Alaska Gold Company

A NovaGold Subsidiary

ROCK CREEK MINE
PLAN OF OPERATIONS
VOLUME 2
Environmental Information Document
May, 2006

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Placer mining on the Rock Creek deposit, 1902

NovaGold

Alaska Gold Company
Rock Creek Project
Plan of Operations
Volume 2
Environmental Information Document
May, 2006

Prepared by
Bristol Environmental & Engineering Services Corporation

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DEFINITIONS AND ABBREVIATIONS

%	percent
<	less than
>	greater than
°	degrees
°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
AAQS	ambient air quality standards
ABA	acid-base accounting
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish & Game
AHFC	Alaska Housing Finance Corporation
AHRS	Alaska Heritage Resource Survey
Alaska Gold	Alaska Gold Company
AN	ammonium nitrate
ANCSA	Alaska Native Claims Settlement Act
AP	acid-generation potential
APA	adult public assistance
APE	
ARDOR	Alaska Regional Development Organization
ASTt	Arctic Small Tool tradition
ATAP	Alaska Temporary Assistance Program
BATF	U.S. Bureau of Alcohol, Tobacco, and Firearms
BEESC	Bristol Environmental & Engineering Services Corporation
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BP	before present
BTU	British thermal unit

DEFINITIONS AND ABBREVIATIONS (continued)

$CaCO_3$	calcite
CFR	Code of Federal Regulations
cm	centimeters
CN	cyanide
CO_2	carbon dioxide
CQMS	calcareous quartz-muscovite schist
CRSA	Coastal Resource Service Area
dBA	decibels averaged
DRZ	damaged rock zone
EMS	Emergency Medical System
EPA	U.S. Environmental Protection Agency
EPCM	
FASL	feet above sea level
FEMA	Federal Emergency Management Administration
ft^2/lb	square feet per pound
FWHA	Federal Highway Administration
GIS	geographic information system
GQMS	graphitic quartz-muscovite schist
GRA	general relief assistance
H_2O	water
HABS/HAER	Historic American Building Survey/Historic American Engineering Record
HAP	heating assistance program
HCT	humidity cell test
ICP/MS	ion-coupled plasma/mass spectrometry
IDF	intensity-duration-frequency
kg	kilograms
km	kilometers
kV	kilovolts
kW	kilowatt

DEFINITIONS AND ABBREVIATIONS (continued)

L	liter(s)
lb/ft^3	pounds per cubic foot
L_{eq}	Equivalent Continuous Noise Level (4db exchange rate)
L_{max}	Maximum Noise Level
m	meter(s)
m/s	meters per second
m^2/kg	square meters per kilogram
mamsl	meters above mean seal level
masl	meters above sea level
mb	millibars
mg/L	milligrams per liter
MHW	mean high water
ml	milliliters
MLW	mean low water
mm	millimeters
mph	miles per hour
MSHA	Mine Safety and Health Administration
MSHA	Mine Safety and Health Administration
Mt	million tonnes
MWMP	meteoric water mobility procedure
NAHASDA/USDA	Native American Housing Assistance & Self-determination Act
NaOH	sodium hydroxide
NCP	Nome Comprehensive Plan
NEPA	National Environmental Policy Act
NJUS	Nome Joint Utilities System
NLUR	Northern Land Use Research
NNP	net neutralization potential
NovaGold	NovaGold Resources Incorporated
NOx	nitrogen oxide(s)
NP	neutralization potential
NRHP	National Register of Historic Places

DEFINITIONS AND ABBREVIATIONS (continued)

PM	particulate matter
PM_{10}	nominal 10 micrometers
PMP	probable maximum precipitation
Project	the Rock Creek Mine Project
PSD	Prevention of Significant Deterioration
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QGS	quartz graphite schist
QMS	quartz-muscovite schist
RC	reverse circulation
SABC	Snake River Above Balto Creek Sampling Station
SCAS	Oregon State Spatial Climate Analysis Service
SEM	scanning electron microscopy
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
tpd	tonnes per day
TRACK	
TSF	tailings storage facility
TSS	total settleable solids
TVs	tension veins
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
w/m^2	watts per square meter
WAD	weak acid dissociable
WD	wind direction
WRCC	Western Region Climate Center
WS	wind speed
XRD	x-ray diffraction

EXECUTIVE SUMMARY

Alaska Gold Company, a wholly owned subsidiary of NovaGold Resources, is proposing to construct and operate two open-pit gold mines and one mill on the Seward Peninsula, near Nome, Alaska. The project will consist of two components: the Rock Creek Mine/Mill Complex and the Big Hurrah Mine.

The Rock Creek Mine/Mill Complex will host the primary open-pit mine, two non-acid-generating waste development rock stockpiles, a gold recovery plant, and a paste tailings storage facility. Ore milling rates will be about 2.75 million tons (2.5 million tonnes) per year, while development rock stripping volumes will be in the range of 4.4 to 5.5 million tons (4 – 5 million tonnes) per year. Milling will include crushing, screening, gravity separation, flotation, and a cyanide carbon leaching process. The expected mine life is 4.5 years, with potential for additional discovery and expansion. The mine site is accessed by the Glacier Creek Road.

The Big Hurrah component will consist of a smaller open-pit gold mine, a non-acid generating development rock stockpile, a temporary stockpile for acid-generating development rock that will be backfilled into the pit, and an ore stockpile. Ore will be transported to the Rock Creek Mine/Mill Complex to be milled. Ore will be mined at a 1,500 tons (1,360 tonnes) per day rate on a seasonal basis for a total of approximately 270,000 tons (245,000 tonnes) per year for 4 years. The mine is accessed by the Nome-Council Highway and an existing Alaska Department of Transportation right-of-way up the Big Hurrah Valley. Road improvements and stream enhancement are planned.

Design engineers developed a preferred alternative by incorporating environmental considerations as the mine plan was developed. Paste tailings were chosen over conventional tailings to reduce volume, negate the need for a supernatant pond, and to reduce the footprint of the tailings facility. Metallurgical research resulted in maximization of gravity separation and flotation methods to minimize the use of cyanide in the beneficiation process. Pit water inflow will be managed through interception wells and groundwater injection wells. Facilities were located outside of wetlands to the extent practicable and the entire mine/mill complex was confined to one watershed to minimize potential water quality and fish habitat impacts.

A summary of the major aspects and expected consequences for the Project is presented in Table ES1 below. The table briefly describes environmental, socio-economic, cultural, and community areas of interest, anticipated consequences that may be incurred by the Project and the intended actions that will mitigate the effects of the Project. Additional information on all aspects can be found in the body of the report, and to a greater degree of detail in the appendices.

Table ES-1 Major Aspects and Consequences

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Public Access	Improved access.	The existing road will be maintained on a year-round basis.	Improved access	The existing road will be built up on gravel fill.
Industrial Use	Increases from mine activity itself.		Increases from mine activity itself.	
Commercial Use	Reduces availability of reindeer herding in the immediate area on BSNC/Sitnasuak lands.	No grazing permits have been requested or issued for this area in recent years. Passage around the site is available.	Private land not available for reindeer grazing permits.	No grazing permits have been requested in this part of the region in recent years. Passage around the site is available.
Residential Use	An increased housing demand of approximately 27 new houses is likely to occur in Nome in response to the workforce. No increase in residential use of the immediate area in the Snake River Valley is anticipated.	Alaska Gold has put some additional land on the real estate market for residential use.	An increased housing demand is likely to occur in Nome. The Big Hurrah workforce is shared with the Rock Creek site. No increase in residential use in the immediate area is anticipated.	Alaska Gold has put some additional land on the real estate market for residential use.
Institutional Use	Slight increase of use of Nome institutions related to increase in population from workforce.	Local hire preference should minimize the increased need for services.	Slight increase of use of Nome institutions related to increase in population from workforce.	Local hire preference should minimize the increased need of services.
Subsistence Use	Subsistence resources will be less available in the immediate area of the mine site. Only the BSNC/Sitnasuak land portion of the project was previously open for subsistence use.	Ample lands and subsistence resources are available throughout the Seward Peninsula as well as the rest of the Snake River Valley. Passage for animals around the mine site is available.	Subsistence resources will be less available in the immediate area of the mine site, although these lands are private and closed to subsistence use.	Ample lands and subsistence resources are available throughout the Seward Peninsula as well as the rest of the Big Hurrah Valley. Passage for animals around the mine site is available.
Acid Rock Drainage Potential	Development rock stockpiles and pit walls have demonstrated through laboratory testing to be non-acid generating. Tailings demonstrate some potential for acid generation and metal leaching.	Tailings will be capped with development rock, organic material and then reseeded.	Some development rock has demonstrated through laboratory testing the potential to be acid generating. Ore did not demonstrate ARD potential to generate acid.	Development rock will be tested during mining operations. Potentially acid generating material will be segregated and backfilled into the pit after mine closure and inundated.

Table ES-1 Major Aspects and Consequences (continued)

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Metal Leaching Potential	Arsenic and antimony may be mobilized from the ore, and, to a much lesser degree, from the development rock. Tailings may leach metal.	The development rock can be managed through blending of rock types. Ore tailings will be contained, then capped and revegetated at closure.	Metals mobility is not anticipated to cause runoff in excess of water quality standards.	Mitigation not anticipated to be needed.
Seismic Risk	Low risk.	Faults in the area disperse seismic energy.	Low risk.	Faults in the area disperse seismic energy.
Surface Water	Subject to natural mineralization with elevated arsenic levels.	Extensive background data were collected for detmining baseline criteria. Surface water is diverted around the facilities.	Baseline data indicate water quality meets Alaska water quality standards.	Surface water is diverted around the mine facilities.
Groundwater	Subject to natural mineralization, escpecially in the area of the mineral deposit.		Subject to natural mineralization especially in the area of the mineral deposit.	
Soils	Minimal topsoil available for reclamation. Average depth 3.5 inches.	Soil will be stockpiled where feasible; development rock weathers readily.	Minimal topsoil available for reclamation. Average depth of 3.3 inches.	Soil will be stockpiled where feasible; development rock weathers readily.
Water Balance	Excess water from groundwater inflow to the pit will require discharge to groundwater.	Mine runoff and pit groundwater inflow will be recycled for use in the milling process. Mine runoff is minimized by water diversion ditches. Excess pit inflow will be managed in compliance with a Class V Injection Well permit.	Excess water from groundwater and precipitation collection in the pit that will require discharge to groundwater.	Will be land-applicated during summer months and/or re-injected into the same aquifer in compliance with a Class V Injection Well Permit.
Pit Lake Modeling	Fills in 1.6 to 3.3 years after closure. Water quality similar to baseline. Arsenic levels, like the natural surface water, will exceed Alaska water quality standards. (pH 7.8 to 7.9).	Redirecting Rock Creek and surface flow back into the pit will diminish the influence of groundwater input. A natural background criterion for arsenic may be established.	Fills in 0.3 year. Water quality similar to baseline and will meet Alaska water quality standards (pH 7.4 to 7.5).	Little Hurrah Creek will be redirected back into the pit. Rapid refill rate limits exposer of pit walls to oxygen-reducing chemical mass load to pit.

Table ES-1 Major Aspects and Consequences (continued)

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Precipitation	1.31 times greater than the Nome precipitation rate. Annual precipitation is 18.8 inches (478 mm).		1.37 times greater than the Nome precipitation rate. Annual precipitation rate is 21.3 inches (540 mm).	
Wind	Predominantly north, northeast. Average wind speed of 9.8 mph (4.4 m/s).		Assumed to be generally represented by the Rock Creek data.	
NOx, SOx and CO Emissions	Combustion engines will release NOx, SOx, and CO, but will remain well in compliance with Ambient Air Quality Standards.	On-site power generation is limited to emergency use only. The facility will be connected to the Nome electrical grid.	Operations will be much smaller with lower potential emissions.	Transport of ore to Rock Creek for milling reduces power generation needs at this site.
Airborne Particulate Matter	Annual average PM_{10} concentration is 5.1 $\mu g/m^3$. Overburden removal, ore mining and milling, and fugitive emissions from vehicle movement will increase airborne particulate matter. Anticipated to be well below the PSD Class II increment levels.		Assumed to be generally represented by the Rock Creek data. Operations will be much smaller, with lower potential emissions. Anticipated to be well below the PSD Class II increment levels.	
Wildlife Habitat	23 wildlife habitats represented at the site.	Similar habitat types appear to be available in surrounding areas. Footprint of activity was compacted to minimize loss of habitat.	17 wildlife habitats represented at the site.	Similar habitat types appear to be available in surrounding areas. Footprint of activity was compacted to minimize loss of habitat.
Wetlands	681 acres (276 hectares [ha]) of wetlands are within the project area; 515 acres (208 ha) will be filled. Approximately 50% of the willow communities will be left undistrubed.	Footprint of activity was compacted to minimize loss of wetlands. Facilities relocated where possible to avoid wetlands, particularly willow wetlands.	No wetlands impacted at the Big Hurrah Mine Site. The transportation route to the site impacts 5 acres (2 ha).	Footprint of activity was designed to avoid use of wetlands in the area. The transportation route is being designed to mitigate pre-existing mining impacts and to enhance fisheries in Big Hurrah watershed.

