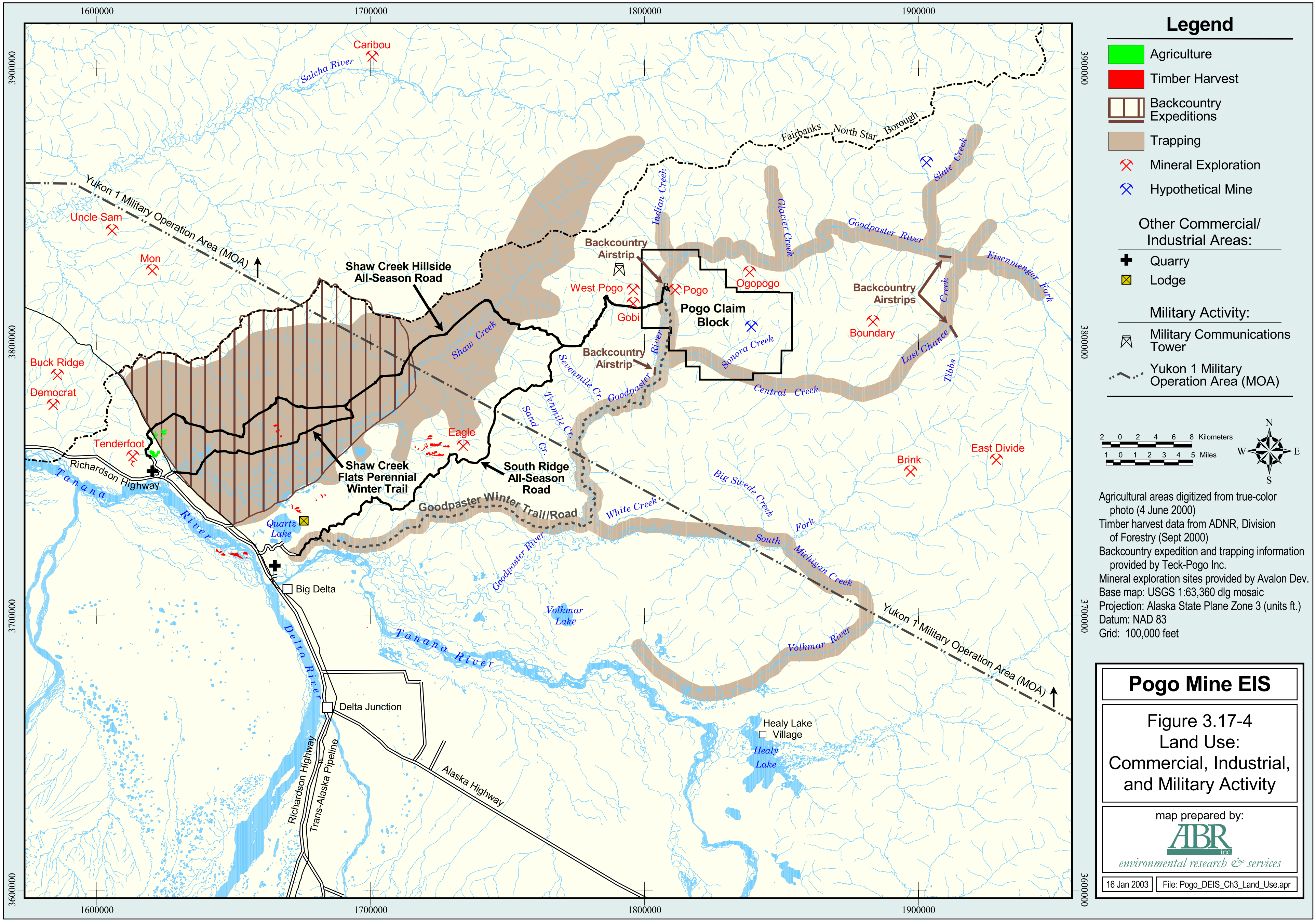
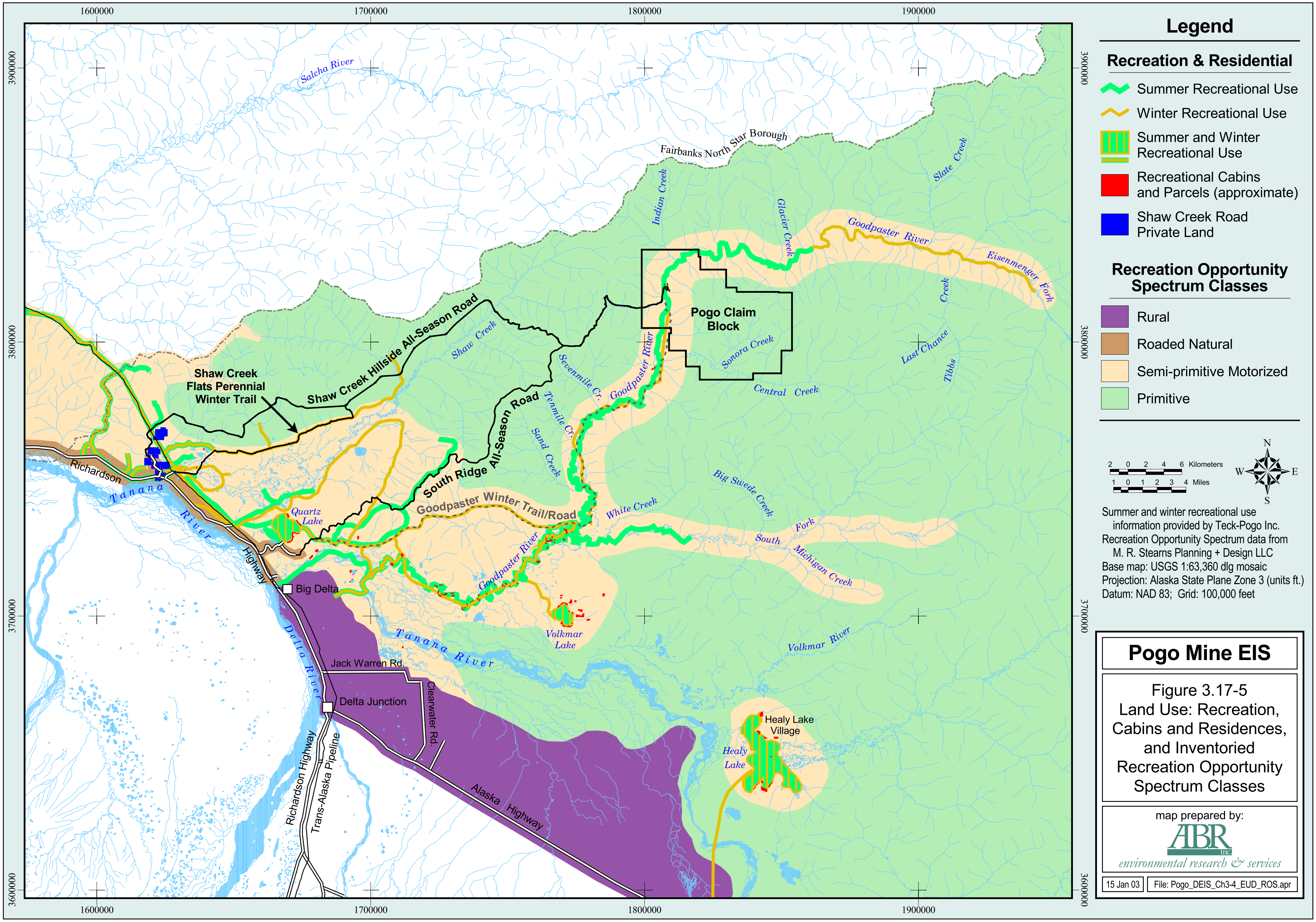
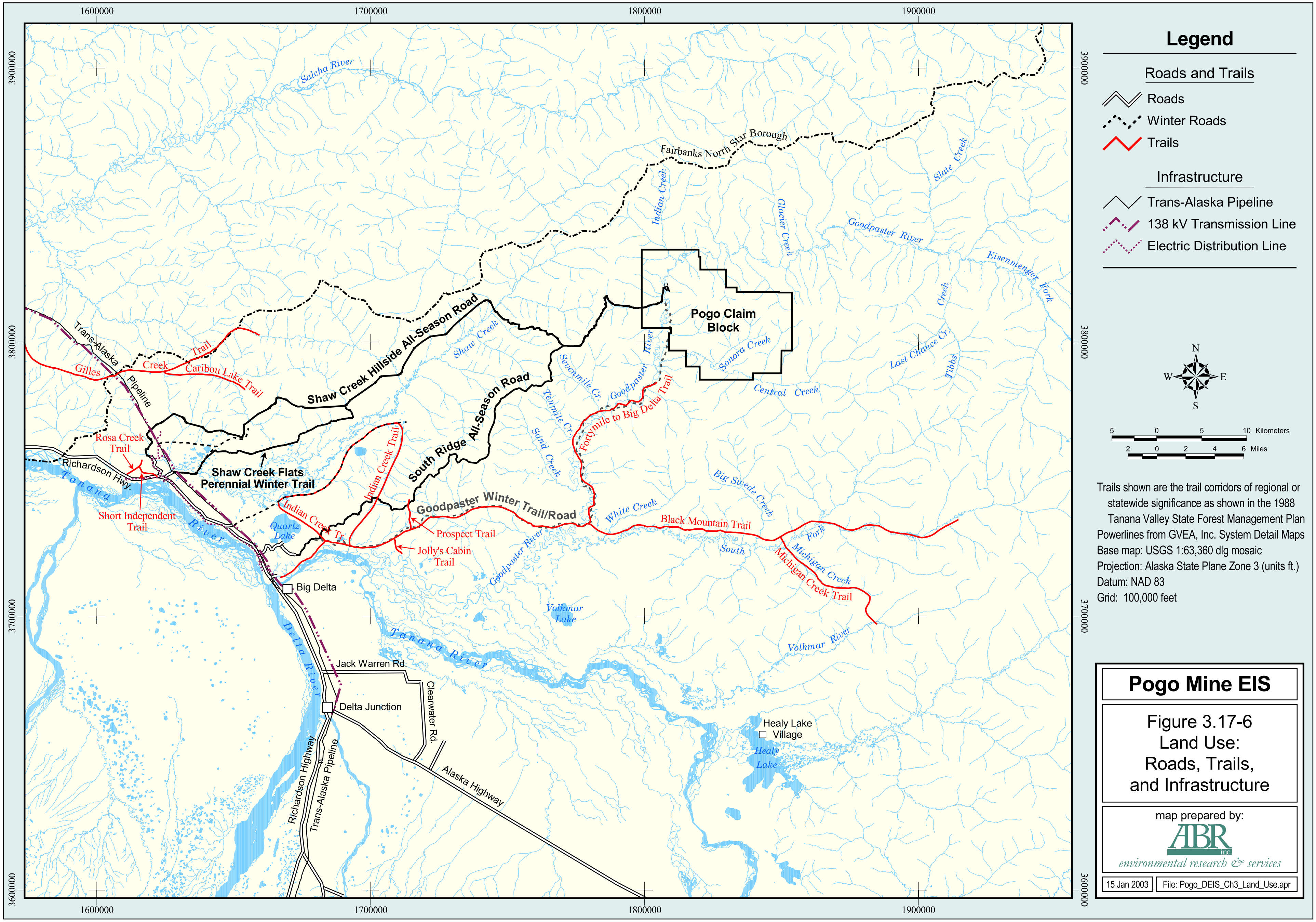


Figure 3.17-4
Land Use: Commercial, Industrial, and Military Activity



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
Summer and winter recreational use information provided by Teck-Pogo Inc.
Recreation Opportunity Spectrum data from M. R. Stearns Planning + Design LLC
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 3.17-5
Land Use: Recreation, Cabins and Residences, and Inventoried Recreation Opportunity Spectrum Classes
map prepared by:
ABR Inc.
environmental research & services
15 Jan 03
File: Pogo_DEIS_Ch3-4_EUD_ROS.apr
Pogo Claim Block
Shaw Creek Hillside All-Season Road
Shaw Creek Flats Perennial Winter Trail
South Ridge All-Season Road
Goodpaster Winter Trail/Road
Big Delta
Delta Junction
Jack Warren Rd.
Clearwater Rd.
Alaska Highway
Richardson Highway
Trans-Alaska Pipeline
Healy Lake Village
Fairbanks North Star Borough
Salcha River
Goodpaster River
Tanana River
Delta River
Volkmar River
Quartz Lake
Volkmar Lake
Healy Lake


Legend
Roads and Trails
Roads
Winter Roads
Trails
Infrastructure
Trans-Alaska Pipeline
138 kV Transmission Line
Electric Distribution Line
Trails shown are the trail corridors of regional or statewide significance as shown in the 1988 Tanana Valley State Forest Management Plan
Powerlines from GVEA, Inc. System Detail Maps
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 3.17-6
Land Use:
Roads, Trails,
and Infrastructure
map prepared by:
ABR inc.
environmental research & services
15 Jan 2003
File: Pogo_DEIS_Ch3_Land_Use.apr
Pogo Claim Block
Shaw Creek Hillside All-Season Road
South Ridge All-Season Road
Shaw Creek Flats Perennial Winter Trail
Goodpaster Winter Trail/Road
Fortymile to Big Delta Trail
Black Mountain Trail
Michigan Creek Trail
Caribou Lake Trail
Gilles Creek Trail
Rosa Creek Trail
Short Independent Trail
Indian Creek Trail
Indian Creek Tr.
Prospect Trail
Jolly's Cabin Trail
Fairbanks North Star Borough
Trans-Alaska Pipeline
Richardson Hwy.
Richardson Highway
Alaska Highway
Jack Warren Rd.
Clearwater Rd.
Big Delta
Delta Junction
Healy Lake Village
Tanana River
Delta River
Goodpaster River
Salcha River
Volkmar River
Volkmar Lake
Quartz Lake
Healy Lake
Shaw Creek
Indian Creek
Glacier Creek
Slate Creek
Eisenmenger Fork
Last Chance Cr.
Tibbs Creek
Central Creek
Sonora Creek
Sevenmile Cr.
Tenmile Cr.
Sand Creek
Big Swede Creek
White Creek
South Fork
Michigan Creek
1600000
1700000
1800000
1900000
3900000
3800000
3700000
3600000
Kilometers
Miles

The gated TAPS pipeline access road near Shaw Creek is for use only by local inholders, but it also provides unauthorized use for recreationalists and others with ATVs and snow machines who circumvent the gate for access along the pipeline pad across Shaw Creek Flats, as well as to the north as far as the Salcha River. A similar TAPS pipeline access road lies off the Richardson Highway west of Quartz Lake, but is not "controlled," as is the Shaw Creek pipeline access road. This road provides public access to Shaw Creek Flats.

An unmaintained approximately 1-mile, dead-end primitive road constructed by the DOF branches off to the southeast from the Quartz Lake access road near the lake (Teck-Pogo Inc., 2000d). There are approximately 5 miles of existing DOF roads in the Tenderfoot egress area, including a 2-mile section with branching Caterpillar trails that end in deep bulldozed exploration trenches.

Another important transportation corridor in the project area is the Goodpaster Winter Trail, a historic public use trail now designated under RS-2477 as a public ROW. Portions of it were initially pioneered as part of the Washington-Alaska Military Cable and Telegraph System (WAMCATS). The Goodpaster Winter Trail has been used sporadically since the mid-1930s by many, including homesteaders, trappers, prospectors, hunters, dog mushers, skiers, other winter recreationists, and by landowners for access to their cabins along the Goodpaster River. In the winter of 1997-1998 it was used to supply Teck-Pogo Inc.'s advanced exploration work on the Pogo project (Teck-Pogo Inc., 2000d).

The TVSF Management Plan (ADNR, 2001b) discusses the many well-developed trails in the project area. Several of these trails systems are used by current residents and visitors for recreation and trapping activities. They include roads and trails through the Tenderfoot area, including a forestry road from the Richardson Highway and ATV trails beyond Rosa Creek.

There are four backcountry airstrips in the project area. One airstrip was constructed on a Goodpaster River gravel bar approximately 20 years ago at the Pogo project site. One was constructed in the 1930s at Tibbs Creek to support hardrock exploration. Another is a private strip constructed in the 1950s opposite Central Creek. The fourth is an enhanced gravel bar along the Goodpaster River used occasionally by high-performance bush aircraft (Teck-Pogo Inc., 2000d; Ridder, 2002).

A 138-kV, wooden, H-pole transmission line, operated by GVEA, parallels the Trans-Alaska Pipeline across the west side of the Pogo project area. The transmission line connects Delta Junction and Fort Greely to the Railbelt power grid. A local distribution line parallels the Richardson Highway and provides power along the highway and to Shaw Creek area residents.

3.18 Subsistence

3.18.1 Subsistence Definition

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 referenced below 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.

Much of the material in this section was derived from a subsistence workshop conducted from August 21 through 23, 2001, in Tok, Dot Lake, and Fairbanks, with a follow-up contact on September 24 in Anchorage. The interviews with Upper Tanana Athabaskan subsistence users were coordinated by the Healy Lake Traditional Council (MENDAS CHA~AG Tribe) with a total of ten individuals. Results of this workshop are contained in SRB&A (2002a).

As defined by Alaska Statutes, "subsistence uses means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of nonedible by-products of the fish and wildlife resources taken for personal or family consumption, and for customary trade, barter, or sharing for personal or family consumption" (AS 16.05.940[32]). Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking.

The federal definition of subsistence comes from Alaska National Interest Lands Conservation Act (ANILCA), Title VIII, Section 803, and is virtually identical to the state definition: "The term 'subsistence uses' means the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade."

Although the term "rural" appears in both the state and federal definitions of subsistence, the Alaska Supreme Court has ruled that rural residents cannot be favored over nonrural residents.

The Alaska Federation of Natives (AFN) (2002) defines subsistence as, "the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today. …Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, tribal cultures and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans. … Subsistence, being integral to our world view, and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical."

The state definition of subsistence has been used in this analysis because the proposed project, and most of its effects, would occur on state land.

Subsistence is part of a rural economic system, called a “mixed, subsistence-market” economy wherein families invest money into small-scale, efficient technologies to harvest wild foods (ADFG, 1998b). Fishing and hunting for subsistence provide a reliable economic base for many rural regions (Wolfe and Walker, 1987), and these important activities are conducted by domestic family groups who have invested in fish wheels, gillnets, motorized skiffs, and snow machines. Subsistence is not oriented toward sales, profits, or capital accumulation (commercial market production); it is focused toward meeting the self-limiting needs of families and small communities. Participants in this mixed economy in rural Alaska augment their subsistence production by cash employment. Cash (from commercial fishing, trapping, and/or wages from public sector employment, construction, firefighting, or other services) provide the means to purchase the equipment used in subsistence activities. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker, 1987).

Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including the Athabaskans of interior Alaska (ADFG, 1998b). Subsistence fishing and hunting are important sources of employment and nutrition in almost all rural communities. ADFG (1998b) estimates the annual wild food harvest in interior Alaska is approximately 6,359,255 pounds, or 613 pounds per person per year. Subsistence harvest levels vary widely from one community to the next. Sharing of subsistence foods is common in rural Alaska.

To understand current subsistence use patterns in the Pogo project area, it is necessary to review the historical settlement patterns, the seasonal round of subsistence resource gathering, the traditional band areas in the region, and traditional subsistence patterns that transcended band territorial boundaries.

3.18.2 Historical Patterns of Subsistence Resource Use

Settlement Patterns and Seasonal Round

Traditional Athabaskan life was based on a mobile subsistence round of traveling from camp to camp at specific seasons to harvest resources generally available at certain times in known places (McKennan, 1959, 1969a, 1969b, 1981; Shinkwin *et al.,* 1980; Andrews, 1995; Simeone, 1982, 1995; VanStone, 1974; Cook, 1989; Mishler, 1986; and Stephen R. Braund & Associates [SRB&A], 2002a). Traditional Athabaskan culture in the Upper Tanana Valley was “based on a highly mobile annual subsistence cycle that included hunting, fishing, gathering and trapping (Shinkwin *et al*., 1980:46). Mobility ranged from very high mobility (occupation of numerous small camps during the year and rare concentration of band personnel) to low mobility (potential for occupying one major camp or village year-round) (Guedon, 1974).

Despite the seasonal mobility associated with following resource concentrations, some locations were often used for longer time periods than others. Shinkwin *et al*. (1980:43) described Upper Tanana Athabaskans as living in “semi-permanent settlements in the lowlands” that were “placed in locations that would minimize travel distance and time to other major resources.” According to Shinkwin *et al*. (1980), three resources in the area occur in dense concentrations seasonally – caribou, whitefish, and waterfowl. Seasonal resource availability dictated where the Tanana Athabaskans were at particular times of year and the number of seasons a particular site might be occupied. Thus, people would base out of a core settlement and move from traditional location to location at key seasons to harvest resources known to be in the vicinity at particular times of the year. As a result, seasonal occupation of the same or similar places occurred year after year (SRB&A, 2002a).

Traditionally, Athabaskan groups “were dispersed for most of the year, pursuing sheep, moose, caribou, waterfowl, fish, muskrat,” and other resources “nucleating at a base camp along lakes and clear water streams in late spring and summer for migratory waterfowl and whitefish runs, and in the fall in strategic areas to obtain migrating caribou. Minor subsistence systems, such as muskrat trapping and berry collecting, overlapped the fish-fowl system and moose and sheep hunting overlapped the caribou subsistence system” (Shinkwin *et al*., 1980:46). The core settlement was often located near the winter camp or summer fishing camp, and this camp was centrally located relative to resources and auxiliary seasonal camps.

The traditional/historic seasonal round of subsistence activities in the Upper Tanana region is illustrated in various sources (e.g., McKennan, 1959, 1981; Guedon, 1974). These sources show that fishing was a summer activity (with limited winter involvement) and moose were sought throughout the year, with concentrated harvest efforts occurring mid-March through April (cows without calves) and mid-July through September (bulls). Caribou migrated through the region in early summer (April to June) and in the fall (late August through December). The fairly stable migration pattern allowed for the construction of semi-permanent caribou fences. Sheep were harvested in July though August/September. Trapping began in November and extended through late February or early March, and waterfowl hunting occurred in spring and fall. Gathering berries was primarily a summer and fall activity, whereas gathering firewood and other plants occurred, in varying levels of effort, throughout the year.

Traditional Band Areas

According to McKennan (1981), the Tanana Indians had no self-defined “tribal” identity, but they “thought of themselves in terms of small local bands that constituted both social and geographical units. Frequently several contiguous bands would be sufficiently interlocked through marriage, geography, and common interests for them to consider themselves a larger unit, or regional band, of which the Upper Tanana division is a good example. McKennan (1981:565) stated, “It is evident that except for natural boundaries such as high mountain ranges, it is extremely hard to draw precise territorial limits for these nomadic people. Adjacent local bands often came together for purposes of communal hunting, trade, or potlatch ceremonies except for those periods when local ‘wars’ temporarily separated them.”

McKennan (1969:100-105, as cited in Shinkwin *et al*. 1980:46) described two types of bands present in the Upper Tanana Valley: local bands and regional bands. Local bands ranged (in interior Alaska) “from 20 to 75 persons, sharing an extensive territory over which they ranged in small groups, coming together in the summer for fishing and in the winter for collective hunting.” Regional bands were composed of several contiguous local bands united by marriage and sharing a common territory. Shinkwin *et al*. (1980:46) stated that “social units were fluid and represented open social systems which could incorporate new members when necessary.” He also said that the units were “well adapted to the ecological constraints represented by interior Alaska,” and that social organization in the Upper Tanana area were “closely controlled by ecological considerations reflected in the land use patterns.” Three bands are relevant to this discussion: (1) the Delta-Goodpaster Band, (2) the Healy River-Joseph Band, and (3) the Mansfield-Kechumstuk Band (SRB&A, 2002a). It is important to note that band areas, while delineating the territory or “property” of the band, do not necessarily represent the area in which each band travels, hunts, or harvests. That latter area is much larger than each band’s individual “territory” (SRB&A, 2002a).

Traditional Caribou Hunting Camps

Bands in the Upper Tanana Valley used both lowland summer camp or settlement locations and a traditional caribou hunting camp in their seasonal rounds. For example, both the Healy River-Joseph Band and the Mansfield-Kechumstuk Band used lowland summer camp or settlement locations (Healy River and Mansfield) as well as caribou hunting camp locations (Joseph and Kechumstuk) situated upland at the base of or in the mountains (SRB&A, 2002a). The literature review did not reveal any discussion of caribou camp locations for the Delta-Goodpaster Band. However, several cultural resources associated with caribou hunting and caribou corrals for this band have been documented (SRB&A, 2002a; Harritt, 2001).

3.18.3 Traditional Subsistence Use Areas versus Band Territorial Boundaries

According to McKennan (1981), precise territorial limits for the nomadic peoples who participated in communal trade, hunting, and potlatch ceremonies among bands were difficult to determine. Several cultural practices (kinship, marriage patterns, matrilocal residence rules, fluidity between bands) and historical patterns (nucleation of communities) serve to show how travel, hunting, and harvesting occurred across these band territories. Furthermore, as whites moved into the area beginning in the early twentieth century, introducing disease, trade goods, missionaries, and policies, residence patterns shifted. These shifts also affected subsistence use patterns (SRB&A, 2002a).