Table ES-1 Major Aspects and Consequences (continued)

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Mammals	Brown bear, moose, musk oxen, beaver, fox, lynx, marten, mink, muskrat, river otter, woverines, and wolves present in area. Activity may dipslace mammals in the immediate area of the mine, but wildlife is generally acclimated to mining activity.	Footprint of activity was compacted to minimize loss of habitat. Similar habitat appears to be available in the surrounding areas.	Brown bear, moose, musk oxen, beaver, fox, lynx, marten, mink, muskrat, river otter, woverines, and wolves present in area. Activity may dipslace mammals in the immediate area of the mine but wildlife is generally acclimated to mining activity.	Footprint of activity was compacted to minimize loss of habitat. Similar habitat appears to be available in the surrounding areas.
Avian Resources	41 bird species at Rock Creek; no bald eagles, no endangered species, 10 species of concern. Loss of 0 to 40% of total available habitat; varies with species.	Footprint of activity was compacted to minimize loss of habitat. Similar habitat appears to be available in the surrounding areas and throughout the Seward Peninsula.	42 bird species, no bald eagles, no endangered species, 10 species of concern. Loss of 0 to 38% of total available habitat; varies with species.	Footprint of activity was compacted to minimize loss of habitat. Similar habitat appears to be available in the surrounding areas and throughout the Seward Peninsula.
Essential Fish Habitat	Loss of rearing habitat for Dolly Varden. Rock Creek flows will be substantially diminished due to groundwater interception.	Reclamation will reestablish the creek channel and flows, and create a pit lake that provides potential overwintering habitat. .	Loss of rearing habitat for Dolly Varden. Minimal use of the creek by Dolly Varden in the impacted area. Transportation route upgrades in Big Hurrah Creek, which provides spawning habitat for pink salmon. Historically provided spawning and incubation habitat for coho samon, but not observed in recent years.	Reclamation will reestablish the creek and create a pit lake that provides potential overwintering habitat in Little Hurrah Creek. Road construction in Big Hurrah Creek area will include removal of historic tailings from stream channel, excavation of channel to provide depth, and creation of overwintering ponds for enhanced fisheries habitat.
Threatened and Endangered Species	No threatened or endangered species in the area, No candidate species or species proposed for listing. No designated or proposed critical habitat.		No threatened or endangered species in the area, No candidate species or species proposed for listing. No designated or proposed critical habitat.	
Cultural and Archeological Resources	One significant cabin site within project boundary, but outside of the development footprint.	Site will not be disturbed.	Several significant sites including a stamp mill.	Stamp mill will remain undisturbed. Other sites will be photo-documented and catalogued.

Table ES-1 Major Aspects and Consequences (continued)

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Demographics	2002 census poulation was 3,511: 58% Alaska Native, 37% Caucasian, 5% other, with an increasing trend in the percentage of Alaska Natives and decreasing trend in the percentage of Caucasians. A total of 134 new residents are expected in association with the mine workforce: a 3.6 % population increase.	Local hire preference will minimize the influx of new people and minimize changes to the ethnic balance.	Solomon year-round population in 2002 census was zero, although it was observed that there were two individuals overwintering in Solomon in 2005. There will be minimal, if any, impacts on the local demographics around Solomon.	The Big Hurrah employees will be seasonal workers from the Rock Creek workforce. It is not anticipated that there will be any workers choosing to reside in the Solomon area.
Economics	Nome has an 11% unemployment rate for individuals seeking work opportunites and a 39.4% rate of unemployed individuals. Increase of 130 full-time jobs for 4 to 5 years at $8.5 million in direct wages per year. Total annual economic benefit of wages and services combined of $13.6 million per year. Local multiplier effect of 1.6.	Local hire preference will ensure that maximum opportunity to reduce local unemployment rates is provided.	Economic impacts are primarily related to Nome.	
Community Services	New workers will increase demand, particularly on health care, education, and utilities. Lower unemployment may lessen demand for multiple health services and social services.	Local hire preference will minimize any additional burden on community services.	Community services impacts are primarily related to Nome.	

Table ES-1 Major Aspects and Consequences (continued)

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Local Government, Powers, Finance	New residential development of approximately 27 homes. Both mine operations occur outside the city limits and do not generate new tax revenue directly. Increased personal spending of an estimated $6 million dollars per year, resulting in an estimated $158,752 per year net increase in municipal income from sales tax.	Local hire preference maxmizes the financial benefits to the Nome area.	Local finance impacts are primarily related to Nome.	
Housing	Present housing stock is in high demand and poor condition. Over half the housing stock is more than 40 years old. Very few vacant lots remain.	Alaska Gold plans to build five houses for management personnel and has submitted three subdivisions for platting approval.	Housing impacts are primarily related to Nome.	
Noise	Noise levels are expected to be highest during construction phase at 42 to 45 dBA in the Glacier Creek Road bypass area near the Nome-Teller highway. Operation levels are expected to be 39 to 42 dBA. No significant impacts are projected at these levels. Associated traffic noise levels at worst case scenario were 62 dBA at 20 feet – below the FHWA criterion of 67dBA.	The movement of equipment and blasting operations into the pit as it develops will lessen the noise level over time. Potential for carpooling and commuter van servcies could reduce the traffic noise.	Noise levels are expected to be highest during construction phase, but not expected to exceed 40 dBA. Operational noise levels are not projected to exceed 30 to 40 dBA. No significant noise impacts are projected at these levels. Associated traffic noise levels, at worst case scenario, were 59 dBA at 20 feet – below the FHWA criterion of 67 dBA.	Both mine operations occur outside the city limits and do not generate new tax revenue directly. Potential for carpooling and commuter van servcies could reduce the traffic noise.

Table ES-1 Major Aspects and Consequences (continued)

Aspect	Rock Creek Consequences	Mitigation	Big Hurrah Consequences	Mitigation
Visual	The proposed mine/mill complex would not be visible from the city of Nome, except at the western edge of town beyond the airport. The mine/mill complex would be visible along the New Glacier Creek Road and from the lower Snake River Valley, including the Nome-Teller Highway where it crosses the Snake River.	The viewshed analysis did not account for the effects of vegetation that will reduce the visual impact of the mine. Reclamation will reduce the visual impact at closure.	The mine will not be visible beyond the Big Hurrah Valley except from some high elevations on surrounding slopes. It will not be visible from the Nome-Council Highway.	The viewshed analysis did not account for the effects of vegetation that will reduce the visual impact of the mine. Reclamation will reduce the visual impact at closure.
Transportation	Accessed by existing state highway. The EIS for the access road assumed an increase in mine-related traffic and the road was found to have no significant environmental impacts. Congruent with past use. Increased local access. May lead to increased hunting pressures in the immediate area. May lead to incidental disturbance to wildlife in the immediate area.	Ore transport will be conducted in tandem, reducing the incidents of disturbance to wildlife.	Accessed by existing state highway and an improved ADOT&PF right-of-way up the Big Hurrah Valley. The Nome-Council road was built to accommodate residential and mine-related traffic An EIS was written for road modifications and the road was found to have no significant environmental impacts.	Historic tailings will be removed from the main creek channel. The channel will be better defined with excavation as needed. Winter fish habitat ponds will be created at two or more locations. Ore transport will be conducted in tandem, reducing the incidents of disturbance to wildlife.

Notes:

$\mu g/m^3$	=	micrograms per cubic meter	m/s	=	meters per second
ADOT&PF	=	Alaska Department of Transportation and Public Facilities	mm	=	millimeters
BSNC	=	Bering Straits Native Corporation	mph	=	miles per hour
CO	=	carbon monoxide	NOx	=	nitrous oxide
dBA	=	decibels averaged	PM_{10}	=	10 micrometers
EIS	=	Environmental Impact Statement	PSD	=	Prevention of Significant Deterioration
FWHA	=	Federal Highway Administration	SOx	=	sulfuric oxide

1.0 INTRODUCTION

The Rock Creek Mine Project (Project) has been found to be within the jurisdiction of the U.S. Army Corps of Engineers because of the proposed excavation and fill activities within wetlands. Alaska Gold Company (Alaska Gold) is required to secure 401 permits for the project, subjecting the proposed project to the authority and review of the National Environmental Policy Act (NEPA) process. All other federal permits anticipated to be required for the Rock Creek Mine are general permits, permits by rule, or Safe Drinking Water Act injection well permits which do not require a NEPA review.

The U.S. Army Corps of Engineers, as the lead permitting agency, is responsible for ensuring that the proposed actions are in compliance with the NEPA, as well as all other applicable federal laws and regulations, and that no significant impacts to the human environment would result from implementing the preferred alternative.

Bristol Environmental & Engineering Services Corporation (BEESC) is under contract to Alaska Gold for the environmental consultation and the preparation of the appropriate environmental documentation for the Project, located north of Nome, Alaska.

2.0 PURPOSE AND NEED

Alaska Gold has been in existence for more than 80 years, producing gold from its 14,000 acres (5,700 hectares[ha]) of mining claims. Historically, most of that mining activity was placer operations using large dredges. In the 1990s, as gold prices fell, Alaska Gold ceased dredging activities and reduced their overall operations. Nome's cyclical economy was especially sensitive to the economic slowdown of the late 1980s and 1990s. Unemployment in Nome went from 8.9 percent (%) in 1990 to 12.9% in 1992 and rose to a 20-year high of 15.2% in 2003. NovaGold Resources Incorporated (NovaGold) purchased the Alaska Gold business and properties with the purpose of returning Alaska Gold to a profitable mining venture. The Project is NovaGold's first effort at restoring profitable mining development to the company and the region.

The purpose of the Rock Creek Mine is to operate a profitable open-pit gold mine.

3.0 PROPOSED ACTION

Alaska Gold, a wholly owned subsidiary of NovaGold, is proposing to begin development of the Project. The Project is located on the Seward Peninsula along the west coast of Alaska, There are two project components: the Rock Creek Mine/Mill Complex located about 6.2 miles (10 kilometers [km]) north of Nome in the Snake River watershed, and the Big Hurrah Mine, located about 31 miles (50 km) east of Nome in the Solomon River watershed.

- Alaska Gold is permitting the mine based on the economic resource as defined by the core drill-hole data. Reverse circulation drill-hole data indicate the resource may be substantially larger. The reverse circulation drill data are not presently included in the planning process or permitting process. If the additional resources are substantiated in the future, Alaska Gold Company will be submitting plan modifications for agency review.

4.0 PROJECT SCHEDULE

Construction is proposed for the first quarter of 2006, with operations commencing in the fourth quarter of 2006.

5.0 PROJECT OVERVIEW

5.1 ROCK CREEK MINE/MILL COMPLEX OVERVIEW

The Rock Creek Mine/Mill Complex will consist of an open-pit gold mine, two non-acid-generating development rock dumps, a gold recovery plant, and a paste tailings storage facility (TSF). The Rock Creek site location is presented in Figure 5.1; the site layout is presented in Figure 5.2. Ore milling rates will be about 2.75 million tons (2.5 million tonnes) per year, while development rock-stripping volumes will be in the range of 4.4 to 5.5 million tons (4 – 5 million tones) per year. The process plant site area will include: a three-stage crushing and screening plant, a crushed ore stockpile, a mill facility, a maintenance shop, an administration and mine dry building, warehouse, explosive storage and fuel storage.

The mine will be operated on a schedule of two 12-hour shifts per day for 365 days per year. The total project staff is estimated at about 130 personnel.

Additional Information is provided in the Rock Creek Mine Project, Plan of Operations Volume 1 Project Description.

Summary design criteria for the Rock Creek Mine/Mill Complex consist of:

- Annual ore milling rate of 2.75 million tons (2.5 million tonnes) per year (7,700 tons [7,000 tonnes] per day). The Big Hurrah Mine will supply about 1,100 tons (1,000 tonnes) per day of the mill feed, with Rock Creek Mine providing the remainder.
- Annual waste production of 4.4 to 5.5 million tons (4 to 5 million tonnes) per year.
- Mill operating availability of 90%.
- Production scheduling and mining equipment requirements are based on an operating schedule of two 12-hour shifts per day for 365 days per year.
- Projected mine life: 4 to 5 years.