Travel/Hunting/Harvest Area Larger than Traditional Band Area

Traditionally, travel, hunting and harvesting areas often occurred outside of the traditional band territories (SRB&A, 2002a). Multiband subsistence activities often occurred, such as communal cooperation in corralling caribou with fences, and band territorial boundaries became flexible in times of need or periods of resource fluctuation. It was not uncommon for one band to join another band if resources were more abundant in the neighboring or more distant band territory. The use of another band territory was generally with permission (SRB&A, 2002a). The reciprocity and temporary movements of a group during times of need were possible due to established kinship ties. Bands also attended joint ceremonial activities with neighboring bands, resulting in a strengthening of the network ties between bands.

Matrilocal Residence Rule

Upper Tanana Athabaskan bands followed a matrilocal residence rule; for the first few years after marriage, the couple lives with the wife’s parents or band, resulting in a husband becoming familiar with more than one hunting area (his band’s hunting area and his wife’s band’s hunting area). Intermarriage and moving from location to location among Upper Tanana bands were common (SRB&A, 2002a).

Kinship

Kinship was, and continues to be, important to Upper Tanana Athabaskans. Tanana Athabaskan society followed exogamous matrilineal descent rules (kinship traced through maternal line and people marry outside of their own band), which strengthened bonds between bands and offered a broader network of kinship ties. Members of one clan could seek help or hospitality from other clan members, regardless of where they lived. In addition, one could seek assistance from his formalized subsistence “partner.” The preferred marriage pattern was cross-cousin marriage in which a man or woman would marry the father's sister's children or the mother's brother's children (McKennan, 1981). In this arrangement, one's "partner" would be both a cross-cousin and brother-in-law. "Rights and duties were reciprocal between partners and included the specified division of any game taken by either" (McKennan, 1981). Intermarriages between Salcha, Delta-Goodpaster, Healy River-Joseph, and Mansfield-Kechumstuk bands were common, and over time, strong interrelationships developed in which people were welcome by kinsfolk over a large geographic area (SRB&A, 2002a). Visiting, providing assistance, attending ceremonial events, sharing hunting areas (respectively with permission), sharing subsistence foods, and trading were common practices among kin relatives in different bands. These activities continue today across the broad area where relatives live (SRB&A, 2002a).

Regional Band

According to McKennan (1981:562), "frequently several contiguous bands would be sufficiently interlocked through marriage, geography, and common interests for them to consider themselves a larger unit, or regional band, of which the Upper Tanana division is a good example." Thus, contiguous local bands, united by marriage and sharing a common territory, could be perceived as a "regional band." This classification in itself is not significant; what is significant is that the Athabaskans living in the region viewed themselves as having sufficient relationships and common interests to be a part of a larger group that included sharing of subsistence foods, hunting territories, visiting, and other social relations.

Nucleation of Communities

As trading posts, missions, schools, and other influences from whites entered the Upper Tanana Region, Athabaskans tended to move to centralized locations beginning what Shinkwin *et al*. (1980) described as a "nucleation involving year-round permanent settlements." This centralization or aggregation occurred gradually as people moved to Healy Lake (fur trading post), Tanacross (mission), and Tetlin (store), for example. Permanent year-round settlement by Athabaskans did not occur immediately because the traditional life-style could not be pursued in one location (Shinkwin *et al*., 1980:47), but over time, people lived more permanently in these year-round settlements, generally centralized around the trading posts, missions, or school.

The placement of these villages, similar to the placement of traditional fish camps, very often occurred in areas where three or more resources could readily be attained and, ideally, the availability of at least one concentrated resource (e.g., fish or caribou) that could be stored (Shinkwin *et al*., 1980). Often these settlements occurred near fish camps that were a part of the more mobile seasonal subsistence residence pattern. The "village" maintained separate camps for caribou, moose, sheep, fish, and waterfowl (Shinkwin *et al*., 1980). For example, Healy Lake, the current community in the territory of the Healy River-Joseph Band, was established at the mouth of the Healy River in 1907 when a fur trading post was constructed there (Cook, 1989). From this location, hunters branched out into the uplands and mountains (for caribou and sheep), along the waterways for fish, waterfowl, and moose, and, ideally, in the nearby vicinity for small game, berries, moose, fish, furbearers, and waterfowl.

This "centralization" or "nucleation" of what was once a more dispersed residence pattern into more semi-permanent communities resulted over time in a more sedentary lifestyle, although frequent mobility persisted (Andrews, 1995). Subsistence hunting and gathering trips occurred from the centralized community rather than moving residences seasonally. Community hunters and gatherers could travel to the various camps that they and their ancestors had traditionally used to harvest caribou, moose, sheep, waterfowl, and other available resources. With the exception of Healy Lake, which has been used for a long time based on archaeological findings, none of the settlements were traditional (pre-contact) camps, although most are in the vicinity of traditional camps (Shinkwin *et al*., 1980).

This establishment of more permanent villages in association with fur trading posts was described by McKennan (1981:567): "The development of the fur trade not only brought obvious changes in Tanana material culture but also affected profoundly the subsistence pattern, round of seasonal activities, social organization, and demography. Semi-permanent villages (Healy Lake, Tanana Crossing…) grew up in the neighborhood of the trading posts." Several members of the Mansfield-Kechumstuk Band moved to Tanacross (SRB&A, 2002a). In addition, descendents and members of the Healy River-Joseph Band live in Fairbanks, Delta Junction, Healy Lake, Dot Lake, and Tanacross, and have relatives in Northway, Tetlin, and other communities (SRB&A, 2002a).

The change from the traditional, dispersed residence pattern in which band members moved seasonally to pursue subsistence resources to living in more centralized communities has had substantial effects on subsistence activities. Today, people do not nomadically follow resources as they did a hundred years ago. Instead they go on hunting, fishing, and gathering trips based out of the residence community and then return to that community. Furthermore, they often travel, among other locations, back to their traditional band areas. Thus, people with kinship and ancestral ties to traditional band areas who are now living in a host of communities located along the highway, including Fairbanks, Delta Junction, Dot Lake, and Tanacross, continue to return seasonally to their ancestral band areas in pursuit of specific resources known to be available in those areas at certain times of the year (SRB&A, 2002a).

3.18.4 Contemporary Subsistence Resource Use Patterns

Pogo Project Area

Upper Tanana River Athabaskan residents from Healy Lake, Dot Lake, Tanacross, Delta Junction, Northway, and Fairbanks use the Pogo Project area for subsistence purposes. Although Marcotte (1991) and NPS (1995) do not indicate any subsistence uses in the Pogo project area for residents of Tok and Tetlin, some may occur. Generally, those individuals who used this area had current and/or ancestral kinship relationships and/or band affiliations with the Delta-Goodpaster or Healy River-Joseph bands. The continued use of different areas by descendants of various bands is intentional and a means of ensuring clan obligation, reciprocity, and sharing of resources (SRB&A, 2002a).

Upper Tanana Region

Upper Tanana River Athabaskans use diverse subsistence resources found in the Tanana River Valley. These resources include, but are not limited to, terrestrial mammals such as caribou, moose, sheep, and bear, small, fur-bearing mammals such as beaver, muskrat, lynx, coyote, marten, hare, and red fox, waterfowl and upland birds, anadramous and resident fish, and berries and plants used for traditional and ceremonial purposes (SRB&A, 2002a).

Subsistence harvest and use of natural resources continues to play a vital role in the economy and culture of the Tanana Athabaskans (SRB&A, 2002a). Currently, the most important subsistence foods include moose, caribou, fish (whitefish, grayling, trout, and burbot), upland birds (grouse and ptarmigan), waterfowl (ducks and geese), porcupine, beaver, and berries.

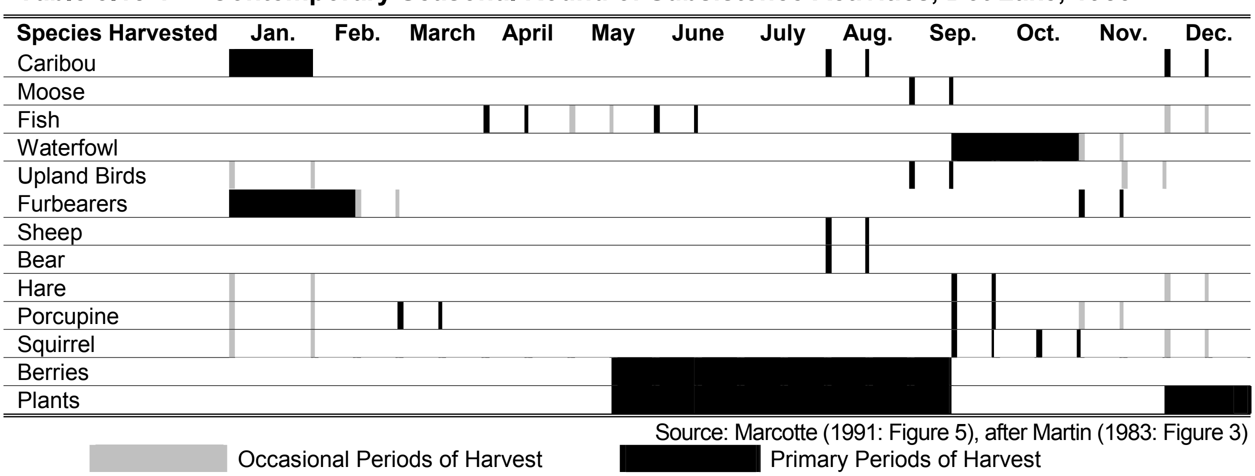
Subsistence hunting tends to be opportunistic in nature. That is, individuals often hunt for multiple resources during the course of a single hunting trip or hunt while traveling for a variety of purposes. For example, an individual might be hunting for moose, but would also harvest upland birds, waterfowl, and berries if presented with the opportunity (SRB&A, 2002).

Contemporary Seasonal Round

Contemporary use patterns differ from historical use patterns in several respects. Currently, subsistence harvest trips are based out of one's community of residence, as opposed to the traditional practice of moving residences seasonally. Also, contemporary use patterns exhibit longer periods of fishing and shorter periods of time hunting large mammals (primarily due to regulatory restrictions). Although there are legal seasons for harvesting resources, such as moose and caribou, other resources are collected throughout the year (e.g., fish) (SRB&A, 2002a).

Table 3.18-1 shows the seasonal subsistence round for Dot Lake in 1983. The activities generally correspond with information gathered in 2001 (SRB&A, 2002a), with the exception that Healy Lake fishing extended year-round. Other differences between the Healy Lake and Dot Lake seasonal round are that Dot Lake residents did not hunt for moose or waterfowl in the spring in 1983 and Dot Lake did not report hunting for moose, caribou, or upland birds in the summer. Both Dot Lake and Healy Lake seasonal rounds indicate a strong subsistence focus during the fall months.

Table 3.18-1 Contemporary Seasonal Round of Subsistence Activities, Dot Lake, 1983



Source: Marcotte (1991: Figure 5), after Martin (1983: Figure 3)

Subsistence Harvests

One general indicator of subsistence use in rural Alaska is the amount of subsistence harvest in communities. Available published information indicated that Healy Lake (Gerlach, 2000) and Dot Lake (NPS, 1995) harvested resources in the Pogo Project area. The ADFG Division of Subsistence (2001), which routinely compiles subsistence harvest data for rural Alaska communities, does not have any systematically gathered subsistence harvest data for Healy Lake. ADFG general harvest data for GMU 20D (within which the Pogo project is located) is available (Gerlach, 2000). However, this data is of limited use because it does not distinguish between general and subsistence harvest; it does not indicate the resident community of the harvesters, and it does not include all species.

Although systematically collected subsistence harvest data is not available for Healy Lake, it is available for the nearby community of Dot Lake. Dot Lake residents have kinship and hunting ties with Healy Lake residents, and also use the Pogo Mine project area for subsistence harvests (NPS, 1995). Therefore, the harvest data for Dot Lake is described here as a representative example of Upper Tanana Athabaskan subsistence harvests. According to Marcotte (1991), Dot Lake residents use a large diversity of resources. In 1987 to 1988, the latest year for which quantitative data is available, residents of Dot Lake harvested an average of approximately 378 edible pounds of wild food per household (Table 3.18-2).