Figure 5.1 Rock Creek Mine Vicinity Map

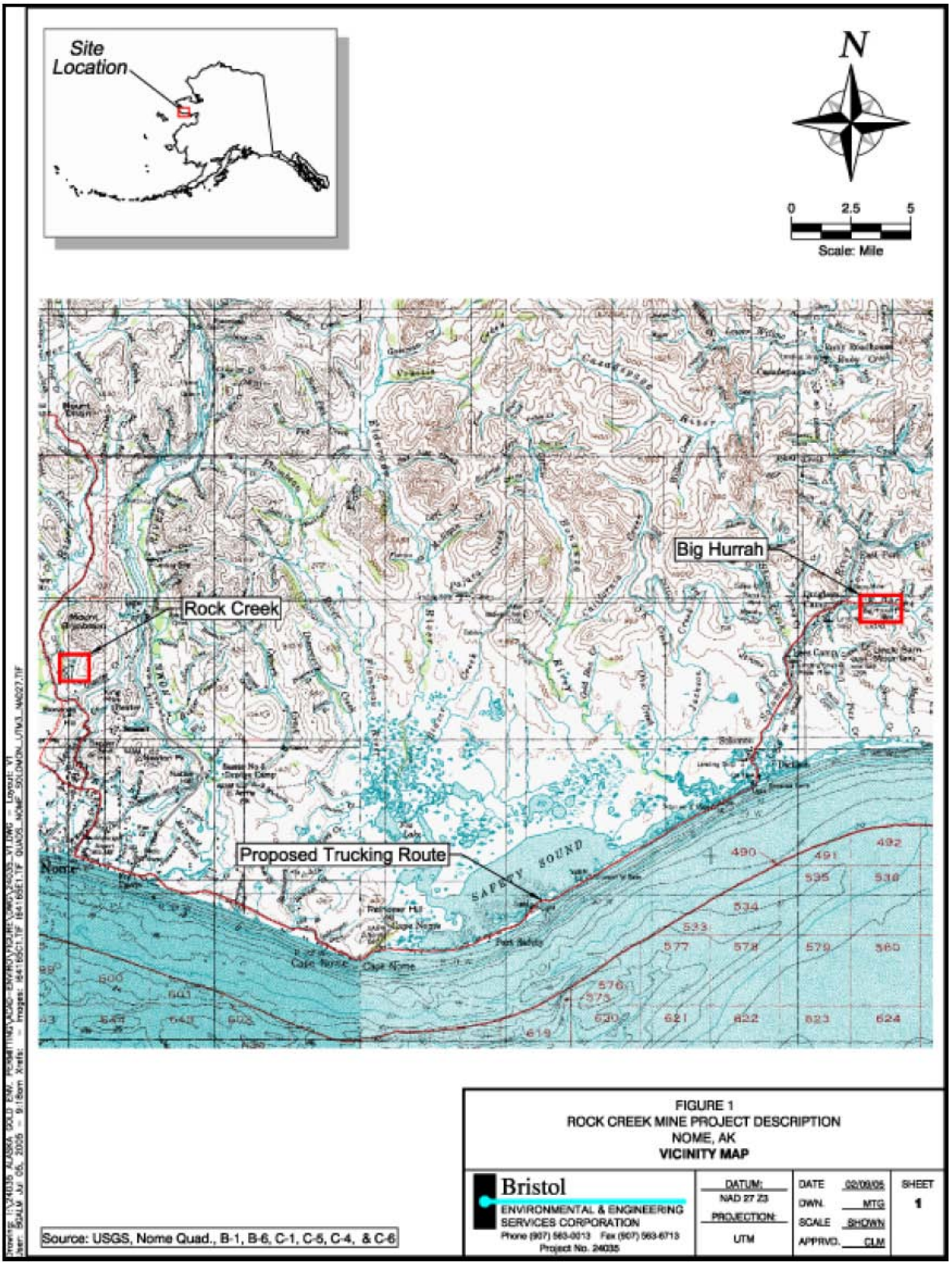
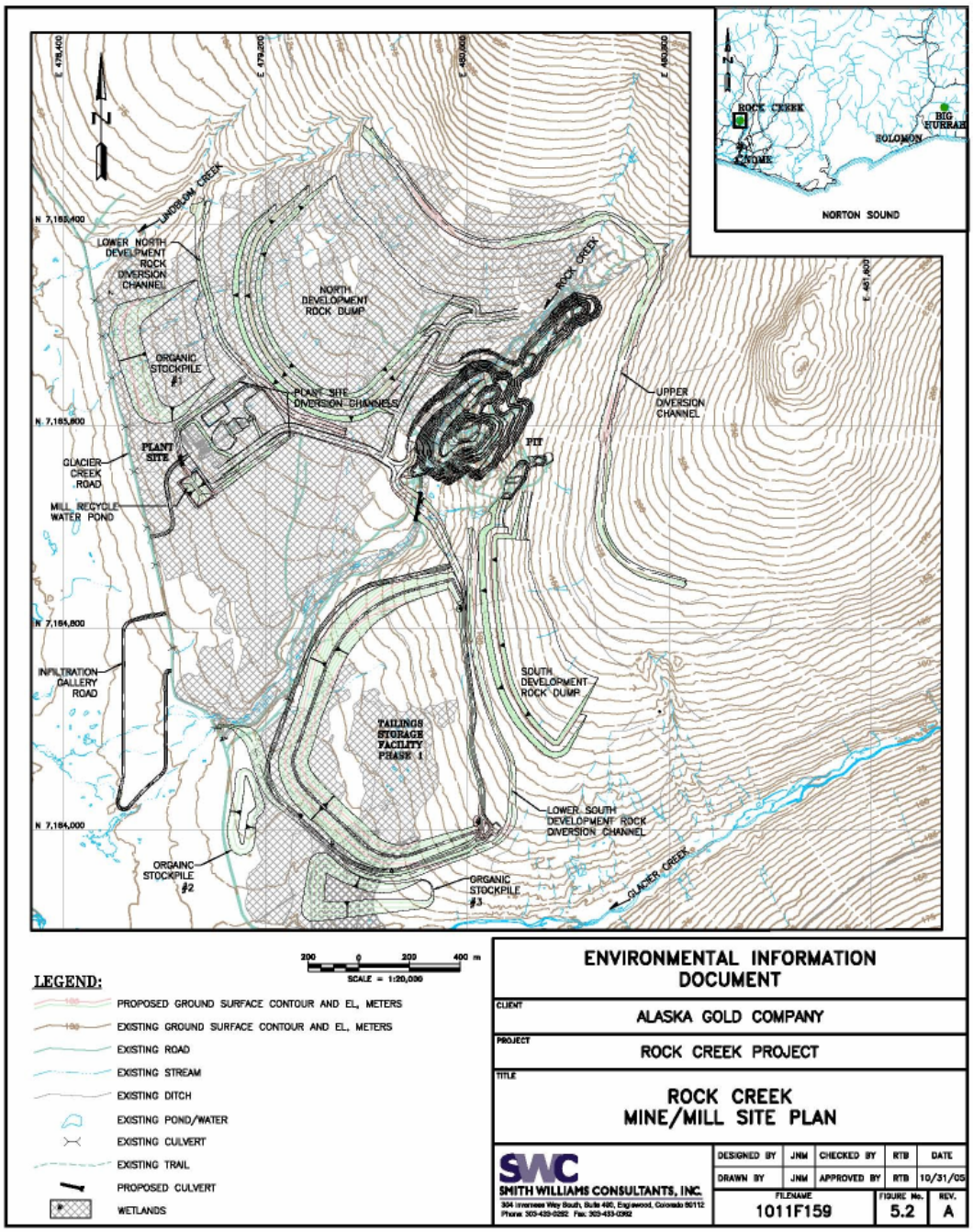


Figure 5.2 Rock Creek Mine Site Layout Map



5.2 BIG HURRAH MINE OVERVIEW

The Big Hurrah Mine facilities will include: an open-pit gold mine, a non-acid-generating development rock dump, a temporary development rock stockpile for potentially acid generating development rock that will be backfilled into the pit at closure, a run-of-mine ore stockpile, a truck maintenance shop, a small administration and mine dry building, explosive storage, and diesel fuel storage. The Big Hurrah site location and layout are presented in Figures 5.3 and 5.4. The ore mining rate will be about 1,650 tons (1,500 tonnes) per day and the stripping rate will be 5,500 tons (5,000 tonnes) per day. Ore will be stockpiled and delivered to the Rock Creek Mill at an average rate of about 1,100 tons (1,000 tonnes) per day.

The Big Hurrah Mine will be operated on the same schedule as the Rock Creek Mine/Mill Complex, with two 12-hour shifts per day. Mine operations will likely only occur for 3 to 6 months of the year, but could be extended to be year-round. Trucking will likely occur on a year-round basis.

Additional Information is provided in the Rock Creek Mine Project, Plan of Operations Volume 1 Project Description.

Summary design criteria for the Big Hurrah Mine consist of:

- Annual ore production of approximately 300,000 tons (270,000 tonnes) per year;
- Annual development rock production of approximately 1.1 million tons (1.0 million tonnes) per year;
- Production scheduling and mining equipment requirements based on an operating schedule of two 12-hour shifts per day for 180 days per year, with a total projected staff of approximately 50 personnel. Personnel and equipment will be allocated on a seasonal basis from the Rock Creek crew and fleet resources; and
- Projected mine life of 4 years.

Figure 5.3 Big Hurrah Vicinity Map

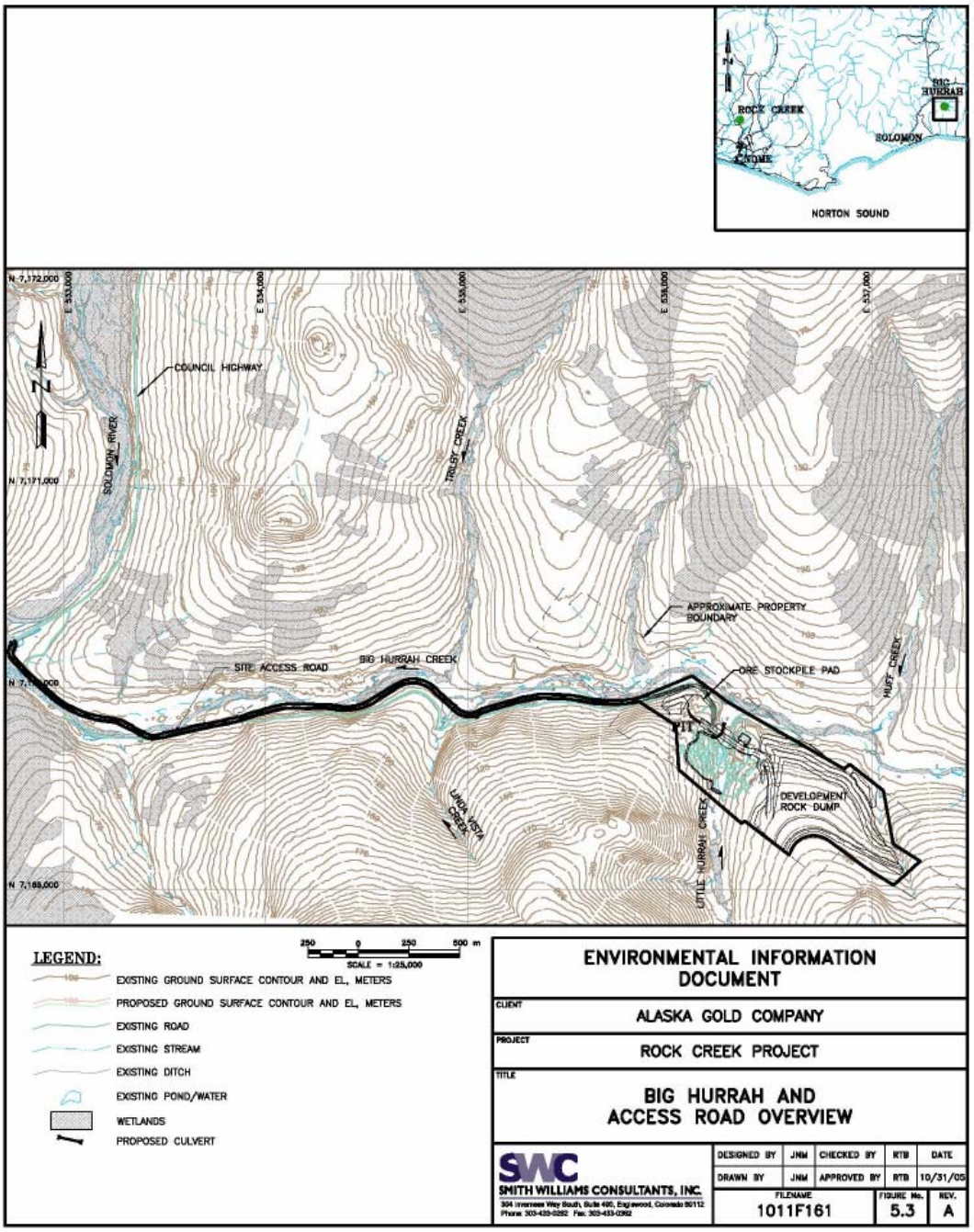
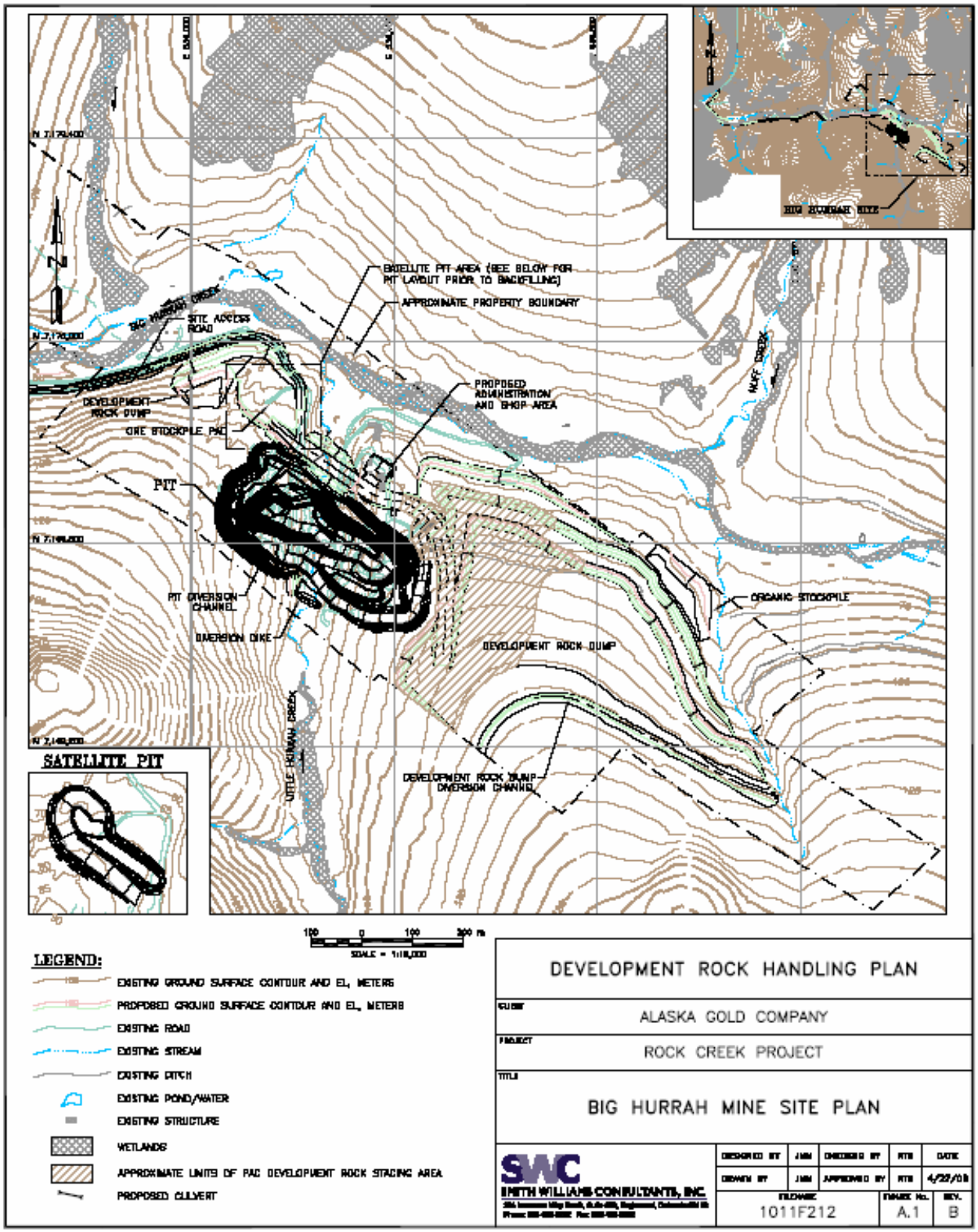