Table 3.18-2 Household Harvest and Use of Fish, Game, and Plant Resources, Dot Lake, June 1987 to May 1988

Resource	Percentage of Households					Per capita Harvest (lbs)	Mean Household Harvest (lbs)
	Used	Attempted Harvest	Harvested	Received	Gave		
All	100	100	100	87	60	115	378
Salmon	80	20	20	73	13	20	66
Non-salmon Fish	93	73	73	33	47	32	105
Big Game	93	60	33	73	20	48	159
Caribou	67	40	20	53	13	8	26
Moose	73	47	20	67	20	39	129
Black Bear	27	7	7	20	0	0	0
Small Game	73	53	53	20	13	5	15
Birds	73	60	60	40	47	2	7
Ducks	47	27	27	33	27	1	2
Grouse	53	47	47	13	33	1	4
Ptarmigan	47	33	33	13	27	1	2
Edible Plants	93	93	93	13	47	8	25
Berries	93	93	93	13	40	7	23
Plants	73	73	73	13	27	1	2
Wood	67	60	60	13	20	—	—

Source: Marcotte (1991: Table 14)

Moose composed approximately 34 percent of the total harvest, fish approximately 45 percent, and caribou seven percent (Marcotte, 1991). Three of four households used resources from all resource categories (NPS, 1994). Ninety-three percent of the Dot Lake households used fish, big game, and edible plants (including berries). Seventy-three percent of the households used small game and birds. Sharing resources was common, and 87 percent of the households received resources while 60 percent gave resources. Residents of Dot Lake indicated they preferred wild foods to store-bought foods. They considered wild food to be an important part of their culture, and wild food is an integral part of Athabaskan traditional ceremonies (Martin, 1983).

Comparing the 1987 Dot Lake subsistence harvest data with nearby communities shows that, while the species composition and percentages are similar, the per capita harvests are greater. For example, ADFG (2001) data for Tanacross, Northway, and Tetlin show that the 1987 subsistence harvests were 250 pounds per capita (51 percent fish, 35 percent moose, and 4 percent caribou), 278 pounds per capita (52 percent fish, 27 percent moose, and 5 percent caribou), and 214 pounds per capita (59 percent fish, 30 percent moose, and 1 percent caribou), respectively. Pounds of a resource harvested are not necessarily indicative of seasonal or cultural value.

Traditional Trails and Contemporary Means of Access

There are a number of well-established and long-used trails in the area between Shaw Creek and the Taylor Highway (SRB&A, 2002a). Modern students of northern Athabaskan ethnography are often in awe of the huge distances that these nomadic peoples walked in their annual subsistence round. As people aggregated into communities, the annual round of moving to different seasonal residences diminished. However, the pattern of making seasonal trips back to traditional hunting and gathering places, although more frequent in the past, still continues today. Whether walked or traveled by snow machine, these traditional trails continue to be used periodically both for travel, hunting, gathering, and trapping, as well as for access into more remote areas (SRB&A, 2002a).

Historically, people accessed wild resources from camps or semi-permanent villages located near the resource to be harvested. They traveled by dogsled, foot, and/or boat. Contemporary access is by means of automobiles, motorized river boats, ATVs, airplanes, and/or snow machines, depending on the season. Boats and canoes are the primary means of traveling to subsistence areas in the summer and fall; ATVs are used to travel to upland areas in the summer and fall; and snow machines provide subsistence access in the winter.

Social Barriers to Subsistence Access

With the influx of non-Natives into the Shaw Creek area during the past several decades, Native hunters do not go to that area as frequently as in the past (SRB&A, 2002a). This “social barrier” emerged when non-Native recreational users and sport hunters moved into an area previously used by more traditional subsistence users. The Native reaction to the influx of white persons was to avoid the area or, if Natives did use the area, to make efforts not to be seen.

Roads and Subsistence

Construction of the Alaska Highway, completed by 1943, had a substantial impact on the lives of Tanana Athabaskans. One of the primary construction camps, located in Tok, housed 5,000 personnel (Simeone, 1995). Road construction and World War II created a boom economy that caused an influx of military and civilian non-residents, and caused an increase in wage employment for local residents (primarily Alaska Natives) that changed the local hunting and trapping economy (Simeone, 1995). Several villages, including Healy Lake, Kechumstuk, and Mansfield, were abandoned as people moved closer to the road for employment. Although hunting and fishing still provided the backbone of the economy, people spent more time earning cash during the road construction boom. Once road construction was completed, few economic benefits were left for the majority of the Native people. The Alaska Highway also opened the previously isolated Upper Tanana Valley region to hunters from Fairbanks and Anchorage. The resultant increased hunting pressure led to more government regulations (Simeone, 1995). The Alaska Highway also affected Native demography and health (Simeone, 1995). Epidemic diseases caused the abandonment of villages such as Healy Lake as people moved to Tanacross and Dot Lake.

After the Taylor Highway was constructed, outside hunters took advantage of the new highway access and harvested caribou along the road (SRB&A, 2002a). The first section of the Taylor Highway was constructed along a traditional Athabaskan trail from Tetlin Junction to Kechumstuck. Once the highway was constructed, nonlocal hunters with vehicles had easy access into this area. Native hunters of North America have a long tradition of allowing the leaders of a migrating caribou herd to pass unmolested. According to this custom, once the leaders pass, the rest of the herd will follow. However, if the leaders are carelessly shot, the herd will become confused and not follow traditional pathways. This dispersing of the herd migration has a negative effect on traditional hunters who typically depend on hunting caribou along relatively predictable migration routes. Outside hunters attracted by a new road often have little knowledge of either the caribou migration patterns or behavior and eagerly shoot the first caribou they encounter. After the Taylor Highway construction, nonlocal hunters apparently shot the leaders of the Fortymile Caribou Herd, causing the herd to “split” and resulting in difficulty for local hunters to harvest in traditional locations (SRB&A, 2002a).

3.18.5 Contemporary Subsistence Use Areas and Species

Figure 3.18-1 depicts the upper Tanana Athabaskan subsistence use areas for *all* resource types. Figure 3.18-2 depicts the same information for the Pogo project vicinity. These figures present two time periods: current use area (within the last 10 years) and lifetime use area (beyond the last 10 years). The figures depict the subsistence use areas for participants in the 2001 subsistence workshop and do not represent the subsistence use areas of all residents in the Upper Tanana Valley (SRB&A, 2002a). Although Upper Tanana Athabaskan subsistence uses are the focus of this subsistence discussion, non-Natives reside in the target communities and likely conduct seasonal harvest activities in the project area. Furthermore, ADFG subsistence use information referenced in this discussion includes community practices and not solely those of Native residents.

The following discussion focuses on the individual subsistence resources harvested by Upper Tanana Athabaskans in the Pogo Mine project area. Maps and additional description to supplement the following discussion can be found SRB&A (2002a).

Fish

Fish is an important subsistence food, reflecting its year-round availability. Fish resources that are harvested in the Upper Tanana Valley include pike, whitefish, grayling, and burbot. Fishing occurs along the length of the Tanana River and in most of the major rivers, creeks, and lakes in the subsistence use area on a year round basis (SRB&A, 2002a).

One favored subsistence activity is ice fishing for pike in the winter. Pike are the first fish seen in the spring when they move out of the lakes to spawn. Whitefish exist over a large area and are easy to catch whenever they are running (generally August through October). The Goodpaster River in the middle of July is a good place to harvest whitefish and pike with a net. Burbot can be harvested from Shaw Creek to Northway along the Tanana River year-round. Salmon are harvested from the Copper and Chistochina rivers. Trout can be harvested at one of the many stocked lakes in the area, including Quartz Lake, Bird Lake, and Jan Lake. Grayling are often harvested in Clearwater Creek, Clearwater Lake, and Volkmar Lake. Ice fishing typically occurs at Lake George, Healy Lake, Volkmar Lake, Goodpaster River, and the Tanana River (SRB&A, 2002a).

Moose

Moose are an important resource for Upper Tanana Athabaskans. The lifetime use area is a large area that stretches north of the Tanana River, from the Salcha River to east of the Taylor Highway in lower lying areas (SRB&A, 2002a). Current use areas can be found along the Tanana River and the Alaska Highway from northwest of Big Delta to Tok, in the Shaw Creek Flats area, and along and around most rivers (Goodpaster River, Volkmar River, Healy River, Gerstle River, Middle Fork, and Johnson River) and lakes (Quartz Lake, Volkmar Lake, Healy Lake, Clearwater Lake, Dot Lake, Sand Lake, and Lake George) in the region. Popular moose hunting areas are along roads, rivers, and creeks, including Shaw Creek, Sand Creek, George Creek, Keystone Creek, Caribou Creek and Rapid Creek. Another area used currently is the Goodpaster River area north of Central Creek near Shawnee Peak (SRB&A, 2002a).

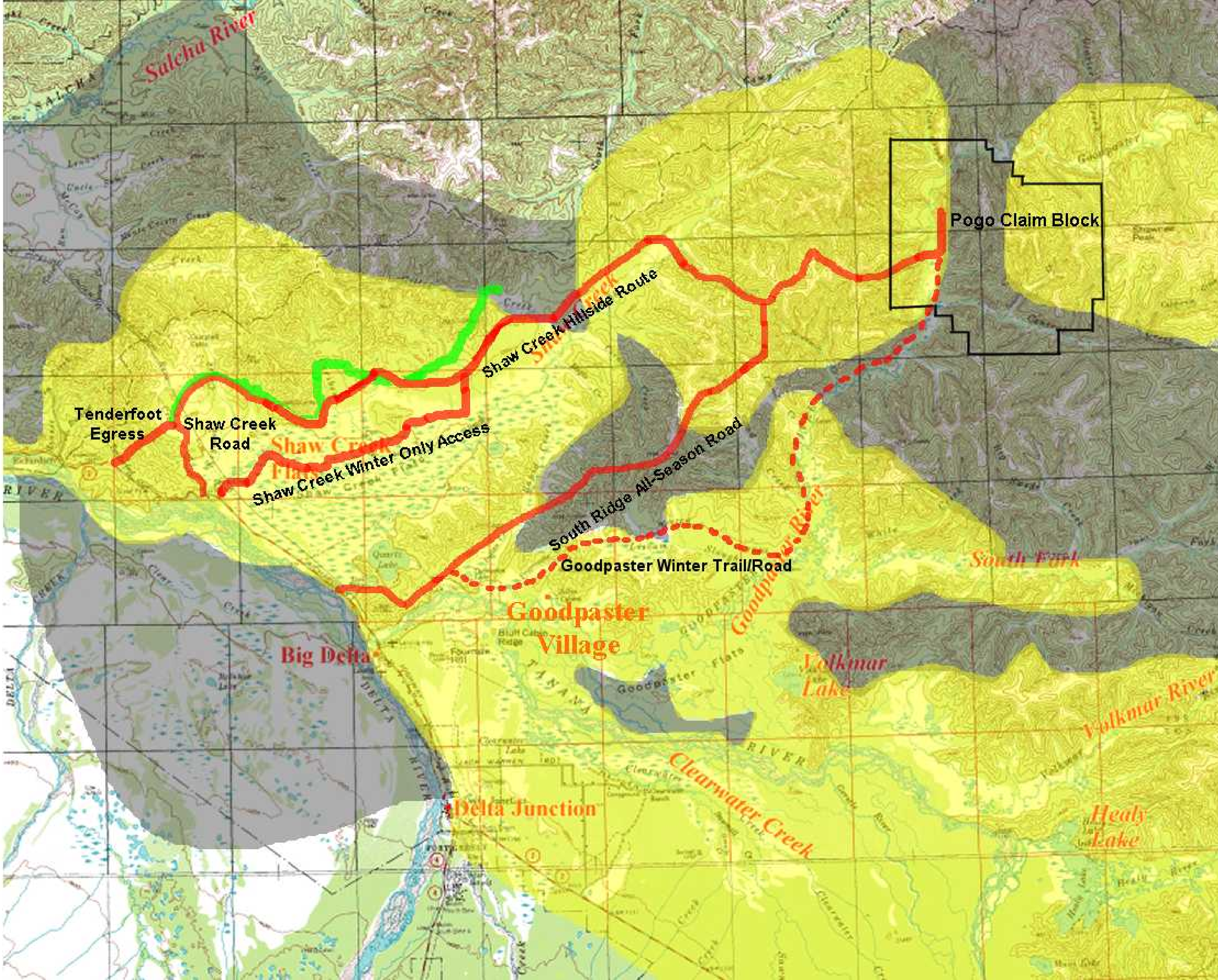
Moose are generally hunted in the fall (often in conjunction with waterfowl hunting), but can be considered a year-round resource, depending on need (including food and ceremonial purposes). Food is taken from the surrounding environment as need dictates. This moose harvest includes hunting for potlatches and memorial potlatches, as well as day-to-day feeding of one's family. Hunting parties usually consist of small groups of men. Moose hunting areas are often accessed by vehicle, boat, ATV, "Argo", and walking. Winter access is by snow machine. Most hunters hunt every year, and often several times a year. A popular hunting method is to travel by boat, for example from Healy Lake to Lake George on the Tanana River, or from Delta to Healy Lake, or from Dot Lake to Lake George (SRB&A, 2002a). The Dot Lake moose hunting area extends into the Pogo Project area (SRB&A, 2002a).

Caribou

Caribou hunting areas are extensive and reflect the widespread distribution of the animals and the changes in migration patterns and population over time (SRB&A, 2002a). Hunters use the area west and northwest of Mount Harper (Figure 3.18-1). This area is often reached by snow machine in winter. Recent hunting for caribou also occurs along both sides of the Taylor Highway. "Stray" caribou are harvested in the Shaw Creek area, as they were harvested 50 years ago. Other recent use areas include the Goodpaster River near its confluence with the Tanana River and the South Fork, the Macomb Plateau (south of the Alaska Highway, south of Lake George), and along the Alaska Highway between Sand Lake and the Robertson River. The caribou lifetime use area encompasses the Goodpaster River and the area north of the Goodpaster River, an area east and north of the Tanana River between the Goodpaster River and Sand Lake, an area between Kechumstuk and Mansfield, and an area south of the Alaska Highway between the Johnson River and Dot Lake (SRB&A, 2002a). The Dot Lake hunting area extends into the Pogo Project area encompassing the Goodpaster River and Shaw Creek drainages (SRB&A, 2002a; NPS, 1995).

Hunting for caribou generally begins in late summer or early fall (before rutting season) and the winter (generally cows). Caribou hunting parties are generally composed of small groups (two to four) of men. Hunters access this resource by boat, ATV, walking, or by road in the fall and snow machines in the winter. Often, combinations of methods are used. Some hunters fly to the hunting area (SRB&A, 2002a).

Figure 3.18.1
Upper Tanana Athabaskan Subsistence Use Areas for All Resources



LEGEND

- Recent Use Areas (last 10 years)
- Lifetime Use Areas
- Access Routes
- Planned DOF Road

Not to scale

Map adapted from Big Delta 1:250,000 USGS Quadrangle

Source: Stephen R. Braund & Associates (2002)

Pogo Mine EIS

Figure 3.18.2
Upper Tanana Athabaskan Subsistence Use Areas for All Resources in the Pogo Project Vicinity

map prepared by
Stephen R. Braund & Associates

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Upper Tanana Athabaskan subsistence users noted historic caribou calving and migration routes in the Mount Harper-upper Goodpaster River area (SRB&A, 2002a). These calving areas extend farther southwest than those depicted by the FCHPT (2000), but the time periods are different. The FCHPT information is primarily from the early 1990s to the present, whereas the local information represents a much earlier time period, extending back to the 1940s and 1950s. Local hunters noted that caribou migration patterns have changed over time. Whereas caribou migrated near Healy Lake in the past, this migration was disrupted beginning in the 1960s when nonlocals began to hunt caribou in the area, shoot the leaders, and consequently alter caribou migration patterns. It is only recently that caribou have returned to the Healy Lake area (SRB&A, 2002a).

Upland Birds

Hunting for upland birds generally occurs in the fall (August/September) at the same time as berry and waterfowl harvests. Access is generally by automobile, walking, or both in the fall and snow machine in the winter. Species harvested are spruce grouse in the fall and other grouse and ptarmigan in the winter. Hunting for upland birds occurs along the "edge of the hills." Recent use areas (last 10 years) are concentrated in areas such as the Shaw Creek Flats, along the Tanana River west of Quartz Lake and between Volkmar Lake and the Robertson River, in the area at the confluence of the Goodpaster and Tanana rivers, along the Goodpaster River and the South Fork, along the Volkmar and Healy Rivers, and around area lakes (e.g., Healy Lake, Lake George, and Sand Lake) (SRB&A, 2002a). The lifetime use area is much larger, and extends from the Shaw Creek Flats south to the Robertson River and east of Joseph. This lifetime use area is associated with the opportunistic nature of subsistence hunting in which upland birds may be harvested as they are encountered while individuals are pursuing other activities such as traveling, or hunting other species such as moose and caribou (SRB&A, 2002a).

Waterfowl

Waterfowl are also an important subsistence resource The waterfowl hunting season generally occurs in the spring and the fall, and often occurs in conjunction with moose and upland bird hunting. Hunting for waterfowl occurs along area lakes, rivers, and creeks. Access to the resource generally occurs through the use of boats, walking, or both. Waterfowl are harvested in all of the area lakes (Volkmar, Healy, George, and Sand lakes), at Shaw Creek Flats, on the Tanana River between its confluence with the Delta River to south of Tetlin Junction, on the Volkmar and Healy rivers, and along area creeks such as Mansfield and George creeks (SRB&A, 2002a).

Sheep

Sheep hunting usually occurs in the late summer/early fall and fall seasons. Sheep hunting occurs in the area around Mount Harper and areas south of the Alaska Highway such as Granite Mountain, Independent Ridge, and the Macomb Plateau (SRB&A, 2002a). Access to these areas is generally by traveling up the creeks and rivers (SRB&A, 2002a). The Dot Lake sheep hunting area extends into the Pogo Mine project area (SRB&A, 2002a).

Bear

Black bears are the primary bear species hunted in the Upper Tanana Valley. Areas hunted over time include the area surrounding the Goodpaster Village site near the confluence of the

Tanana and Goodpaster rivers, the area near the confluence of the Tanana and Gerstle rivers, Lake George, Sand Lake, and an area south of the Robertson River (SRB&A, 2002a). The Dot Lake bear hunting area extends into the Pogo Mine project area (SRB&A, 2002a).

Berries

Species of berries that are harvested in the fall include blueberries, cranberries, raspberries, black berries, salmon berries, high-bush cranberries, and currants. Wild rhubarb is also harvested at the same time. Berries are typically harvested during caribou or moose hunting. Berry harvest areas include the confluence of the Goodpaster and Tanana rivers, along the Tanana River at Shaw Creek Flats, along the Tanana River between Johnson Slough and Chief Creek, along the Volkmar River, and around most lakes in the area (Healy Lake, Lake George, Sand Lake, Dot Lake, and Lake Mansfield) (SRB&A, 2002a).

Plants Used for Traditional and Ceremonial Purposes

Plants used for traditional and ceremonial purposes include sweet grass and juniper. Sweet grass is used in steam baths and in tea. The juniper plant has leaves that are used in the steam bath and in draughts for coughs and rheumatism. Use areas for plants include an area along the Tanana River west of Shaw Creek Flats, an area along the Tanana River southwest of Quartz Lake, along the Tanana River south of Volkmar Lake, an area between the Volkmar River and Healy Lake, along the east coast of Twelvemile Lake, along the Tanana River south of Lake George and Sand Lake, near the confluence of the Tanana and Robertson rivers, and on the southern shore of Lake Mansfield (SRB&A, 2002a).

Minerals Used for Traditional and Ceremonial Purposes

Red “paint” gathered at specific locations was traditionally used as a sealant or coating on snowshoes and sled runners, as “war paint,” and as a trade item for copper. Traditionally, the sources of the paint were “protected” information. Mount Harper is one source for this paint (SRB&A, 2002a). Different groups had different colors; for example, Salcha and Goodpaster – orange paint; Healy Lake – red paint; Gwich’in – light blue) (SRB&A, 2002a).

Trapping

Because of low fur prices, trapping is currently not a widespread practice. This activity occurs in the winter between November and March or April. Areas of recent use (last 10 years) are from the general area of Healy, George, and Sand lakes, extending northeast up the rivers as well as other discrete lowland areas (SRB&A, 2002a). Lifetime use areas encompass a larger area, including the major rivers and creeks such as Shaw Creek, Goodpaster River, and Tanana River. Species harvested during trapping activities include marten, wolverine, wolf, coyote, lynx, fox, beaver, muskrat, mink, and weasel (SRB&A, 2002a).

3.18.6 Summary

Subsistence harvest and the use of natural resources continue to play a vital role in the economy and culture of the Tanana Athabaskans in the Upper Tanana region. Current Athabaskan residents, including part-year residents, of Healy Lake, Dot Lake, Delta Junction, Tanacross, Northway, and even Fairbanks, with historical and kin-associated relationships to the study area continue to harvest traditionally used fish, moose, caribou, upland birds, waterfowl, small fur-bearing mammals, sheep, bear, berries, plants, minerals, and small furbearers in the Pogo Mine project vicinity. Reciprocal family and hunting relationships continue to play a role in the subsistence practices of Upper Tanana communities of Healy Lake, Dot Lake, Delta Junction, Northway, and Tanacross, and also kin who live in Fairbanks.

3.19 Cultural Resources

3.19.1 Prehistoric and Contact Period Resources

The middle Tanana River is a portion of the unglaciated Beringia Refugium of the late Pleistocene era, and because of this aspect of the paleoecology, it possesses high potential for containing some of the earliest traces of humans on the North American continent. Traces of early man in the vicinity of the proposed project exist at Broken Mammoth, Swan Point, and the Mead site (Yarborough, 2000). In a clear example of the area's important archaeological potential, mammoth ivory was worked into tools at Broken Mammoth (Holmes, 1996). One of the earliest cultural traditions in the North American Arctic, the American Paleoarctic tradition, is represented in the buried deposits more than 10,000 years in age at the three sites named above. The sites in the area containing remains of Pleistocene fauna in association with human tools are some of the most important in North America (Holmes, 1996; Cook, 1996). They offer opportunities to not only gain insights into ways early man coped with a considerably different world than that of today, but to obtain important insights into the ways humans adapted to environmental changes that occurred at the end of the last ice age.

As the Holocene era progressed, cultural changes that occurred in the region as a whole included the initial appearance of Northern Archaic culture at around 6,000 years ago in some areas of Alaska (NPS, 1998). Many questions concerning Northern Archaic cultural development remain to be answered by both new discoveries of the traces left by the Northern Archaic people and new interpretations of data. Specific issues include the nature of relations between Paleoarctic culture and the Northern Archaic. In the project area, indications are that people were absent for some time following the tenure of the Paleoarctic tradition (Yarborough, 2000). Nevertheless, there are indications that some type of relationship may have existed in technological elements such as the Paleoarctic type of blade and core technology that is also documented at sites with what are otherwise characteristic Northern Archaic tools.

A recent synthesis of Northern Archaic origins suggests that the culture spread as a diffusion of characteristic tool forms such as the Northern Archaic notched points that were accepted in varying degrees by different groups in the region (NPS, 1998). The overall distribution of the technology indicates that the diffusion cross-cut different cultures and language groups during mid-Holocene times. Many important questions remain concerning Northern Archaic culture. For example, what were the temporal, cultural, and possibly environmental factors that supported the development of a distinctive Northern Archaic technology while enabling the persistence of an important technological element of Paleoarctic culture? Answers to questions such as this may be contained in the archaeological deposits of undiscovered sites in the project area. Examples of sites containing Northern Archaic remains in the vicinity of the project area are the Campus site and Dixthada (NPS, 1998).

Changes that took place in the environment over the past 6,000 years undoubtedly affected the human inhabitants of the region in ways that are only poorly understood. The emergence of the Athabaskan culture of the Alaskan interior is thought to be directly traceable to Northern Archaic origins by some (NPS, 1998). Nevertheless, by 2,000 years ago, identifiable Athabaskan cultural patterns had emerged in some interior areas. There is yet much to be learned about the ethnogenesis of Athabaskan culture and the environmental and cultural influences that contributed to its development. In this regard, an important question is: Did environmental and cultural changes that occurred during the past 6,000 years have impacts that were sufficient to either precipitate changes in technologies such as house construction, or could the changes have resulted in a withdrawal of humans from the area until conditions ameliorated? An important natural event that occurred during this time to the southeast of the project area, the eruption of Mt. Bona around AD 1250, is an example of a sudden environmental episode that undoubtedly had an impact on the residents of the upper and middle Tanana River area (NPS, 1998). Related questions are, Did this event result in a temporary abandonment of the area by humans? What were the effects of the eruption on the environment in the project area?

Climatic periods of glacial maximum and minimum expansions during the Holocene are well documented in northern regions, and their effects on the cultures at different stages of prehistory remain major avenues of inquiry in studies of northern prehistory. Plant communities and general climatic patterns had stabilized by around 6,500 years ago (NPS, 1998), but fluctuations in temperatures and environmental shifts of smaller magnitudes nevertheless affected the human inhabitants of the region to some degree. Related questions are, How did the prehistoric ancestors of the historical Athabaskan inhabitants adapt to climate changes, such as the Little Ice Age that began around AD 1450? What other factors operating in prehistoric times contributed to the ethnogenesis of the Native culture encountered by the first European explorers? The historic Tanana Athabaskan sites in the area undoubtedly contain information that would provide illumination for these areas of inquiry.

The traditional territory of the Tanana Athabaskan tribe roughly corresponded with the Tanana River drainage and extended westward to the confluence of the Kantishna and Tanana rivers, north to the headwaters of the Tolovana River, and to the southeast to the northern slopes of the Wrangell Mountains (NPS, 1998). A total of five bands with their respective territories composed the Tanana tribe. The area of the proposed project includes portions of the Goodpaster and Healy River-Joseph bands (McKennan, 1981).