Figure 5.4 Big Hurrah Site Layout Map



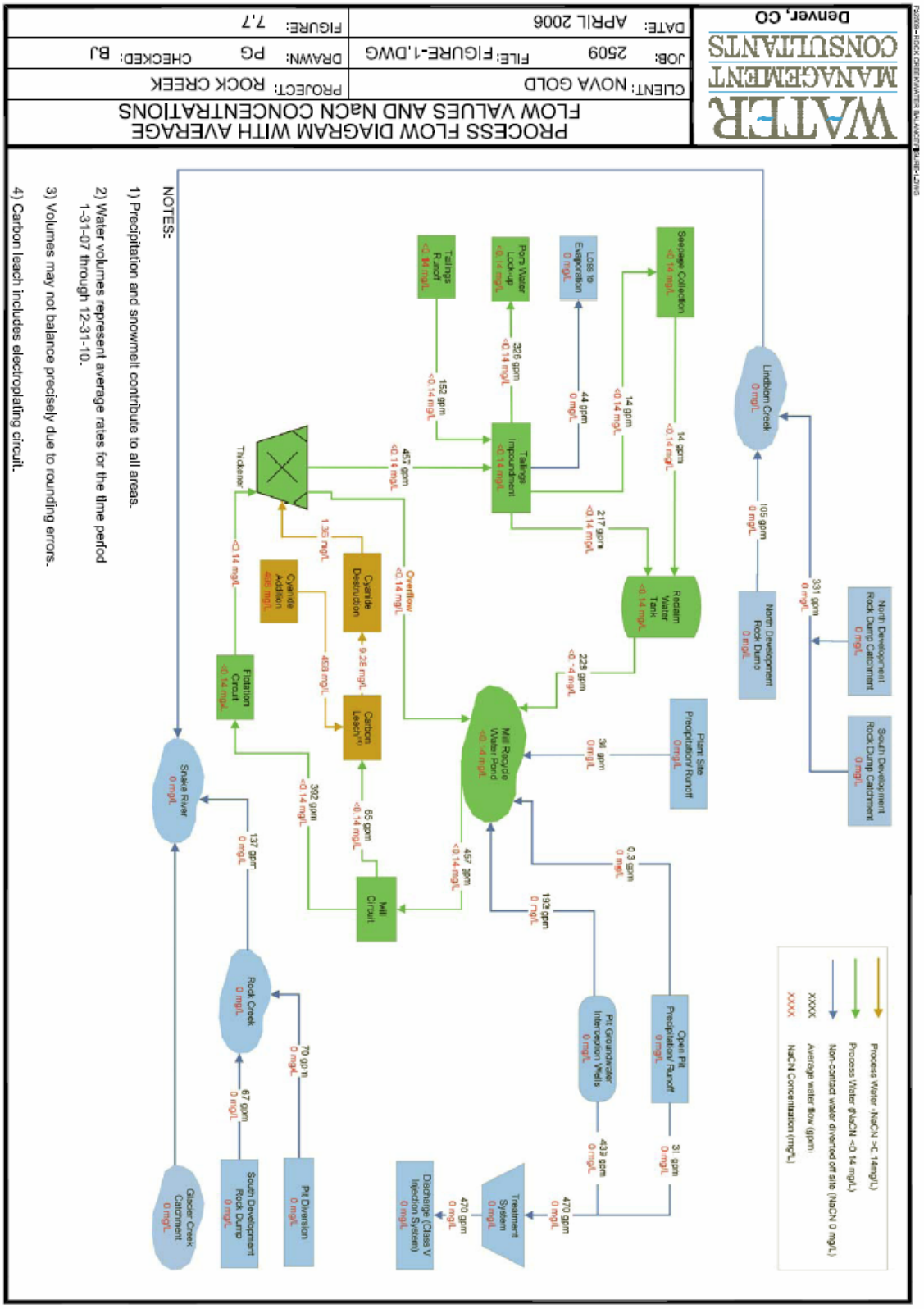
5.3 MILLING

All processing of ore from the Rock Creek and Big Hurrah pits will occur at the Rock Creek Mill/Mine Complex. Ore milling rates will be about 2.75 million tons (2.50 million tonnes) per year.

Ore will be processed with the use of a gravity circuit, followed by a flotation circuit on the gravity tails. The flotation concentrates and gravity middling concentrates will be processed on site using a cyanide leaching and carbon recovery circuit. Leached ore from the cyanidation process will be subjected to treatment for destruction of free cyanide and combined with the tailings from the flotation circuit. The combined tailings will be processed in a paste tailing thickener and deposited in a tailings storage facility.

Gold recovered in the carbon stripping circuit will be refined with the gravity concentrates in a furnace, and a doré bar will be produced on site. Gold doré will be shipped to a refinery for the final stages of refining and sale. A detailed flow diagram (Figure 5.5) of the milling process is located below.

Figure 5.5


WATER MANAGEMENT CONSULTANTS
Denver, CO
PROCESS FLOW DIAGRAM WITH AVERAGE FLOW VALUES AND NaCN CONCENTRATIONS
CLIENT: NOVA GOLD
PROJECT: ROCK CREEK
JOB: 2509
FILE: FIGURE-1.DWG
DRAWN: PG
CHECKED: BJ
DATE: APRIL 2006
FIGURE: 7.7
Process Water -NaCN >C 14mg/L)
Process Water @NaCN <0.14 mg/L)
Non-contact water diverted off site (NaCN 0 mg/L)
Average water flow (gpm)
NaCN Concentration (mg/L)
Lindblom Creek 0 mg/L
105 gpm 0 mg/L
North Development Rock Dump 0 mg/L
331 gpm 0 mg/L
North Development Rock Dump Catchment 0 mg/L
South Development Rock Dump Catchment 0 mg/L
Seepage Collection <0.14 mg/L
14 gpm <0.14 mg/L
14 gpm <0.14 mg/L
Loss to Evaporation 0 mg/L
44 gpm 0 mg/L
Pore Water Look-up <0.14 mg/L
326 gpm <0.14 mg/L
Tailings Runoff <0.14 mg/L
152 gpm <0.14 mg/L
Tailings Impoundment <0.14 mg/L
217 gpm <0.14 mg/L
Reclaim Water Tank <0.14 mg/L
229 gpm <0.14 mg/L
Plant Site Precipitation/ Runoff 0 mg/L
36 gpm 0 mg/L
Mill Recycle Water Pond <0.14 mg/L
457 gpm <0.14 mg/L
Open Pit Precipitation/ Runoff 0 mg/L
51 gpm 0 mg/L
0.3 gpm 0 mg/L
Pit Groundwater Interceptor Wells 0 mg/L
193 gpm 0 mg/L
439 gpm 0 mg/L
470 gpm 0 mg/L
Treatment System 0 mg/L
470 gpm 0 mg/L
Discharge (Class V Injection System) 0 mg/L
Thickener
457 gpm <0.14 mg/L
Overflow <0.14 mg/L
1.36 mg/L
Cyanide Destruction
9.26 mg/L
Cyanide Addition 498 mg/L
453 mg/L
Carbon Leach
Flotation Circuit <0.14 mg/L
<0.14 mg/L
65 gpm <0.14 mg/L
Mill Circuit
302 gpm <0.14 mg/L
Snake River 0 mg/L
137 gpm 0 mg/L
Rock Creek 0 mg/L
70 gpm 0 mg/L
Pit Diversion 0 mg/L
67 gpm 0 mg/L
South Development Rock Dump 0 mg/L
Glacier Creek Catchment 0 mg/L
NOTES:
1) Precipitation and snowmelt contribute to all areas.
2) Water volumes represent average rates for the time period 1-31-07 through 12-31-10.
3) Volumes may not balance precisely due to rounding errors.
4) Carbon leach includes electroplating circuit.

5.4 WATER MANAGEMENT

5.4.1 Rock Creek Mine/Mill Complex

Surface water and precipitation runoff from undisturbed areas upslope of the Rock Creek facility development rock dumps and open pit will be diverted around the project area in a northerly flowing channel that empties into Lindblom Creek. Precipitation runoff from the South Development Rock Stockpile will filter through the vegetative mat into the surrounding area and/or be routed along a channel and re-introduced back into lower Rock Creek. A similar channel system will direct precipitation runoff from the North Development Rock Stockpile onto the tundra that drains towards Lindblom Creek. Surface runoff from rock stockpiles is expected to be benign and will not require treatment to meet applicable water quality standards. Surface runoff will flow over vegetative mat before reaching surface water minimizing potential sedimentation. All of the diversion channels will require a NPDES Stormwater Multi-Sector General Permit.

Water collected in the open pit will primarily be from direct rainfall and snowmelt. Strategic placement of snow fences will minimize the collection of snowfall in the pit and mineralized area to the greatest extent practicable.

Water from the plant site area, along with water pumped from the open pit, seepage collected from the toe of the tailings dam, and rainfall and snowmelt within the TSF, will be collected and directed to collection sumps, which will be pumped to the Mill Recycle Water Pond for recycle back to the process plant.

Pit water inflow volume is expected to exceed water consumption at Rock Creek. Groundwater wells, placed along the pit perimeter, will intercept groundwater before it drains into the mineralized zone. Excess water from the interception wells will be reintroduced back into the alluvial groundwater system below the mineralized zone under a Class V Injection Well permit. Ferric chloride water treatment will be provided, as needed, to ensure that the groundwater meets all applicable state and federal groundwater quality standards. As a contingency in the event that water consumption exceeds available water resources, provisions could be made to accommodate water withdrawal as needed from the diversion ditches and/or water wells within the Snake River alluvium, or directly from the Snake River. Additional information is available in the Hydrology Section of the appendices.

5.4.2 Big Hurrah Mine

Surface water will be diverted around Big Hurrah facilities via a network of precipitation runoff channels. One channel will collect precipitation runoff upstream of the development rock stockpile and direct it into the unnamed creek to the east. Little Hurrah Creek will be diverted upstream of the pit, contained in a channel along the west side of the pit, and directed back into Little Hurrah Creek downstream of the mine, thereby avoiding the mineralized zone. Strategic placement of snow fences will minimize collection of snowfall in the pit and mineralized area to the greatest extent practicable.

Precipitation runoff from the development rock stockpiles is expected to be benign and will filter through the vegetative mat into the surrounding area or drain into the Big Hurrah Creek drainage.

Dewatering wells will be installed around the perimeter of the operating pit, as necessary, to intercept groundwater before it enters the pit. Intercepted water and pit water will be managed according to its chemistry and treated using a ferric chloride process, if necessary, so it can be land-applied or re-injected to the local groundwater system via a drainfield, infiltration gallery, or injection wells in accordance with a Class V injection well permit.

5.5 PROCESS WATER

5.5.1 Rock Creek Mine/Mill Complex

Normal process water consumption at the Rock Creek facility is expected to be in the range of 264 million gallons (1,000,000 m3) per year, (500 gallons per minute [gpm]) mainly resulting from water lost in the voids of the paste tailings deposit. Other water losses, such as seepage and evaporation, will be minimal compared to tailings void losses. Process water will be provided from various sources, including water supply wells, pit seepage, precipitation on the tailings area, and surface runoff. A minimum operating water inventory will be maintained in the recycle pond.

5.5.2 Big Hurrah Mine

Process water considerations are confined to the Rock Creek Mine/Mill Complex, because there will be no ore processing at the Big Hurrah Mine.

5.6 POWER

5.6.1 Rock Creek Mine/Mill Complex

The Rock Creek facility will require about 9 to 11 megawatts of electric power, most of which is dictated by the milling operation. Power will be supplied from the Nome Joint Utility System and delivered to the site via a 25-kilovolt (kV) power line. A new power line must be installed along the Glacier Creek Bypass Road to the mine site. The DOT right-of-way along the Glacier Creek Bypass Road includes adequate lands for power line installation. Backup power to the plant will be provided by two 375 killowatt (kW),diesel generators, which will provide sufficient power to: maintain the operation of pumping systems sufficient to control the shutdown of the plant, prevent spills, and prevent freeze-up of process components. The generators will not have the power capability to operate the entire plant.

5.6.2 Big Hurrah Mine

Power to the Big Hurrah Mine facilities plant will be provided by a diesel-electric generator sufficient to provide ample power for a shop, office, and water handling facility.

5.7 ACCESS

5.7.1 Rock Creek Mine/Mill Complex

The Rock Creek facility is located adjacent to the existing Glacier Creek Highway.

The on-site access roads and haul roads at Rock Creek will be constructed largely over frozen overburden soils. There will be a maximum of three crossings of Rock Creek required at the Rock Creek site, depending on the final choice of diversion ditch designs. All on-site stream crossings occur upstream of known fish habitat in Rock Creek: one above the pit associated with the diversion channel, one below the pit associated with the plant site access to the tailings facility/diversion channels and explosive storage, and one below the TSF to allow access to the seepage recovery system and to the diversion channels. All culverts have been designed to pass the flow from a 100-year/24-hour storm event.

5.7.2 Big Hurrah Mine

The Big Hurrah Mine will be located 3.1 miles (5 km) from the Nome Council Highway. An existing State of Alaska omnibus road crosses Big Hurrah Creek and leads up to the site. Improvement to the road will be required to accommodate vehicles in excess of 10,000 pounds (4,500 kilograms [kg]) gross vehicle weight. Plans for the road improvement include removing historic dredge piles from the streambed for use as road fill. Removal of the dredge piles will allow the creek to establish better channelization within the floodplain. Concurrent excavation to deepen the channel, combined with the establishment of 2 to 3 fish pools, is anticipated to result in improved fishery habitat in Big Hurrah Creek. This project is being cooperatively planned and developed between Alaska Gold and Alaska Department of Natural Resources, Office of Habitat Management and Permitting.