Historical Tanana Athabaskan patterns of land use reflect both ways in which game animals and other types of resources were used by the inhabitants through the different seasons of the year, as well as the beliefs and perceptions the inhabitants had concerning property and social organization. An overall, general pattern was for the territory or range of a regional group to include a major stream or river. Lands behind the river provided the territorial “hinterlands” that, in combination with the river, usually contained the major array of resources that would be used by the group through an annual cycle (NPS, 1998).

Site types within a given territory ranged from winter settlements to hunting and fishing camps, and to other types of temporary use locations where specific resources occurred, such as moose or caribou ranges and berry-picking areas. The boundaries of the territory were recognized by the inhabitants of adjacent territories, on the basis of traditional, customary use of the land by the resident group (Holmes, 1975).

The primary focus of Tanana subsistence during the summer months was on several species of salmon taken with fish traps and dip nets from weirs constructed across lake outlets; whitefish were also important (McKennan, 1981; Yarborough, 2000). Other resources used during the late summer included berries, roots, and waterfowl. In the fall, the focus shifted to caribou migrating into the uplands; caribou fences and corrals were constructed for harvesting the animals with bows and arrows (McKennan, 1981). Caribou meat was dried for the winter months. In addition to fish and caribou, sheep were hunted in late summer and moose were taken during times the bands were at lower elevations, during the spring, summer, and fall. Winters were spent at upland locations.

While social organization within a territorial group was by and large egalitarian, leaders or chiefs emerged at such times when persons were needed to fill roles in which coordination of activities was required (U.S. NPS, 1998). Examples of this type of leadership can be seen in coordinated hunting efforts such as caribou drives and similar activities. In addition, a big chief sometimes emerged within a territory as a person vested with the responsibility of negotiating treaties with neighboring groups, or as one who spoke for the group in matters of trade and other types of negotiations. The home village of such a person was sometimes regarded as the principal village in the territory. Important villages in the project area are *Jiizechagge* (Goodpaster Village) and *Tathchagge* (Big Delta) (Yarborough, 2000). In the context of the preceding discussion, it is likely that important chiefs lived in each of the villages, a circumstance that may have been especially important socially because the two villages were located in territories of different bands (McKennan, 1981; Yarborough, 2000). Although the two villages may have functioned as fish camps during the summer months in late precontact times, contact period descriptions suggest that Goodpaster Village at least showed evidence of winter habitation (Yarborough, 2000; Mishler, 1986). Winter settlements were supposedly located in the uplands, presumably in the higher elevations, and away from the river, based on ethnographic information (McKennan, 1981).

Historic Tanana Athabaskan sites in the vicinity of the project have been documented by Andrews and Mishler (Yarborough, 2000). Sites documented in the project area as a result of these efforts include Goodpaster Village (*Jiizechagge)* and two “village” sites on Shaw Creek, and a number of names that distinguish locations and areas with cultural importance in the project area. Included here are areas along the Goodpaster River, Shaw Creek, Quartz Lake and Thompson Lake, Indian Creek, Thompson Hill, and the bluff on which the Mead site is located (Yarborough, 2000). Yarborough notes that some of these cultural resources may be eligible for the National Register of Historic Places as “traditional cultural properties.”

3.19.2 Historic Environment

Exploration of the area began in 1885 as part of an expedition led by Lieutenant Henry Allen of the U.S. Army (Yarborough, 2000). Little or no contact occurred between the Euroamericans and the Natives during this expedition. Although missionary activities in the region between 1891 and 1892 undoubtedly resulted in contacts with the inhabitants of Goodpaster Village and Big Delta, scant documentation of the encounters exists (Mishler, 1986). A subsequent military expedition in 1898 actually resulted in the first visit to Goodpaster Village (*Jiizechagge*) by Allen and by another military expedition led by Castner (Mishler, 1986; Yarborough, 2000). Important results of these trips were some of the first descriptions of the inhabitants of the area.

Alfred Brooks also visited Goodpaster Village in 1898 during a geological survey of the Tanana River. Although he wrote little in the way of description, he did take the first photographs of the village (Mishler, 1986). Also of import is Brooks’ encounter with white prospectors who were preparing to travel to the upper Goodpaster; their expedition appears to constitute the initial mining activity in the area (Mishler, 1986). It is important to point out the 1898 documentation by Castner (Mishler, 1986) of village residents possessing rifles. Rifle possession was undoubtedly a reflection of the Goodpaster Natives’ participation in the fur industry on the lower Tanana River. These types of artifacts, including trade beads and similar items, are the first physical evidence of Euroamerican presence in the area.

Activities related to historical mining in the Tanana River Valley began around 1870 as part of the transitory gold rush activities in the vicinity of the Yukon River, with a subsequent major discovery on the Klondike in 1898-1999. Prospectors began exploring the Tanana River Valley early in the process – by the 1870s (Alaska Environmental Information and Data Center, 1974; Saleeby, 2000). By 1873, a trading post had been established on the Yukon River at the mouth of the Tanana River and provided support for the mining developments in the region. During the early years of the enterprise, the explorations and travels of prospectors were extensive, but for the most part undocumented. An exception to this rule was an incident recorded by Castner during his explorations in the Tanana River area in 1898. In this account, he reports rescuing two white men – presumably prospectors – who had traveled from Dawson in the Yukon Territory, by way of Fortymile, Lake Mansfield, Ketchumstuck Hills, and the Tanana River. One of the prospectors related to Castner that he had prospected up the Volkmar River 50 miles, presumably in search of gold (Castner, 1900). None of the cultural resources sites recorded to the present for the project area contains remains of the early gold rush activities in the region.

A military project begun in 1902 also produced remains with historical importance. In that year Lieutenant Billy Mitchell surveyed a route for installation of a section of the WAMCATS between Eagle and Tanana (Yarborough, 2000). The purpose of this project was to provide communication between army posts in Alaska and Washington, D.C. A segment of the route of the line follows the course of the Goodpaster River in the project area. In 1938, a miner began hauling freight over a winter trail that may have been used previously by dog mushers (Yarborough, 2000). Subsequent use of the Goodpaster River Valley was related to mining operations in the upper drainage, with the primary function being a route for hauling freight and supplies.

Historical hardrock development and mining activity in the upper Goodpaster region occurred primarily in the Black Mountain area, approximately 20 miles east of the area now known as Pogo, on four small quartz vein lodes during the period from 1936 to 1941. The historic lodes included the Blue Lead, Blue Lead Extension, Grey Lead, and Grizzly Bear. Total production was approximately 1,150 oz (Tweiten, 1990). Between 1990 and 1994, these historic properties were consolidated into a single claim block, now known as the Rob property, and have been further explored since 1995 without the delineation of important new gold resources (Teck-Pogo Inc., 2003).

3.19.3 Project Area Sites

Table 3.19-1 lists the cultural resource sites in the project area, and within the area of potential effect (APE). These sites were identified from the Alaska Heritage Resources Survey (AHRS) files in the State Historic Preservation Office (SHPO, 2002), baseline field reconnaissance surveys commissioned by the Applicant (Yarborough, 2000 and 2001), and direct consultations with Native organizations and individuals (Harritt, 2001). There are no ANCSA Section 14(h)(1) sites located in the APE.

Table 3.19-1 Archaeological and Historical Sites in the General Project Area

AHRS Site No.	Site Name	Site Type	Period/Date
XBD-003	Central Telegraph Station	Communication Site, U.S. Army Signal Corps	Historic, Euroamerican AD1903
XBD-004	Campbell Cabin	Log trapping cabin	Historic, Euroamerican AD1903
XBD-013	Rosa Creek Cave	Rock shelter	Prehistoric
XBD-014	Shaw Creek I	Site/ Fish camp/ Fish wheel/ Garden	Prehistoric/Historic, Athabaskan
XBD-015	Shaw Creek II	Site, graves, and caches	Prehistoric/Historic, Athabaskan
XBD-016	Shaw Creek Summer Camps	Summer fishing camp with fish traps	Protohistoric/Historic, Athabaskan
XBD-017	Tanana River Site	Site/ "Indian Camp"	Prehistoric
XBD-018	Quartz Lake	Site (artifacts along shore)	Prehistoric
XBD-019	Indian Creek Cache	Cache site	Prehistoric
XBD-031	Koppenhaver	Lithic scatter	Prehistoric
XBD-041	Lost Lake Site	Log structure	Historic, Euroamerican AD1904
XBD-051		reported site	
XBD-053	Seppala Cabin	Cabin and out structures	Historic, Euroamerican AD1940-1950s
XBD-054	Henry "Butch" Stock's Roadhouse (Alonzo Maxey's Roadhouse)	Roadhouse	Historic, Euroamerican AD1904-1930
XBD-055	Sternwheeler S.S. Nabesna	Shipwreck	Historic, Euroamerican AD1900s
XBD-057	Nigger Bill's Roadhouse	Roadhouse	Historic, Euroamerican AD1900s
XBD-059	Ben Bennett's Trading Post	Village	Historic, Athabaskan
XBD-060	Bert and Mary Hansen's Roadhouse	Log Structure, roadhouse dismantled 40 years ago	Historic, Euroamerican AD1900s
XBD-063	Tenderfoot Roadhouse	Roadhouse/Store	Historic, Euroamerican AD1912
XBD-071	Mead Site	Site (2 components)	Prehistoric
XBD-072	Quartz Lake I	Site	Prehistoric
XBD-073	Thompson Lake Site	Site	Prehistoric
XBD-074	Bluff Cabin Ridge Site	Site	Prehistoric
XBD-075	Goodpaster Sawmill Site	Sawmill	Historic, Euroamerican AD1900s
XBD-076	Goodpaster Cabins Site	Three cabins	Historic, Euroamerican AD1900s (early)
XBD-077	Goodpaster I	Site/Artifacts/Hearths	Protohistoric/ Historic, Athabaskan
XBD-081	Goodpaster II Jiizechagge or Old Goodpaster Village)	Cache pits/"Abandoned village"	Historic Athabaskan AD1902
XBD-092		reported site (no info in AHRS)	
XBD-125	Big Delta Cremation Ground	Burial/Sacred site	Historic Athabaskan
XBD-130	BM "Shaw"	reported site (no info in AHRS)	
XBD-131	Broken Mammoth Site	Site/ Camp (multicomponent)	Prehistoric 11,770+/-210BP-2,040+/-65BP
XBD-132*	Big Delta Historic District	District (Includes sites: XBD-059, XBD-133-154)	Historic, Euroamerican AD1904-1941
XBD-155*	Lithic Site	Site/Artifacts	Prehistoric
XBD-156	Swan Point	Site/Camp (multicomponent)	Prehistoric/ Historic, Athabaskan 12,060+/-70BP to 1,220+/-70BP
XBD-157	Lithic Site	Site/Lithic scatter	Prehistoric

Table 3.19-1 Archaeological and Historical Sites in the General Project Area

AHRS Site No.	Site Name	Site Type	Period/Date
XBD-158	Lithic Site	Site/Lithics	Prehistoric
XBD-159	Quartz Lake	Site, artifacts eroding out of bluff	Prehistoric
XBD-160	"Activity Area"	Site	Prehistoric
XBD-161	"Activity Area"	Site	Prehistoric
XBD-170	Prehistoric Site	Site, lithic	Prehistoric
XBD-171	Prehistoric Site	Site, lithic	Prehistoric
XBD-172	Tenderfoot Creek Boiler & Driftmine Site	Mining	Historic, Euroamerican AD1910s
XBD-173	Tenderfoot Creek Log Cabin & Bridge Site	Mining/Bridge/Cabin	Historic, Euroamerican AD1910s
XBD-182	Hearth Feature	Fire cracked rock/Calcined bone	Prehistoric, 360+/-60BP
XBD-184	Surface Feature	Surface feature	Prehistoric
XBD-185	Rock Cairn	Rock cairn	
XBD-190	Shaw Creek Village (1)(UTN 34-1)	Village	Protohistoric/Historic Athabaskan
XBD-191	Shaw Creek Village (2)(UTN 34-2)	Village	Protohistoric/Historic Athabaskan
XBD-197	Fowler Farm Archaeological Site 1	no further information available	
XBD-198	Fowler Farm Archaeological Site 2	no further information available	
XBD-199	Fowler Farm Archaeological Site 3	no further information available	
XBD-200	Fowler Farm Archaeological Site 4	no further information available	
XBD-235	Gilles Creek	Prehistoric Site in Pogo Area	Prehistoric
XBD-238		Graves	Historic, Athabaskan
XBD-239		Graves	Historic, Athabaskan
XBD-240		Graves	Historic, Athabaskan (ca. AD1912)
XBD-241		Fishing and trapping location	Historic, Athabaskan (AD1947-1950)
XBD-242		Graves	Historic, Athabaskan
XBD-243		Camp and cemetery	Historic, Athabaskan (ca. AD1914-1953)
XBD-244	John's Camp	Camp	Historic, Athabaskan (ca. AD1914-1950s)
XBD-245		Fish camp with fish wheel	Historic, Athabaskan (ca. AD1920s)
XBD-246	Trapping Camp	Trapping Camp	Historic
XBD-247		Fire cracked rock	Prehistoric

* Listed on the National Register of Historic Places

Source: AHRS

3.20 Visual Resources

Visual resources, and their analysis, address the importance of the inherent aesthetics of the landscape, the public value of viewing the natural landscape, and the contrast or change in the landscape from proposed project alternatives. Existing visual quality, constituents, landscape visibility and scenic classes, and visual absorption capability are commonly used to describe the affected visual environment.