All on-site stream crossings occur upstream above the area of significant use fish habitat in Little Hurrah Creek. On-site access roads and haul roads will be constructed from non-acid generating development rock excavated from the pit. Stream crossings will consist of non-acid generating rockfill from the development of the Big Hurrah pit. The rockfill will include culverts sized to pass storm flow from a 100-year/24-hour storm event and to allow fish passage. It is anticipated that two stream crossings will be required on Little Hurrah Creek. The first is below the pit, to allow access to the administration buildings, maintenance shop, and development rock dump. The second is associated with the east diversion channel. Culverts will be removed at closure.

5.8 FUEL STORAGE

All diesel fuel and gasoline to be used by the project will be barged into Nome during the summer season. Near the Nome port area, several large diesel tank farms are available for use through independent suppliers. Fuel will then be transported and stored on site at both mines. Spill containment supplies will be on hand at both mine sites. Diesel and gasoline fuel storage tanks and/or bladders at both sites will be contained within dual-lined and bermed areas, with a spill containment capacity equal to or greater than 110% of the largest container.

Lubricants will be delivered in drums and/or totes, and stored in a secured area at both sites. Lubricant drums and tanks will be stored within lined and bermed areas, with spill containment capacity equal to or greater than 110% of the largest storage vessel. The majority of the lubricants will be stored at AGC's laydown areas in Nome.

5.8.1 Rock Creek Mine/Mill Complex

Diesel fuel will be delivered to the Rock Creek facility via tanker truck. Fuel storage at the site will be minimized. Assuming a one-week supply, the site will store about 30,000 gallons (113,530 liters [L]) of diesel fuel. It is estimated that annual diesel fuel requirements for the Rock Creek facility will be in the range of 1 million gallons (3.8 million L). Gasoline consumption at the site, mainly for service vehicles, will be less. On-site storage is assumed to be 1,500 gallons (6,000 L).

5.8.2 Big Hurrah Mine

Diesel fuel will be delivered to the Big Hurrah site via tanker truck. Fuel storage at the site will be minimized. Assuming a one-week supply, the site will store about 10,000 gallons (36,000 L) of diesel fuel.

5.9 EXPLOSIVES STORAGE

All explosives handling and storage at both sites will comply with applicable state, federal, U.S. Bureau of Alcohol, Tobacco, and Firearms (ATF), and Mine Safety and Health Administration (MSHA) regulations. Blasting agents will be barged to Nome during the summer months; therefore, about eight months of bulk ammonium nitrate (AN) storage is required. Initiators and boosters will be flown to Nome separately.

5.9.1 Rock Creek Mine/Mill Complex

A total of about 1,400 tons (1,300 tonnes) of AN (with a peak annual consumption of 2,400 tons [2,200 tonnes]) for the Rock Creek site will require storage. Bulk AN may be stored in 1-ton Super Sacks®. High explosives will be segregated from the AN and stored in a separate bermed and locked magazine. The explosives storage will be located away from the rest of the project facilities, as required in the American Table of Distances referenced in the MSHA regulations.

5.9.2 Big Hurrah Mine

Blasting agents will be barged to Nome during the summer months; therefore, about eight months of bulk AN storage is required at Rock Creek. A total of about 110 tons (100 tonnes) of AN (with a peak annual consumption of 385 tons [350 tonnes]) will require storage at Big Hurrah at any one time. Bulk AN may be stored in 1-ton super sacks. Explosives will be on site during active operations only. When explosives are on site, they will be stored in a separate, locked magazine. The explosives storage area will be bermed and located away from the rest of the project facilities.

6.0 ALTERNATIVES ANALYSIS

6.1 ALTERNATIVE 1: (PREFERRED ALTERNATIVE)

6.1.1 General Description

The project, as described above, consists of an open-pit mine at two sites, Rock Creek and Big Hurrah. Ore from both sites is to be milled at the Rock Creek site. Ore will be processed with the use of a gravity circuit, followed by a flotation circuit on the gravity tails. Flotation concentrate will undergo a cyanide carbon-stripping process. Leached ore from the cyanidation process will be subjected to treatment for fixation of free cyanide and combined with the tailing from the flotation circuit. Gold recovered in the carbon-stripping circuit will be refined with the gravity concentrates in a furnace, and a doré bar will be produced on site. Gold doré will be shipped to a refinery for the final stages of refining and sale. The beneficiation process will produce paste tailings that will be placed within a containment structure.

6.1.2 Selection Rationale

This alternative met the preferred status by sustaining the project as economically viable while incorporating a wide range of environmental mitigation measures.

This alternative incorporates a beneficiation process that produces paste tailings with a solids content of 75%, instead of conventional tailings with a solids content of 35%. Several environmental advantages were gained through the decision to produce paste tailings. Tailings volume was reduced, and the tailings could sustain a steeper bank slope of 5 to 6%, resulting in a smaller footprint and less disturbance to wetlands. The lower moisture content in the paste tailings also negates the need for a supernatant pond and greatly reduces the propensity for tailings seepage. Paste tailings produce a stable tailings stockpile that will not readily erode, and, with the deposition of a cap of organic matter, will be amenable to revegetation. As part of the reclamation, a silt layer will be deposited on top of the tailings, along with 1 to 2 feet (0.3 to 0.6 meters [m]) of overburden organic material. Thermal modeling was also performed on several alternative designs involving liners and thermosiphons to evaluate their effectiveness in minimizing the seepage volume originating within the tailings storage facility. Multiple scenarios to the alternative designs were evaluated and it was determined that the design which extended the geomembrane liner into the underlying weathered bedrock provided a greater reduction in seepage than designs which incorporated thermosyphon systems. The complete Tailings Alternative Analysis is attached in the Tailings Analysis section of the appendices under, Rock Creek Report, Tailings Alternative Analysis Final Report.

Extensive metallurgical research was conducted to determine how to maximize the use of gravity separation and flotation for the recovery of the gold from the ore. The use of gravity separation before flotation allows for the mechanical recovery of approximately 70% of the gold. After the use of gravity separation, a flash flotation cell selectively separates the remaining gold ore from the waste, greatly reducing the amount of ore to be processed through the cyanidation process by 85%. These two processes in turn significantly reduce the amount of cyanide to be used at the site. Further, the cyanidation

process will all be conducted within tanks sited within an engineered containment facility, to provide secondary containment of cyanide-laden slurries and solutions. Milling facilities were consolidated at the Rock Creek site for economical reasons and because of resultant reductions in the overall footprint. Consolidation of tailing facilities would simplify tailings management and minimize the potential for environmental impact. Additional information on the metallurgical process is attached in the Metallurgical section of the appendices in the report titled Metallurgical Investigation and Process Development.

Power generation at the Rock Creek site has been designed to maximize usage of the Nome Joint Utilities Power Plant. Not having diesel generation on site will reduce diesel storage at the site thereby minimizing the potential for fuel spillage.

The placement of facilities has been designed to minimize the overall footprint of the project and to avoid wetlands where feasible. Wetland mapping was conducted early in the process. As a result, as the conceptual design was completed, wetlands were avoided to the greatest extent practicable. At Rock Creek, development rock stockpiles were relocated to minimize wetland impacts. Where the overall goal of avoiding wetlands could not be realized, attention was focused on minimizing disturbance to higher value willow wetlands by moving the stockpiles into the lower-value open tundra wetlands to the extent feasible. The Big Hurrah facilities are all located outside of wetlands. To further minimize the footprint, the Big Hurrah mine plan includes backfilling of the satellite pit with development rock and then using that foundation as a pad for the ore stockpile.

Minimal impacts to creeks are attained by careful placement of all facilities and development stockpiles. At the Rock Creek Mine/Mill Complex, all facilities and development rock stockpiles are confined within the Rock Creek drainage, avoiding placement of facilities within adjacent drainages. Although, there is some water diversion from the site into Lindblom Creek and drainage from the north development rock stockpile flows towards and into Lindblom Creek. At the Big Hurrah development, rock stockpiles were designed to avoid placement within the local creeks,

Geotechnical stability of the development rock stockpiles has been ensured through optimization of slope configuration to avoid slope failure. Options to stack higher or steeper did not meet acceptable safety standards. The preferred location of the development rock stockpiles avoids the steeper terrain of the areas uphill, and particularly to the north of the present location, for maximum stability.

The tailings impoundment preferred location was determined on the basis of geotechnical stability through minimal base slope and the avoidance of higher dam sections that would be required on the steeper topography found throughout the alternative locations within the project area. This location also accommodates avoidance of higher-value wetlands, avoids encroachment on other private lands, and maintains the design principle of confining facilities within the Rock Creek drainage.

Further minimization of disturbance to wetlands is accomplished through the use of development rock and/or historical tailings for all road and foundation fill, thereby avoiding additional disturbance in the creation of new quarries or material sites. The power line linking the facility to the Nome Joint Utilities will be placed within the existing

road right-of-way so as not to create a new wetlands disturbance area, and workers will reside in town and commute to the site, thereby eliminating the disturbance that would be associated with creating a personnel-camp. Additionally, the access road into the Big Hurrah Mine will be located within an existing road right-of-way.

An additional environmental aspect to this alternative is the stream restoration project that is proposed in conjunction with the improvements to the access road to the Big Hurrah mine site. The access road is being designed in cooperation with the Alaska Department of Natural Resources, Office of Habitat Management and Permitting, not only to locate the road where it least impacts the stream, but also to incorporate fishery enhancement components into the construction plan. The majority of road fill will be composed of historic tailings, to avoid additional disturbance in the creation of new quarries or material sites. Historical tailings will be removed to bank-full height, which simultaneously provides banks for stream channel establishment while allowing for flood attenuation capacity. Any additional tailings and fill material will come from pits strategically located within the floodplain. Pits will be designed and located to meet Habitat Division criteria and will serve to enhance fish habitat for over wintering and spawning. Stream channeling is presently disturbed as a result of historical dredging in the area; the main channel will be deepened to assist the stream in reclaiming a main channel in accordance with Habitat Division criteria.

6.2 ALTERNATIVE 2

This alternative was not economically viable. The alternative incorporates the same mine design, but was based on processing the ore without the use of cyanide. Substantial research was conducted to determine if economically sufficient amounts of gold could be recovered from the ore through the use of gravity separation and flotation. The alternative looked at gravity separation followed by flotation, followed by an additional gravity separation phase. Research was also conducted to determine if a finer grind would liberate the gold without the use of cyanide. The research and bench tests were unable to produce an acceptable gold recovery rate. Additional information on the metallurgical process is attached in the appendices under the Metallurgical section in the report titled Metallurgical Investigation and Process Development.

6.3 ALTERNATIVE 3 (NO ACTION ALTERNATIVE)

Under this alternative, the Project would not be constructed and the site would be reclaimed in accordance with the exploration reclamation plans.

The no-action alternative removes the potential for economic growth associated with the mine and its potential 135 jobs. This loss would be notable in this economically depressed community. The development of the mill also has the potential to allow for further development of other small mineral deposits in the region, particularly deposits that could not economically support an independent mill. By not constructing the Project mill, the no action alternative may further hinder this potential for additional economic benefit.

The no action alternative would prevent disturbance to wetlands at the Rock Creek site. However, the fishery enhancement potential associated with the proposed mitigation projects would not occur. Improvement to fishery habitat in Nome, where many of the streams have been disrupted by historic mining, may be of greater ecological value than avoiding the disturbance of open tundra and willow wetlands which are abundant throughout the region.

7.0 AFFECTED ENVIRONMENT AND CONSEQUENCES

7.1 REGIONAL LOCATION

7.1.1 Location and Site Characteristics

The Rock Creek Mine/Mill Complex is bounded on the northeast by Mount Brynteson, to the west by the Snake River, and on the south by Glacier Creek. The elevations on the project area vary from between 100 feet (30 meters) and 650 feet (200 meters) above sea level. The property is located within the Bering Straits Resource Area Coastal Management District. The Rock Creek area has been placer mined extensively in the past 100 years. Much of the area shows visible disturbance and there are tailings piles located throughout the region.

The Big Hurrah Mine site is bounded on the south by the Uncle Sam Mountains, on the north by Big Hurrah Creek, to the west by Linda Vista Creek, and by a small unnamed intermittent creek to the east. The elevations on the property vary from 150 feet (45 meters) to 500 feet (150 meters) above sea level. The property is located within the Bering Straits Resource Area Coastal Management District. The Big Hurrah area has been extensively placer and hard rock mined in the past 100 years. There is an abandoned adit, and a 20-stamp mill still in existence at the site.

According to the U.S. Department of Agriculture Forest Service, classification system, the project is located within the Seward Peninsula Tundra–Meadow ecological subregion. The terrain is fairly hilly with broad and narrow valleys. Forested areas and trees are generally nonexistent at either site, although closed willow thickets exist in wetland areas at the Rock Creek site.

Soils generally are poorly drained and shallow. On hill slopes and ridges, soils are formed in gravelly regolith material over weathered bedrock. At the upper elevations, soils generally have minimal organic horizons and may be fairly rocky, with bedrock exposed at surface in some areas.

Vegetation in the area consists mostly of tundra mat, sedges, shrubs, mosses, lichens, willows, and, in some places, cottonwoods. The Seward Peninsula is home to more than 170 species of birds and small mammals including arctic foxes, Alaska hares, land otters, lynxes, and ground squirrels.

Wetlands have been identified across the Rock Creek site, and predominantly lie within the northwestern portion. There are no wetlands within the project footprint at the Big Hurrah Mine site. The Big Hurrah Creek access route occurs within the Big Hurrah Creek floodplain. The complete wetlands analyses for Rock Creek and Big Hurrah are attached in the Biological Resources section of the appendices under Preliminary Jurisdictional Determination Various

Wetlands Adjacent to Rock Creek, and Preliminary Jurisdictional Determination Little Hurrah Creek and Big Hurrah Creek.

Surface drainage in the Rock Creek Mine/Mill Complex area is primarily through the watershed of the Snake River. The drinking water source for the Nome community is Moonlight Springs, located near the southern base of Anvil Mountain in an adjacent valley. Additional important drainages are located around the Project's Big Hurrah site and include Big Hurrah Creek and its tributaries and the Solomon River. Throughout the Seward Peninsula, there are numerous other rivers and streams, including the Nome River, which lies between the Snake and Solomon rivers.

The project site is characterized by cool summers and cold winters. Annual temperatures range from a minimum of -27.9 Fahrenheit (F) (-33 Celsius [C]) to a maximum of 85.1F (29.5C) with an average annual temperature of 31.6F (-0.2C). Annual precipitation is relatively low, averaging less than 28inches (in) (71 centimeters [cm]), with the majority of precipitation falling as rain in summer. Monthly winter snowfall totals range from 4.7 in (12 cm) to 11 in (28 cm), on average. Temperatures usually drop below freezing in Nome around October and remain below freezing until late April. January is typically the coldest month of the year. Norton Sound usually begins freezing in November. The average annual precipitation is 18 in (0.5 m), including 56 in (1.4 m) of snowfall. Most of the precipitation falls during July, August, and September. Snow accumulation is greatest from early November to March; the majority of the snow will melt by April or May.

7.2 PAST AND PRESENT LAND USE

Nome was developed as a service and trade center for nearby and inland gold fields throughout the Seward Peninsula. Present day regional recommendations within the City of Nome Coastal Management Program list mineral development as a priority goal "to encourage mining and mineral processing in a manner consistent with economic needs and natural resource protection."

7.2.1 Public Access

7.2.1.1 Affected Environment

The Snake River Valley is presently accessed for mining; subsistence hunting, fishing, and gathering; recreational cabins; bird-watching; dog mushing; and general sightseeing. Access is via the Glacier Creek Highway. A recent realignment of the road accesses the valley through more gentle terrain that may be more reasonable to maintain on a year-round basis.

The proposed mining activities within the Snake River Valley are confined to a small footprint of private lands owned by Alaska Gold and additional lands owned by the Sitnasuak and Bering Straits Native corporations. An Alaska Gold policy prohibiting trespassing on company lands is consistent throughout the region. The Rock Creek mining claims, as with all Alaska Gold lands, have been and remain closed to public access. Access to Sitnasuak/Bering Straits Native Corporation Lands varies according to Sitnasuak policies.

The Solomon River is accessed for hunting and fishing and use of recreational cabins. Access is via the Nome/Council Highway. The Big Hurrah River Valley is accessed for similar uses. The Big Hurrah River Valley is accessed through a nonmaintained state right-of-way up the floodplain and along a road located on Solomon Corporation lands. The Big Hurrah Mine is completely located on private Alaska Gold lands which prohibit trespassing.

7.2.1.2 Consequences

Access to the Snake River Valley will continue to be available to the general public. Road access that has been limited in the past because of seasonal road closures could improve as a result of the new alignment of the Glacier Creek road and by the year-round use of the road by the mining company and associated road maintenance. Traffic will increase over the first 3 miles (5 km) of the Glacier Creek road, particularly in association with employee shift changes. Haul truck traffic is anticipated to be two trucks traveling together at 45 minute intervals at its maximum.

Access to the Solomon and Big Hurrah River valleys will continue to be open along the existing highway and state right-of-way. Access may improve as a result of year-round mining and/or hauling activities and associated road maintenance. Mine operations will be limited at Big Hurrah, resulting in minimal traffic increases. Haul truck traffic is anticipated to be two trucks traveling together at 45 minute intervals at maximum.

7.2.2 Industrial Uses

7.2.2.1 Affected Environment

Industrial use within the Snake River Valley and the Big Hurrah Valley has been confined to continuous intermittent mining activity for the past 100 years.

7.2.2.2 Consequences

Industrial use will increase over current use, but will be congruent with historical use of the area. Mining methods will change from placer mining to hard rock mining methods.

7.2.3 Commercial Uses

7.2.3.1 Affected Environment

Reindeer herding is the only present or past commercial activity within the Snake River and Big Hurrah valleys.

Reindeer were first introduced to Alaska in 1891 when 16 animals were shipped over from Siberia. The herd survived and between 1892 and 1902 more reindeer were brought over from Siberia, along with Siberian Natives and Saami herders to teach Eskimo people successful reindeer herding skills. In 1937, Congress passed the Reindeer Act which restricted ownership of reindeer to Alaska Native people to provide increased opportunity for their economic well-being.

Under various owners and managers, the population of reindeer has fluctuated. The herd numbered 10,000 head in 1905 and grew to an estimated 640,000 reindeer by 1937, then decreased to 23,000 head by 1985. Reduced reindeer herds were in large part due to the loss of animals to the wild caribou herds. Improvements in reindeer herding techniques through the use of helicopters, snowmachines, and radio collars, as well as methods to reduce disease and stress, have led to an increase in the current reindeer population.

The Seward Peninsula area provides approximately 15 million acres (6 million ha) of open grazing on natural vegetation for more than 25,000 animals out of the total 40,000 reindeer in Alaska today. Reindeer grazing entitlements were set aside in the 1937 Reindeer Act by the Bureau of Land Management (BLM) for approximately 1 million acres (400,000 ha) per entitlement. These entitlements have been passed down through the generations, generally remaining within the same families. Their management of the herds is overseen by the Reindeer Herders Association. Herders are responsible for securing land use permits for the lands within their entitlement that will be used by the herd. State and federal agencies issue 5-year land use permits for public lands. Use of Native corporation land or other private lands is by negotiation.

The Rock Creek Mine/Mill Complex is a private in-holding within the Davis grazing unit. These lands are owned by Alaska Gold Company and Sitnasuak Native Corporation. No grazing permits or agreements have been established in the recent past for the use of these lands for the Davis reindeer herd. During the summer months of recent years, the Davis herd commonly grazed further north and east of the project near the Casadepaga, Eldorado, and Bonanza rivers. The herd, which numbers approximately 3,000 animals, is brought in closer to the Nome area during the winter months to prevent intermingling with the wild caribou herds and for protection against wolves.

The Big Hurrah Mine is a private in-holding within the Gray grazing unit. The land is wholly owned by Alaska Gold Company. No past or present grazing permits have been established for use of these lands for the Gray reindeer herd. No grazing permits have been issued by the Solomon Native Corporation for the surrounding lands in recent years. Grazing did occur in the area historically, but there was substantial loss of animals to caribou herds and use of the area was discontinued. During the summer months of recent years, the Gray herd, which numbers approximately 400 animals, primarily grazed to the south and east of the site on a peninsula adjacent to the Golovin Lagoon. No information was immediately available about the winter grazing range.

7.2.3.2 Consequences

Neither mine site is within a high-use grazing area. The lack of grazing land use agreements at either of these sites presently or in the recent past indicates that use of these lands for mineral development does not represent a direct loss of range to the herd.

The availability of open land on all sides of both mine sites adequately allows for reindeer movement through the area, and avoidance of noise and traffic associated with the proposed project, if the herders were to initiate grazing on lands immediately surrounding either of the sites. Grazing entitlements for both herds are expansive, approximately 1 million acres

(400,000 ha) each, with ample opportunities to continue herding in areas not affected by the proposed project.

The proposed project will include a local hiring preference, but will still likely bring in some workers from other areas. There is concern among the Reindeer Herders Association that non-local workers may not be familiar with reindeer herding and consequently may mistake the animals for wild caribou that may be legally hunted. This concern could be mitigated through a commitment by the company to educate workers as well as through educational efforts by Fish and Game or other game management agencies and groups.

All other commercial activities in the area occur within the town of Nome, where there are a variety of services including stores, restaurants, hotels, car rentals, mechanic shops, metal fabricators, one theater, and banks. The use of these services will likely increase with the influx of additional workers and as support resources for the mine itself.

7.2.4 Residential

7.2.4.1 Affected Environment

Residential use of the Snake River Valley primarily occurs in the area where the Nome-Teller Highway crosses the river. There are about 5 year-round residential houses in this area, along with several other recreational cabins. There is one year-round resident upriver near the confluence with Glacier Creek and numerous recreational cabins scattered upriver throughout the valley. There are two recreational cabins within the Big Hurrah Valley.

7.2.4.2 Consequences

The proposed project is not expected to create greater need for residential use within the project area. Land surrounding the project area is primarily owned by Alaska Gold Company or by the local Native corporations and is not generally available for residential development. The mine is likely to attract some regional residents to move into the town of Nome, as well as additional employees moving in from outside the region. Housing consequences for the region are discussed in the socioeconomic section of this document.

7.2.5 Institutional

7.2.5.1 Affected Environment

There are no institutional services within the Snake River Valley. Health and social services, including a regional hospital, are available within the nearby town of Nome.

7.2.5.2 Consequences

Consequences to the institutional services within the greater Nome community are discussed in the socioeconomic section of this document.

7.2.6 Subsistence

7.2.6.1 Affected Environment

Subsistence in the Nome area consists of hunting/fishing and gathering various plant products. Residents gather various roots (Mussu), plants (Sura, Iu, fireweed), and berries (cloud-, blue-, black-, and cranberries, and currents) during spring, summer, and fall months. The materials gathered and hunted/fished are used by the residents for food, clothing, and other everyday living supplies. Residents in the Nome area hunt for brown bear, moose, caribou, fox, wolverine, wolf, muskrat, musk oxen, squirrel, weasel, rabbit, ptarmigan, and various waterfowl.

Four major species of Pacific salmon (chinook, pink, chum, and silver) travel up the Snake River during fall spawning. Trout and Arctic grayling inhabit the Snake River year-round. Brown bear, moose, and caribou may inhabit the Snake River drainage with frequency, while the remaining animals only occasionally inhabit the Snake River area.

Subsistence in the Solomon River area consists of hunting, fishing, and gathering plants and berries. Solomon is located on the west bank of the Solomon River 3.0 miles south of Big Hurrah Creek.

Musk oxen, moose, brown bear, reindeer, fox, beaver, and porcupine are widely distributed throughout the general area. Fish are the staple of the subsistence diet. Fish camps are clustered at the waters' edges with rows of salmon filets drying in the sun. Fish camps are found today in Solomon.

This area was originally settled by the Eskimos of the Fish River Tribe in the 1900s. Solomon has a subsistence-based culture depending on fishing and hunting for waterfowl and ptarmigan. During the gold rush of 1899 and 1900, thousands of people moved to the Solomon area. Three enormous dredges worked the Solomon River. In 1939, the present community relocated to its present site. In 1940, the Bureau of Indian Affairs (BIA) constructed a large school. The post office and BIA school were discontinued in 1965. The Solomon Roadhouse operated until the 1970s.

7.2.6.2 Consequences

Subsistence activities have coexisted within the presence of mining in this area through the last 100 years and are expected to continue uninterrupted throughout mine operation.

There is undisturbed land east and west of the Rock Creek Mine/Mill Complex, allowing for animal passage through the Snake River Valley so that migration and animal movement can continue unhindered. The Big Hurrah Valley runs north and south and has undisturbed lands in both of these directions to similarly allow unhindered migration and animal movement. Extensive areas of undisturbed wildlife habitat exist throughout the region and around the mine site. The Nome Coastal Management Program encourages the assured public access to subsistence areas; the Project will not hinder subsistence access. Year-round mining activity and associated road maintenance may improve access to subsistence resources.

7.3 GEOLOGY

7.3.1 Geologic Background for Project Area

7.3.1.1 Rock Creek Deposit

The Rock Creek deposit is hosted in the Mixed Unit of the Nome Group. These rocks are assumed to be derived from a continental shelf setting during the Cambrian to Devonian periods. They have been subjected to prograde blueschist facies metamorphism during the Jurassic period that resulted in northerly trending isoclinal folding. Later northerly directed compression resulted in east-west striking folds and thrust faulting. Later retrograde greenschist facies metamorphism during the Cretaceous period accompanied recumbent isoclinal folding of the earlier fabric.

Gold at Rock Creek is contained in two distinct types of mineralization. Tension veins (TVs) account for approximately 75% of the tons and 65% of the gold content in the deposit. The Albion Shear accounts for most of the rest of the deposit.

The Albion Shear also strikes northeast and dips to the southwest and is present the length of the deposit. Gold in the Albion is hosted primarily in quartz veins that are up to 10 ft (3 m) wide. The quartz veins are often broken or brecciated. The quartz is often bluish in color because of the presence of fine-grained pyrite and lead sulfosalts. Free gold is locally present in Albion veining, but less so within the tension veins. Gangue minerals in the Albion include: lead sulfosalts, arsenopyrite, pyrite, stibnite, and minor base metal sulfides.

TVs are northeast striking, steeply northwest dipping, sheeted veins, rarely greater than 4 inches (10 centimeters [cm]) wide. Tension veining is most common at the southern end of the deposit; however, vein density also increases proximal to the Albion Shear. Gold is strongly associated with arsenopyrite; other gangue minerals include: quartz, carbonate, arsenopyrite, and pyrite, with lesser stibnite, base metal sulfides, and lesser lead sulfosalts.

7.3.1.2 Big Hurrah Deposit

The Big Hurrah deposit will be mined as an open-pit mine to supply supplemental ore to the Rock Creek Mill. The known gold resource lies within land owned 100% by Alaska Gold, with the surrounding lands owned by Solomon Native Corporation Lands.

The Big Hurrah deposit is also hosted in the Mixed Unit of the Nome Group. These rocks are assumed to be derived from a continental shelf setting during the Cambrian to Devonian periods. They have been subjected to prograde blueschist facies metamorphism during the Jurassic period and later retrograde greenschist facies metamorphism during the Cretaceous period.

Gold mineralization at Big Hurrah is hosted in quartz veins contained within fault zones that strike northwest, dipping variably to the southwest, and varying in thickness from less than 3 ft (1 m) to greater than 33 ft (10 m). The mineralized zones can be traced along strike for roughly 1,312 ft (400 m) and are cut off by north-striking post-mineralization faults. The gold in these mineralized zones is contained primarily in sub-parallel quartz veins containing carbon on the vein margins or as thin films within the veins, giving them a ribbon texture.

Stockwork quartz veins that vary in thickness from a few millimeters to 2 inches (5 cm) are also present and can be auriferous. While the mineralized zones are quite consistent, individual quartz veins are irregular and vary in thickness, pinching and swelling along strike and downdip. Gold often occurs along with graphite, scheelite, pyrite, or arsenopyrite.