3.20.1 Existing Visual Quality

Ecological unit descriptions (EUDs), or "mapping units," were determined for the project area by Adams (2000). Procedures for determining elements of the EUDs, including landscape character, scenic attractiveness, and scenic integrity, followed U.S. Forest Service (1995). Figure 3-20.1 presents the EUDs for the Pogo Mine project area.

The Shaw Creek Foothills area is characterized by rolling foothills with rounded slopes. Specific creeks within the unit include Keystone, Caribou, and Gilles creeks. The area has a southwest aspect with elevations varying from 1,200 at the base to roughly 2,000 ft AMSL.

The scenic attractiveness of the Shaw Creek Foothills EUD is described as "typical" of the area. There are no outstanding features that add variety or vividness. The area is almost completely natural with no cultural patterns that contribute positively or negatively to the viewed landscape. The scenic integrity of the unit, in general, is very high.

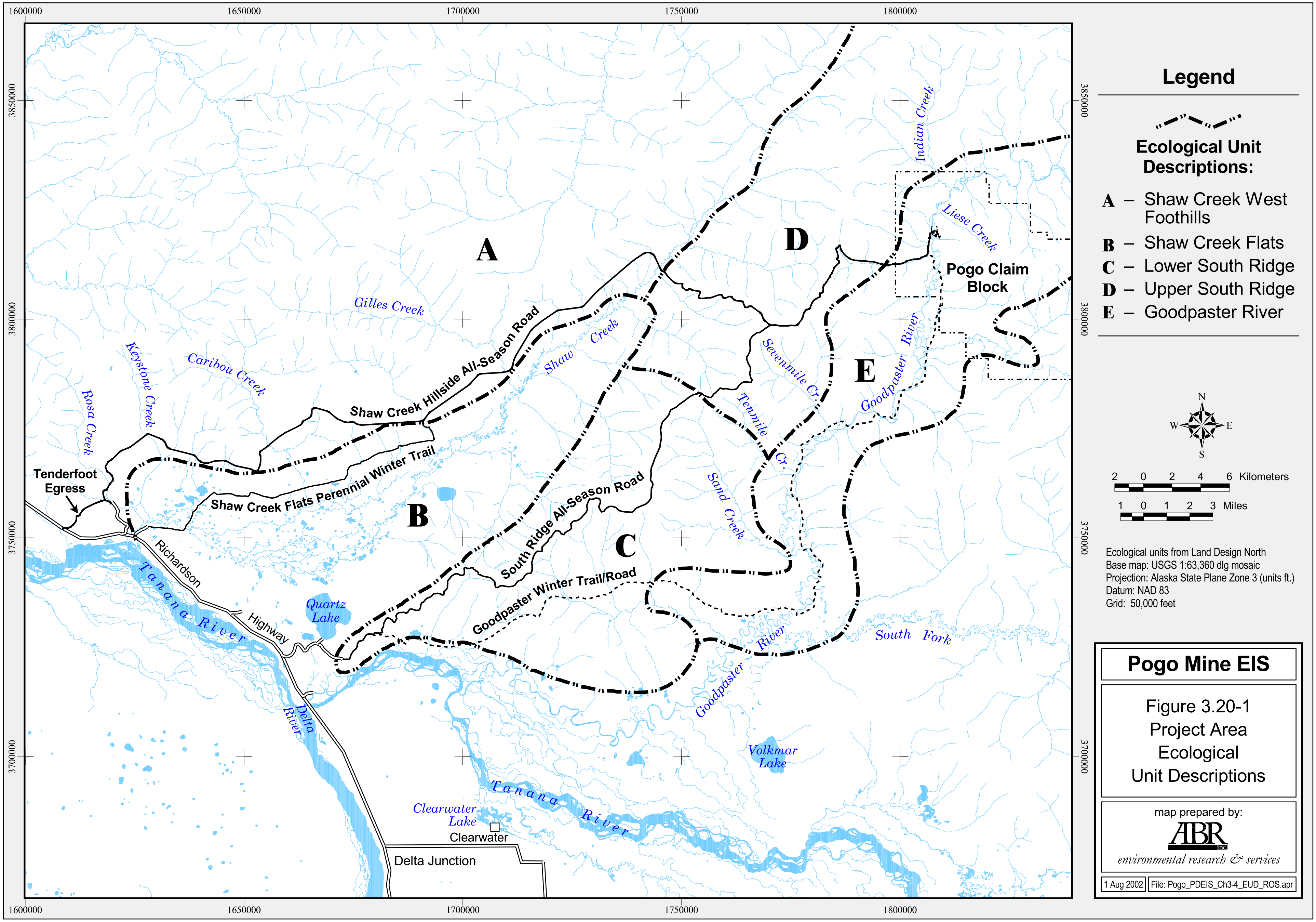
Shaw Creek West Foothills EUD

View towards Shaw Creek foothills

View of Shaw Creek foothills above the flats

The lower elevations of the Shaw Creek Flats EUD are characterized by level terrain with small lakes, ponds and wetlands. Shaw Creek is the dominant Creek in the valley with numerous small meandering creeks and interconnected water bodies.

The scenic attractiveness of the Shaw Creek Flats EUD is described as "typical" of valleys that feed into the Tanana River Valley. The infrastructure improvements at Quartz Lake, the Trans-Alaska Oil Pipeline, the Richardson Highway, and the power and telecommunications lines are found in the southern and western margin of the EUD, but are relatively minor intrusions into the unit as a whole; therefore, the overall scenic integrity of the area remains very high.


Legend
Ecological Unit Descriptions:
A – Shaw Creek West Foothills
B – Shaw Creek Flats
C – Lower South Ridge
D – Upper South Ridge
E – Goodpaster River
N
W
E
S
2 0 2 4 6 Kilometers
1 0 1 2 3 Miles
Ecological units from Land Design North
Base map: USGS 1:63,360 dlg mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet
Pogo Mine EIS
Figure 3.20-1
Project Area
Ecological
Unit Descriptions
map prepared by:
ABR
environmental research & services
1 Aug 2002
File: Pogo_PDEIS_Ch3-4_EUD_ROS.apr
1600000
1650000
1700000
1750000
1800000
3850000
3800000
3750000
3700000
A
B
C
D
E
Pogo Claim Block
Tenderfoot Egress
Shaw Creek Hillside All-Season Road
Shaw Creek Flats Perennial Winter Trail
South Ridge All-Season Road
Goodpaster Winter Trail/Road
Richardson Highway
Gilles Creek
Caribou Creek
Keystone Creek
Rosa Creek
Shaw Creek
Indian Creek
Liese Creek
Sevenmile Cr.
Tenmile Cr.
Sand Creek
Goodpaster River
South Fork
Tanana River
Delta River
Quartz Lake
Volkmar Lake
Clearwater Lake
Clearwater
Delta Junction

Shaw Creek Flats EUD

Shaw Creek Flats from Richardson Highway

Shaw Creek Flats near the Trans-Alaska Pipeline

The Lower South Ridge EUD is composed of the lower hillsides of the ridgeline that divides the Shaw Creek and the Goodpaster River valleys. Tenmile Creek defines it to the northeast, as does the valley north of Corda Creek. Named creeks include Liscum Slough, Progressive Creek, Sand Creek, and Tenmile Creek, which all drain into the Goodpaster River, and Rapid, Eagle and Corda creeks, which drain into Shaw Creek.

The area is characterized by low hills rising from approximately 1,000 ft AMSL to relatively high domes. A portion of the lower Goodpaster Winter Trail is in this EUD. Shaw Creek Dome, at an elevation of 3,630 ft AMSL, is the dominating element of the unit. The lower hillsides in this EUD are considered “typical” in visual attractiveness, while Shaw Creek Dome and its related topographical elements are considered “distinctive.”

Lower South Ridge EUD

Shaw Creek Dome from Liscum Slough

Goodpaster Winter Trail at Progressive Ck.

The Upper South Ridge EUD includes the lower and upper hillsides and ridgelines of the South Ridge, between the Shaw Creek Valley and the Goodpaster River Valley. This EUD features a continuous ridgeline with elevations that range between 2,500 and 4,000 ft AMSL. Unlike the Lower South Ridge EUD, the upper ridgeline has no distinctive peaks or valleys.

Typical of upper elevations in the Tanana River Valley, the hills provide a strongly unifying element that is clearly distinctive. The bare peaks draw attention and provide uniqueness within the setting. There are no intrusions, such as roads or structures visible from the air or from other locations in the adjacent valleys, in this EUD; therefore, it is considered to have a high level of scenic integrity.

Upper South Ridge EUD

View of Goodpaster River Valley with South Ridge in background, looking westward from Tabletop at the proposed Pogo Mine site.

The Goodpaster River EUD is composed of the lower hillsides and drainages that form the Goodpaster River, which is a meandering clear-flowing stream with no altered portions along its length. Numbers of creeks flow into the river, with the South Fork of the Goodpaster River being the most distinct. The character and dominance of the river within the setting provides a very distinctive landscape.

The Goodpaster River area includes approximately 80 property households with more than 50 cabins located on or along the banks of the river, mostly south of the South Fork (Teck-Pogo, 2000d). Many of the cabins are visible from the river and also provide access and unobstructed views of the river as well. A substantial portion of the Goodpaster Winter Trail route is located in this EDU. The Pogo Mine site contains the only other recognizable alteration in this unit. A group of trees prevents a view of the present mine operations from the river; but operations are readily visible from the air. This EDU has very high scenic integrity for those portions of the unit without cabins or visible mine improvements.

Goodpaster River EUD

Lower Goodpaster River

Upper Goodpaster River near 1525 Portal (at left)

3.20.2 Constituents

The following have been identified as members of the public that may have a concern for visual resources in the project area (Adams, 2000):

- 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
- Goodpaster Winter Trail users
- Quartz Lake residents and visitors
- Other recreational users of the area

Concern levels for the majority of these constituents were rated as “high” (Land Design North [LDN], 2000). Many of these constituents value remoteness and have a high regard for the scenic integrity described above under “Existing Visual Quality.”

3.20.3 Landscape Visibility

In general, the background views within the project area, such as those seen in the South Ridge and Shaw Creek Foothills EDUs, have a “high” constituent concern level and a “very high” scenic integrity classification. These background views include those from the Shaw Creek Flats, the Goodpaster River, and the Richardson Highway areas.

Similarly, the foreground views of the Goodpaster River corridor and area surrounding Quartz Lake also have a “high” constituent concern level and a “moderate” to “very high” scenic integrity classification. These foreground views include those from the Goodpaster River, the Goodpaster Winter Trail, and Quartz Lake.

3.20.4 Visual Absorption Capability

Visual absorption capability (VAC) refers to the ability of a landscape to accommodate human alteration. In general, LDN (2000) made the following conclusions about the project area:

- Shaw Creek Flats, Goodpaster Flats, and Liscum Slough have high VAC due to their flatness and well-screened locations.
- Thompson Lake and the Indian Creek, Corda Creek, and Rapid Creek drainages have high VAC also due to their flat topography at lower elevations.
- Quartz Lake has low VAC due to its accessibility and inability to accept alterations without loss of character and scenic condition.
- Hillsides below approximately 1,250 ft AMSL have high VAC because they are screened from the Richardson Highway by existing vegetation.
- Steep slopes, such as Shaw Creek Dome and other areas of the South Ridge, have low VAC because they are susceptible to erosion and road cuts are likely to be more visible.
- Slopes along the Goodpaster River have high VAC as long as a vegetative buffer of 150 ft is maintained at the river’s edge. The effectiveness of this technique, however, varies with respect to slope, elevation, and proximity of a viewer.

3.21 Recreation

Interior Alaska offers a wide range of year-round outdoor recreation activities and opportunities that are considered extremely valuable and important to local residents and visitors to the area. Local and other residents from the greater Fairbanks area use the project area for recreation, and income is also provided from tourism activities based on recreational opportunities. Recreational activities occur throughout the project area and largely involve dispersed recreation such as hunting, trapping, fishing, hiking, skiing, snow machining, river boating, canoeing, dog mushing, and other private and commercial activities. Although recreational use is dispersed throughout the project area, several primary use areas can be identified.

3.21.1 Recreation Areas and Activities

Goodpaster River Valley

The Goodpaster River is an important recreational resource in the project area. Local Delta region and Fairbanks residents own approximately 63 cabins as well as other undeveloped recreational parcels along the lower 60 miles of the river. Four recreational users currently spend considerable time at their cabins year-round; three of these are located near the farthest downstream location where the historic winter trail crosses the Goodpaster River. The fourth is a trapper whose cabin is located downriver from the confluence of the Goodpaster River and Central Creek (Korvola, 2000a).

The Goodpaster River also is used for hunting, trapping, fishing, hiking, skiing, snow machining, dog mushing, river boating, and floating by Delta region and other interior Alaska residents, as well as owners of recreational properties in the project area. Year-round use of the upper Goodpaster drainage above Central Creek appears to be light; however, there has been increased recreational activity near the confluence of Pogo Creek and the Goodpaster River during the September moose hunting season (Korvola, 2000a).

In addition, the Goodpaster River supports an important fishery, primarily for grayling, but also for northern pike, burbot, and round whitefish. The majority of anglers are Goodpaster cabin owners or residents of the Delta Junction area (Korvola, 2000a). Table 3.21-1 presents the five primary species of fish harvested in the Delta region during specific months of the calendar year.

Table 3.21-2 presents angler days from 1996 through 1998 and the number of recorded graying harvested from the Goodpaster River. Table 3.21-3 presents the calendar of hunting and trapping in the Delta region, and Error! Reference source not found. presents big game hunting effort in the Shaw Creek and Goodpaster drainages.

Table 3.21-1 Calendar of Fishing by Species in the Delta Region

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Whitefish	*	*	*	*	*	*	*	*	*		*	*
Burbot	*	*	*	*	*	*	*	*	*	*	*	*
Pike	*	*	*	*	*	*	*	*	*	*	*	*
Grayling			*	*	*	*	*	*	*			
Salmon									*	*	*	

Darbyshire & Associates (1980), Ridder (2002)

Table 3.21-2 Goodpaster River Sport Fish Effort and Harvest, 1996 to 1998

Year	Angler Days	Grayling (all lengths)
1996	1,244	835
1997	2,266	644
1998	774	668

ADFG, 1996, 1997, 1998a

Table 3.21-3 Calendar of Hunting and Trapping in the Delta Region

Species/Group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sheep								*	*			
Moose									*			
Bear					*	*	*	*	*	*		
Bison	*	*	*						*	*	*	*
Snowshoe Hare	*	*	*					*	*	*	*	*
Ptarmigan/Grouse	*	*	*	*				*	*	*	*	*
Ducks/Geese									*	*	*	*
Caribou									*			
Furbearers	*	*	*								*	*

Darbyshire & Associates (1980), Ridder (2002)

Table 3.21-4 Big Game Hunting Effort in the Shaw Creek and Goodpaster Drainages

Species[1]	/ Drainage	1998	1999	2000	2001
Moose	Shaw Creek	81	71	91	98
	Goodpaster	117	111	121	134
Caribou	Shaw Creek	1	0	0	N/A
	Goodpaster	5	1	11	N/A
Sheep	Shaw Creek	0	0	0	0
	Goodpaster	1	2	2	1
Black Bear	Shaw Creek	0	1	4	N/A
	Goodpaster	1	3	2	N/A
Brown Bear	Shaw Creek	0	1	1	N/A
	Goodpaster	0	1	1	N/A

[1] Only successful hunters noted for black and brown bear

Similar to other locations within the project area, the Goodpaster River Valley also is noted for both recreational and commercial trapping, including the harvesting of lynx, marten, beaver, muskrat, snowshoe hare, and wolf (Korvola, 2000a).

In addition, a well-developed winter trail system along the Goodpaster River is used by a variety of recreational modes, including snow machines, dog teams, and skiers in the winter and spring months (Teck-Pogo Inc., 2000d). Although people use the winter trail for day trips (20 percent), its main use is for overnight trips by fishers and residents accessing their cabins on the Goodpaster River (80 percent). During most years, the trail is used once or twice for organized events such as races or trail rides. It is also used up to three times per day by up to four different dog mushing teams (Korvola, 2000a).

Shaw Creek Valley

Moose hunting effort in the project area primarily occurs along the Richardson Highway, the Trans-Alaska Pipeline work pad, and the trails in lower Shaw Creek Flats. Trappers also are active in the Shaw Creek Valley (Korvola, 2000a). The mouth of Shaw Creek, along the edge of the flats, is also an important grayling fishery, especially in the spring. In recent years, recreational airboat activity also has increased in the Shaw Creek Flats.

The Shaw Creek Flats area also supports the Indian Creek Trail, connecting the Richardson Highway, Quartz Lake, and the Goodpaster River, primarily for winter recreational uses. In addition, there are eight private recreational parcels in the lower Shaw Creek Flats. These parcels are accessed by airboat, ATV, and snow machine (Korvola, 2000a).

Quartz Lake

The Quartz Lake Recreation Area and vicinity are popular destinations for both summer and winter recreational activities. Summer recreational activities on and around Quartz Lake include fishing, boating, hiking, swimming, and ATV riding. The lake itself is the most popular fishing destination in the Tanana Valley because of road access and ADFG stocking efforts. Quartz Lake supports both a winter ice fishery and an open-water fishery. Quartz Lake also supports casual trapping activities (Korvola, 2000a; Ridder, 2002).

Estimates of effort, harvest, and catch in the Quartz Lake fishery have been obtained annually since 1983 through statewide harvest surveys. From 1996 to 1998, the average annual effort was 9,095 angler-days, with an average annual harvest of 5,437 coho salmon, 650 Arctic char, and 11,799 rainbow trout (Table 3.21-5).

Table 3.21-5 Quartz Lake Sport Fish Effort and Harvest, 1996 to 1998

Year	Angler Days	Coho Salmon	Arctic Char	Rainbow Trout
1996	10,155	7,785	436	12,565
1997	6,956	2,999	313	8,496
1998	10,175	5,526	1,201	14,335
Average	9,095	5,437	650	11,799

ADFG, 1996, 1997, 1998a

Volkmar Lake

There are 38 private recreational parcels in the vicinity of Volkmar Lake. The lake is accessed by airboat, airplane, and snow machine. Volkmar Lake offers good fishing for Northern pike both summer and winter. In addition, moose hunting occurs around Volkmar Lake (Korvola, 2000a, Ridder, 2002).

Healy Lake

Healy Lake offers both summer and winter fishing. There are 19 private recreational parcels in the vicinity of Healy Lake in addition to the village of Healy Lake. The lake is accessed by riverboat, airboat, airplane, and snow machine. An ice road provides access in the winter months. Moose and waterfowl hunting is popular around Healy Lake (Korvola, 2000a, Ridder, 2002).

Tanana River

The Tanana River offers salmon, grayling, whitefish, northern pike, and burbot fishing (ADFG, 1996, 1997, and 1998a). Riverboats, canoes, rafts, and kayaks also are used by residents and visitors on many rivers in the project region, including the Tanana, between mid-April and October. Waterfowl and moose hunting are popular along the Tanana River (Korvola, 2000a, Ridder, 2002).

Other Recreational Areas and Activities

Other dispersed recreational activities in the project area include hiking and gardening in summer, berry picking toward fall, wood gathering year-round, and winter sports such as dog mushing, skiing, and snow machining (Table 3.21-6). Locally available berries include blueberries, raspberries, strawberries, bearberries, crowberries, high- and low-bush cranberries, and currents. Numerous well-developed trails in, around, and through the region are used by an estimated 200 snow machines and 5 to 15 dog teams (Ridder, 2002).

3.21.2 Recreation Opportunity Spectrum

Recreation Opportunity Spectrum (ROS) is used by many land management agencies, including the U.S. Forest Service and Bureau of Land Management, to describe and identify recreational settings. ROS describes the mixes or combinations of settings, remoteness, access, activities, and probability of recreation opportunities along a spectrum that is divided into six classes: primitive, semi-primitive nonmotorized, semi-primitive motorized, roaded natural, rural, and urban. The ROS represent a range of recreational experiences from a high probability of self-reliance, solitude, challenge, and risk to social experiences with a high degree of interaction with other people (U.S. Forest Service [USFS], 1998).

Table 3.21-6 Calendar of Selected Recreational Activities in the Delta Region

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Berry Picking							*	*	*			
Hiking and Gardening					*	*	*	*	*			
Wood Gathering	*	*	*	*	*	*	*	*	*	*	*	*
Dog Mushing	*	*	*							*	*	*
Skiing	*	*	*							*	*	*
Snow Machining	*	*	*							*	*	*

Darbyshire & Associates (1980), Ridder (2002)

Four ROS classes were inventoried in the project area: primitive, semi-primitive motorized, roaded natural, and rural. The inventoried ROS classes within the project area are illustrated in Figure 3.17-5.

- **Primitive** These areas are present throughout the project area, especially in the higher elevations. Primitive areas are characterized by essentially unmodified natural environment of fairly large size. Many of these areas, including the upper reaches of the Goodpaster River and the higher elevations of the surrounding ridges, include very few, if any, modifications to the natural setting. Interactions between users are very low and evidence of other users is minimal. Motorized use of these areas is extremely limited and primarily restricted to backcountry airstrip access, if available. Evidence of surface or vegetative disturbance is limited and there is little evidence of primitive roads, motorized use or human users.
- **Semi-Primitive Motorized** These areas include trails and water bodies in the project area, such as the lower Goodpaster River and Goodpaster Winter Trail, Indian Creek Trail, Shaw Creek Flats, and Volkmar Lake. These areas have subtle modifications to the natural setting, such as primitive roads/trails, motorized use areas, and small isolated structures, such as cabins found along the Goodpaster River downstream from Central Creek and lower Shaw Creek Flats. Motorized access in semi-primitive areas is almost entirely limited to trails and water bodies (Ridder, 2002).
- **Roaded Natural** These areas include the Richardson Highway from north of Shaw Creek Road to Big Delta, Shaw Creek Road, Quartz Lake, the Richardson Highway south of Delta Junction, and the Alaska Highway southeast of Clearwater Road. The natural setting in these areas includes moderate alteration, where the cultural modifications do not dominate the setting and generally harmonize with the natural landscape. Roads and highways are present, and structures are scattered, remaining visually subordinate. Frequency of human contact is low to moderate. Over the 12 miles between Shaw Creek Road and Big Delta, the natural setting is only slightly altered, with only two houses, one gravel pit, and one quarry visible (Ridder, 2002).
- **Rural** The Richardson Highway and Alaska Highway corridors from Big Delta to the intersection of Clearwater Road and the Alaska Highway, including Delta Junction, and to Jack Warren and Clearwater roads, were inventoried as rural. The natural setting between the Tanana River Bridge at Big Delta, and Delta Junction, is substantially altered with cultural modifications, i.e., service facilities and infrastructure are constantly in sight. Roads and highways are obviously present and structures readily apparent. Frequency of human contact is moderate to high in these areas. Additionally, from Big Delta in the west to the Gerstle River in the east, the area north of the highways to the Tanana River (excluding north of the Clearwater River) is substantially altered with very visible farmlands and houses (Ridder, 2002).

3.22 Utilities

The only utility associated with the project area that could supply enough power to meet the needs of the Pogo project is GVEA. GVEA is a nonprofit, member-owned cooperative headquartered in Fairbanks that provides electrical service to the FNSB, the Denali Borough, unincorporated areas between these two boroughs, and along the Richardson Highway to Fort Greely. Clear Air Force Station, Eielson Air Force Base, Fort Wainwright, Fort Greely, Fort Knox Gold Mine, the University of Alaska Fairbanks, and the communities of Fairbanks, North Pole, Nenana, Delta Junction, and Healy are all located in GVEA's service area.

GVEA provides electricity to approximately 90,000 people through more than 36,000 service locations, and has a generating capability of 224 MW of power, with an additional 70 MW available through the existing Fairbanks-Anchorage Intertie (U.S. Department of Interior [USDI], 1998). In 1997 GVEA peak demand was 163 MW (GVEA, 1998). The project area is served by an existing power line that parallels the Richardson Highway from Fairbanks to Delta Junction.

In anticipation of projected growth in its service area, GVEA has proposed a modification to its North Pole power plant that would provide an additional 60 MW of continuous power and 120 MW of peak power. The proposed GVEA project is presently in the air permitting process, with the first phase of the project projected to be on-line by the end of 2004.