7.3.2 Acid Rock Drainage and Metal Leaching Potential

7.3.2.1 Affected Environment

Rock Creek Mine/Mill Complex

Natural conditions at the Rock Creek Mine/Mill Complex site do not indicate the presence of acid rock drainage. pH values in Rock Creek (measured at three stations within the creek), which bisects the mineral deposit, are generally neutral, ranging from 6.26 to 9.01 and averaging 7.7.

Metal leaching, however, does occur naturally at the Rock Creek site, and can be observed in groundwater immerging near the mineralized zone. Metal leaching affects the surface water quality, probably due to input from groundwater sources. Values in both the groundwater and surface water are near consistent in exceeding the Alaska State Drinking Water Standard for arsenic. (The present standard is 50 micrograms per liter (µg/L), but a standard of 10 µg/L has been approved for implementation in January 2006.) Groundwater pH values were generally neutral at both sites, ranging from 6.9 to 7.1 at MW03-02 and ranging from 7.43 to 7.7 at MW03-03.

Arsenic concentrations in the groundwater range from 1,170 to 3,980 µg/L, with an average of 1,977 µg/L in the well near the pit area (MW03-02). Upstream, the closest well (MW03-03) had arsenic values of 39 to 52 µg/L with an average of 45 µg/L. Three main springs/seeps were located in the upper reaches of Rock Creek. Arsenic levels were measured at each seep on August 12, 2005. Total arsenic values for the three sites showed considerable variability, measuring 233 µg/L at SEEP1, 55.5 µg/L at SEEP2, and 115 µg/L at a third seep titled IRON for the obvious orange mineral staining at the site.

The influence of the seeps is attenuated in the stream, as seen at the furthest upstream surface water station in Rock Creek (RCK1) which measures 47.4 µg/L total arsenic on average. Arsenic concentrations in Rock Creek surface water (total recoverable, taken from three stations within the creek) range from 2.35 to 392 µg/L and average 75 µg/L.

Exisiting conditions at the Big Hurrah mine site, which include historic mining disturbances, also do not indicate the presence of natural acid rock drainage. pH values in Little Hurrah Creek, which bisects that mineral deposit, are generally neutral, if not slightly basic, ranging from 6.31 to 8.75 with a mean value of 7.31 in Upper Little Hurrah Creek and a mean value of 7.83 in Lower Little Hurrah Creek. Arsenic concentrations in Little Hurrah Creek generally meet Alaska State Drinking Water Standards, indicating metal leaching does not occur to a substantial degree at the Big Hurrah site.

7.3.2.2 Consequences

Determination of acid rock drainage and metal leaching potential from mining activity is accomplished through a series of tests on the various rock types anticipated to be disturbed and/or exposed by the mining project. A brief explanation of the tests conducted on the Rock Creek and Big Hurrah rock types is offered below.

Paste pH

Paste-pH data provide a quantitative estimate of the pH of a lixiviant such as rainwater on initial contact with the test sample. Because of the short solid-solution reaction time defined by the test, paste-pH data reflect the net acid-generation/consumption potential of readily hydrolyzed mineral phases only. Typically, these include carbonates and sulfosalt weathering products.

Acid-base Accounting (ABA)

Acid-base accounting (ABA) is an industry-standard procedure for appraising the acid generation (or acid consumption) potential of rock and soils. The procedure involves the assessment of two parameters: neutralization potential (NP) and acid-generation potential (AP). These parameters are subsequently used to calculate interpretive indices, including net neutralization potential (NNP) and NP:AP ratios. ABA provides a snapshot in time, based on bulk chemistry of sulfur and carbon species only, and does not account for the kinetics of the reactions nor the availability of the minerals at the reaction front. ABA does indicate if the neutralizing minerals and sulfur are present in quantities necessary to buffer pH in the neutral- to slightly-alkaline range or generate net acidity.

Neutralizing Potential

Values of NP indicate the capacity of rock materials to buffer acidity produced by sulfide oxidation or other proton-generating reactions. The determination of NP values for all samples in this project followed the U.S. Environmental Protection Agency (EPA) Sobek protocol (Sobek, et al., 1978). A volume of 1:3 hydrochloric acid (HCl) is applied to a 2-gram sample of crushed rock and agitated until any "fizzing" reaction ceases. Approximately 125 milliliters (ml) of water (H2O) is added, and the sample boiled to expel any dissolved carbon dioxide (CO2). The resultant solution is subsequently back-titrated with sodium hydroxide (NaOH) to a pH of 8.3. A NP is calculated based upon the normality of the acid and base applied and the mass of sample. All results are normalized to a conventional unit of tons calcite (CaCO3) (equivalent) per 1,100 tons (1,000 tons) of rock. The reported results do not necessarily imply that CaCO3 is present.

An alternative method used to determine NP values for confirmatory testing is the peroxide siderite correction for the Sobek method (Skousen, et al., 1997). This method addresses potential erroneously high NP calculations from the above described standard Sobek method due to the presence of siderite or other iron carbonates in the material. For this method, a 2 gram sample is boiled in HCl for 5 minutes, and then filtered. The filtrate is then added to a 30 percent peroxide solution and boiled for 5 minutes to drive the oxidation of ferrous to

ferric iron. The solution is then titrated to determine the calcium carbonate equivalent for the acid consumed during the test.

The NP of the material may also be calculated based on the total inorganic carbon (TIC) content of the sample. TIC content is determined in the laboratory as the difference between the total carbon content and the total organic carbon (TOC) content. Total carbon is measured using the standard LECO furnace method. For TOC determination, inorganic carbon must be removed from the samples by bathing the samples in 2N HCl for 24 hours, followed by rinsing and centrifuging. The sample is then analyzed for TOC using the LECO furnace method. The difference between total carbon and TOC is the TIC content of the material. The NP is calculated based on the TIC, and converted to standard units (i.e., TIC, as percent carbon, is multiplied by a factor of 83.3 to convert to NP, as tons CaCO3 per 1,000 tons of rock).

Acid-generation Potential

Numerous procedures exist for the determination of AP. All include the analytical derivation of the various forms of sulfur, including total and pyritic sulfur. The potential proton yield is calculated in accordance with the stoichiometry of pyrite oxidation. Options for the derivation of an appropriate sulfur value include: the assignment of all sulfur within a sample to stoichiometric pyrite; the analytical differentiation of sulfide sulfur from other sulfur species, and assignment of the former to stoichiometric pyrite; and the mineralogical determination of pyrite sulfur. A modification of the Sobek (1978) method, involving the use of sulfide sulfur for AP calculation, is most widely deployed worldwide. This procedure can, however, be considered conservative with respect to samples which hold a significant component of sulfide sulfur in non-pyrite phases. For these evaluations, values of AP were calculated using both total sulfur and sulfide-sulfur data.

Meteoric Water Mobility Procedure (MWMP)

MWMP testing for this project was conducted according to Standard Methods (1992). This method is a standard leach procedure involving a 24-hour, single-pass column leach using a 1:1 water to rock ratio. The extraction solution is distilled, deionized water. This method provides an indication of the propensity of minerals in the samples to leach under environmental conditions. Leachates from this test are not necessarily representative of long-term environmental exposure; rather they are more indicative of a “first flush” chemistry that results from dissolving the relatively mobile mineral salts. Results from these tests are used in preliminary characterization of environmental behavior of materials and to define the next phase of geochemical testing.

X-ray Diffraction (XRD)

XRD is used to identify and estimate the quantity of major rock-forming minerals of each sample. These mineralogical data help verify the mineralogical sources of the key ABA species. For example, carbonate rocks that are in the form of siderite (iron carbonate) will release iron in addition to the buffering carbonate. The type and quantity of mineral phases also influence how the rock will weather in the environment.

Ion-coupled Plasma/Mass Spectrometry (ICP/MS)

ICP/MS testing is a pseudo whole-rock analysis whereby the material to be tested is digested (leached/dissolved) and the liquid is analyzed for elemental content. The degree of digestion depends on the particular method, but it is assumed that the digestion is complete enough to be representative of the bulk rock chemistry.

Detailed Mineralogy

Splits from humidity cell testing (HCT) samples are submitted for detailed mineralogy and ABA to allow more thorough interpretation of the kinetic test results in context with a clear understanding of the samples' acid generation or neutralizing potential, and their mineralogy. Detailed mineralogy includes doing optical characterization in hand samples and by optical microscope, scanning electron microscope (SEM) and electron microprobe, if necessary. This provides valuable information about rock type, mineralogy, the nature of the acid-generating and acid-neutralizing mineral phases, alteration/reaction phases, grain size, porosity, and morphology. The optical inspection was used to define further testing using SEM and/or microprobe analysis.

Humidity Cell Testing

Samples were collected from each of the major development rock lithologies and two tailings samples. HCTs are kinetic tests. That is, they are intended to provide data as a function of time instead of a "snapshot" in time that results from static testing. This information is critical to understanding how materials respond to weathering through time as they are exposed to multiple wetting and drying cycles in the environment. Humidity cells, in particular, are designed to simulate multiple wetting and drying cycles to establish optimal conditions for weathering of the sample. Typically, 2.2 to 3.3 pounds (1.0 to 1.5 kg) of material is placed in a column and undergoes weekly flushing using distilled water at a 1:1 water:rock ratio. The leachate from each week is analyzed for key parameters (volume of leachate recovered, pH, total dissolved solids (TDS), temperature, sulfate, iron, acidity, alkalinity, and redox potential). Samples are stored and combined into a composite representing four weeks and sent for detailed chemistry. Tests run a minimum of 20 weeks and are then stopped when parameter concentrations stabilize or indicate negligible weathering is occurring. Data are processed to estimate weathering rates, chemical mass release rates, and depletion times for neutralizing versus acid-generation potential in the samples.

Rock Creek Mine/Mill Complex

Geochemical testing for Rock Creek was conducted in two phases, followed by additional confirmatory testing specifically for ABA analysis. Phase 1 was completed in April 2004 and provided the basis for an initial characterization of development and ore rock and defined the needs for Phase 2 geochemical testing. Phase 2 sampling was completed in the third quarter of 2005, and consisted of kinetic testing and systematic static testing and to fill in data gaps

based on the Phase 1 results. Confirmatory testing was performed in March 2006 to define the different sources of neutralizing potential present in the Rock Creek development rock and ore.

Phase 1 consisted of static tests on representative development rock and ore samples. The number of samples was based on the relative tonnage of each material type that was predicted to be excavated from the mine. The geochemical sampling and analysis plan proposed sampling based on tonnages and rock types, with a total of 65 million tons (59 million tons) of excavated rock mass. The focus of the sampling and analysis, based on rock type percentage, was on quartz-muscovite schist (QMS), calcareous quartz-muscovite schist (CQMS), and graphitic quartz-muscovite schist (GQMS). The number of samples for the Phase 1 work was based on a minimum of one sample per 5 Mt of materials (MEND, 1994), and in most cases exceeded this guideline.

Phase 1 testing was conducted in two parts. Archived pulp samples from previous drilling and testing programs were available. Bulk chemistry (ICP/MS) of the pulps had already been completed, samples were of an appropriate grain size, and they provided statistically representative coverage of the development and ore material. Borehole locations and intervals were selected to provide a spatially representative set of samples. Therefore, pulps were used for ABA and XRD analysis. The second part included MWMP testing and required whole core. These core samples were available only from the ongoing drilling program. MWMP tests were accompanied by ABA, XRD, and ICP/MS testing to allow correlating results to the tests conducted on the pulp materials. Each rock type was represented in MWMP testing.

Phase 2 testing included HCTs on selected, representative samples of ore, development rock, and tailings. HCT samples were split and analyzed for detailed mineralogy, chemistry, and ABA. In addition, systematic testing was initiated of all reverse-circulation, exploration drill cuttings at 15-ft intervals. These ABA analyses allowed complete and systematic coverage of the entire ore body and related development rock.

Confirmatory sampling and analysis was conducted to define and quantify the various types of neutralizing potential and to provide additional information on the north portion of the Rock Creek deposit. A total of 104 representative samples were selected from five different rock types including CQMS, CS, GQMS, QGS, and QMS. The standard Sobek, siderite-corrected, and total inorganic carbon analytical methods were used for the determination and comparison of (NP) values.

Bulk rock elemental chemistry indicate few elements that are elevated relative to average igneous rocks. These include gold, arsenic, molybdenum, lead, sulfur, antimony, and zinc. Of these, arsenic, antimony, and molybdenum are indicated at elemental concentrations which could, if mobilized in the environment, pose an environmental risk. This is corroborated by the MWMP results, which indicate elevated arsenic and antimony in the ore samples and one development rock sample of quartz graphite schist (QGS). Based on current estimates of the distribution of lithologies among mined rocks, leachable arsenic and antimony occurrence is limited to only 7% of the potential development rock material, while arsenic and antimony are more widely distributed and mobile (at least in the short-term conditions tested by MWMP) in the ore. Given the apparently small percentage of the QGS material compared to the total development rock mass, it would be possible to engineer or otherwise manage the development rock handling to limit the long-term risk of impacts from the QGS material.

Based on Phase 1, Phase 2 and confirmatory testing, average ABA data for both ore and development rock samples indicate overall non acid-generating material. ABA test results indicate that less than 3% of samples are in the "potentially acid generating" category according to industry guidelines (using the AP:NP ratio based on sulfide-sulfur AP and standard Sobek NP). Depending on the method of interpretation, development rock and ore will be either "non-acid generating" or "uncertain." The variations in ABA results using the three alternate methods for determining NP (confirmatory testing) are relatively insignificant and within the range of analytical error. The overall interpretation of acid generation/neutralization capacity of the samples data does not differ significantly based on the different methodologies. The ABA results suggest that the development rock and ore material will not pose a risk of acid generation in the short- or long-term. The few samples categorized in the uncertain range, could potentially generate acid in the long-term, however the effects would be dispersed and would be mitigated by the other, non acid-generating/net neutralizing tonnage of rock material. This is supported by the block and geologic models of the site indicating PAG materials are well dispersed in and around the ore body.

These interpretations are supported by XRD analyses which confirm the presence of alkaline phases, predominantly in the form of dolomite and calcite. HCT results for all samples indicate strongly neutralizing conditions both during the test and from long-term depletion calculations. All samples, including the ore composite and tailings, are generating alkaline leachate with circumneutral pH and no measurable acidity. This indicates that acid rock drainage from development rock and pit walls is not a short- or long-term issue at Rock Creek. Metals concentrations vary depending on the material, including rock types that generate moderate to very low and nondetectable concentrations of key metals, including arsenic. This is expected because natural arsenic concentrations in groundwater and surface water in the area are generally elevated.

Development rock at the Rock Creek project will be placed using run-of-mine blending, such that material excavated from the deposit that does not go to the mill will be deposited in designated development rock facilities. The Rock Creek development rock, from a geochemical standpoint, is ideal for this stockpiling technique because of the following aspects:

- The deposit is relatively homogenous in terms of ABA and metals content. There are few, if any, well-defined blocks of unique, acid-generating material such that they could be feasibly segregated or handled differently.
- The ABA data indicate a preponderance of NP compared to AP in all lithologies in all areas of the deposit.
- The few acid-generating samples are of mixed lithology and location in the deposit such that no single lithology or area of the deposit will be acid generating, thereby eliminating the possibility of "hot spots" in the development rock facilities.
- There is no indication, from any of the test work to-date, of any short- or long-term acid generation developing from the Rock Creek development rock.

Big Hurrah Mine

Geochemical testing for Big Hurrah was conducted in a single phase, as sample material became available from the 2004 and 2005 drilling programs. Testing included systematic sample collection of 332 samples from all 2005 reverse circulation exploration drilling, on 15-ft (4.57 m) composite intervals from 30 boreholes, ranging from 0 to 240 ft (0 to 73 m) deep. The two major lithologies being tested were QGS and QMS. Together these two rock types comprise 89% of the rock collected and the majority of the development rock and ore. Five other lithologies were identified, none of which comprised more than 5% of the rock collected. Confirmatory testing was also performed on samples from Big Hurrah to evaluate the source of neutralizing potential present in the development rock and ore.

ABA and pH testing were conducted on all 332 of the samples collected. ICP/MS testing was conducted on all lithologic types of rock. Additional geochemical testing, including leach testing by meteoric water mobility procedure (MWMP), mineralogy by XRD, detailed mineralogy and humidity cell testing (HCT), was conducted on one sample of QGS 32- to 39-ft (10- to 12-m) development rock, one sample of QMS 13- to 20-ft (4- to 6-m) rock, and one sample of QGS 52- to 59-ft (16- to 18-m) rock. This sampling regime is based on the general distribution of lithologies within the project area.

Bulk rock elemental chemistry at Big Hurrah, indicates several elements that are elevated relative to average igneous rocks. These include gold, silver, arsenic, molybdenum, cadmium, sulfur, antimony, and zinc. Of these, antimony and arsenic are indicated at elemental concentrations which could, if mobilized in the environment, pose an environmental risk. On the basis of MWMP leach testing, only arsenic and antimony are indicated at elevated concentrations in first flush of the materials. Ongoing kinetic testing will provide time-based weathering rate estimates of these constituents, which can then be used to estimate long-term potential for impacts and how to mitigate these impacts. ABA test results indicate that 55 samples (17 percent) out of the 332 samples tested are “potentially acid-generating” according to industry guidelines (using the AP:NP ratio based on sulfide-sulfur AP and standard Sobek NP). Ore is interpreted as more acid neutralizing than the development rock with a geometric mean NP:AP ratio of 6.1, compared to 2.8 for development rock.

Thirty-four additional samples were analyzed using standard and alternate methods for determining NP. The standard Sobek method predicts the highest value of NP in the samples followed by the siderite-corrected Sobek method (15 % lower), and total inorganic carbon determination (24 % lower). The lower siderite-corrected values are qualitatively confirmed by the reported presence of iron carbonate minerals observed during mineralogical analysis.

HCT samples include development rock representing QGS lithology (2 samples) and GMS lithology (1 sample). These lithologies were selected because they comprise the vast majority of the development rock that will be generated at Big Hurrah. The two samples of QGS represent different acid-base characteristics based on ABA testing so that the range of QGS is represented in the HCTs. The GMS is representative of average ABA characteristics of the GMS material. All three samples are currently generating alkaline leachate with circumneutral pH and no measurable acidity. Short and medium term kinetic test data indicate materials at the Big Hurrah site will not generate acid.

Based on the Rock Creek materials, and in comparing the Rock Creek and Big Hurrah bulk rock ICP/MS chemistry data, it is probable that metals availability will be significantly (one order of magnitude) lower at the Big Hurrah site. While a direct correlation between metals concentration and mobility cannot be made, the much lower metals concentrations at Big Hurrah will likely result in lower aqueous (i.e., mobile) concentration of these metals in site runoff. These preliminary conclusions are verified by MWMP results. Therefore, while the kinetic and mineralogy testing for Big Hurrah is as yet incomplete, currently available data for Big Hurrah rock and the extensive data for Rock Creek rock provide strong assurance that metals mobility will not cause runoff in excess of water quality standards at Big Hurrah. This assumption will be verified by kinetic testing and mineralogy testing currently underway.

For the purpose of development rock management, the percentage of potentially acid generating (PAG) development rock has been estimated based on a site-specific NP:AP ratio for the Big Hurrah materials. The quantity of PAG will be determined by operational sampling. For the purpose of closure design, a value of 51 % was used, which represents the amount of development rock that is represented by samples that plot below the site-specific NP:AP ratio of 1.9 (based on sulfide-sulfur AP and siderite-corrected NP). PAG material with a NP:AP ratio of a 1.0 or less will be stockpiled in the development rock stockpile during mining, and then backfilled into the open pit at closure. Additional geochemical testing, will be designed and approved by ADEC and ADNR to refine the estimates of PAG at various NPR ratios. The NPR ratio used for determining backfill PAG material will be refined and raised to a ratio that optimizes the storage capacity within the pit. All remaining PAG material with a NP:AP ratio above the final cutoff ratio will be blended with the NAG material in the development rock storage area and have net NAG composition. Upon completion of mining, the segregated PAG material will be placed into the open pit where it will be inundated with water, reducing exposure and mineral oxidation.

7.3.3 Seismic Hazard

7.3.3.1 Affected Environment

Alaska is the most seismically active state in the United States and spans 3,000 miles (4,800 km) of the boundary between the Pacific and North American plates. Historical records indicate that earthquakes in Alaska center principally in two seismic zones. The most important is the Aleutian Island Arc which extends 2,500 miles (4,000 kilometers), from Fairbanks through the Kenai Peninsula to the Near Islands. The second principal seismic zone begins in southeastern Alaska and extends down the west coast of North America to Vancouver Island. The project sites are located on the Seward Peninsula which lies well outside either of these two zones.

Within a 125-mile (200-km) radius area of the project sites, 90 earthquakes were identified in the U.S. Geological Survey (USGS) worldwide earthquake database search for the period between 1907 and 2004. These earthquakes had magnitudes ranging from 2.6 to 6.5 and were located at distances ranging from 9 to 120 miles (15 to 194 km) from the Rock Creek site. Regional seismicity monitoring of the Seward Peninsula from 1977 to 1982 indicates seismic activity in the 2 to 5 magnitude range and appears widespread throughout the peninsula and

adjacent offshore regions. The broad distribution suggests the seismic deformations are distributed over a number of faults and not concentrated on one or two major faults. The principal mapped faults on the Seward Peninsula are the Bedeleben and Kigluaik faults, located about 50 miles (80 km) northwest of Nome. Seismic activity is also concentrated along the eastern end of the late Cenozoic faults west of Teller. Additional information on seismic risk is attached in the Geology section of the appendices under the title Rock Creek project Seismic Hazard Report.

Rock Creek

Three main faults are located around the Rock Creek Mine/Mill Complex site. The North Albion Creek Fault is to the northeast, Sophie Gulch and lower Sophie Gulch faults are located to the south, and the Brynteson Fault is located southwest of the project site.

Big Hurrah

There are three common sets of faults in the vicinity of Big Hurrah. A member of the oldest set is the northeast-striking Huff Creek Fault located east of the proposed development rock dump. Of intermediate age are a set of northwest-striking faults that host mineralization at Big Hurrah. The strike limits of known mineralization at Big Hurrah are defined by the most recent set of north-striking faults. The western limit of known mineralization is defined by the West Hill Fault, which is located along the west margin of the pit. The eastern limit of known mineralization is defined by the Hurrah Fault located along the eastern edge of the pit.

Faults generally have more seismic activity near them. When there are numerous faults in an area, the seismic energy is dissipated and the overall severity of seismic events within the region is reduced. Because there are numerous faults throughout the peninsula, and several faults in the area surrounding the project site, the seismic risk in the area is limited in extent and frequency. Additionally, the faults located at the project sites have not been identified as being seismically active and are not identified in the seismic hazard assessment performed for the sites.

7.3.3.2 Consequences

Strong ground shaking from an earthquake in the vicinity of the project area could result in minor to moderate damage to the mine facilities, depending on magnitude, duration, and predominate period. A seismic event with a 475-year return period is considered appropriate for design of a facility with a 6- to 9-year operational life. This event has a 10% probability of exceedance in 50 years and a 2% probability in 9 years. For the TSF and the waste rock dump sites, a post-closure life of 200 years is assumed. Valera Geoconsultant (2005) recommends designing the TFS for post-closure of 2,500 years and a probability of exceedance of 8%. The acceptable level of seismic risk for designing major structures is typically prescribed by the regulatory agencies or is the responsibility of the owner. Acceptable levels of risk are based on the consequences of ground failure or damage to the facility. Valera Geoconsultant (2005) concluded the level of risk considered in their study is reasonably conservative. Rock Creek project engineers have incorporated these guidelines into all construction design.

7.4 SOILS

7.4.1 Affected Environment

The Seward Peninsula is underlain by bedrock belonging to the Nome Group. The parent rock of this group consists of shales, siltstones, marls, and limestone deposited in a shallow water continental shelf setting. Carbonaceous schist, calc schist, and mixed schist are closest to the surface, with carbonaceous schist present in the stream valley with mixed schist to the east and calc schist generally to the west (Krzewinkski, et al., 2005, in Valera Geoconsultants, 2005).

7.4.1.1 Topsoil

The Nome soils are a combination of two types of Histic Pergelic Cryaquepts with loamy or gravelly textures. The soils are poorly drained with a shallow permafrost table (5 to 30 inches [13 to 76 cm]). The soils formed in moderately deep loamy sediment are underlain by very gravelly and stony material. The soils are formed in alluvial material and support tundra vegetation (USDA, SCS, 1979). The Exploratory Soil Survey of Alaska (1979) indicates the Rock Creek Mine/Mill Complex site as being in the highland area of the Seward Peninsula.

Topsoil depth at the Rock Creek site was measured at each of the 26 wetland survey soil pit test sites. The sites were not distributed in a random manner, but were primarily sited to analyze wetlands, with occasional test pits to characterize upland sites. Thus, there are 17 wetland sites and nine upland sites. The distribution of wetlands and uplands at the site is approximately 50/50. Topsoil depth throughout the Rock Creek site ranged from 0.5 to 14 inches (1.3 to 36 cm). Of the 17 wetland sites, depths ranged from 0.5 to 14.0 inches (1.3 to 36 cm) with a mean value of 5.9 inches (15 cm). Of the nine upland sites, the depth ranged from 1 to 6 inches (2.5 to 15 cm) with a mean value of 3.5 inches (8.9 cm). A map of measured topsoil depths is attached in the Geology Section of the appendices under Rock Creek Topsoil Map.

Topsoil depth observations were not taken during the Big Hurrah wetlands survey. Estimates of topsoil depth were made based on the records of soil horizons, depth of organic matter, and root zone, as well as through observation of the photographs of the soil test pits. Topsoil depth at the Big Hurrah ranged from 2 to 5 inches (5 to 13 cm), with a mean value of 3.3 inches (8.4 cm). The complete wetlands analyses are attached in the Biological Resources section of the appendices under Preliminary Jurisdictional Determination Various Wetlands Adjacent to Rock Creek, and Preliminary Jurisdictional Determination Little Hurrah Creek and Big Hurrah Creek.

7.4.1.2 Permafrost

The Rock Creek and Big Hurrah sites are located near a regional boundary between continuous and discontinuous permafrost, with permafrost depths approaching approximately 330 feet (100 m) in the Nome area. The surface zone of the permafrost horizon termed the "active layer" repeatedly thaws and freezes on an annual basis as the seasonal air temperatures changes. This zone could be about 6.5 to 10 feet (2 to 3 meters) at the Rock Creek site (Valera Geoconsultant, 2005).

The extent of permafrost at the Rock Creek and Big Hurrah sites was estimated using visual observation from test pits and soil temperatures taken at test pits. Readings from eight thermistors installed at the Rock Creek site also added to the database. Additional inferences of surrounding areas were made based on similarities in vegetation and landform.

Six of the thermistors were placed near the TSF and Mill areas at the Rock Creek site. The remaining two thermistors were installed in the vicinity of the open pit. Data indicating the depth of the active layer were available from four of the sites and indicated an active layer that ranged from 3 to 38 feet (1 to 12 m), with a mean value of 19 feet (6 m). Thermistors have not been installed at the Big Hurrah site, but preliminary soil temperature data indicate that discontinuous permafrost does exist at the site.

Field investigations and laboratory testing of samples collected for engineering purposes for the various facilities at the proposed Rock Creek Mine/Mill Complex site provide the following additional soils data.

> Plant Site – A total of three borings were drilled and 19 test pits excavated. Subsurface conditions were found to be fairly consistent across the plant site. Highly weathered bedrock was encountered at depths ranging from 2 to 10.5 feet (0.6 to 3.2 m) below the existing ground surface. The highly weathered bedrock is generally greater than 5 feet (1.5 m) thick. Permafrost was encountered in all three borings drilled at depths of 2.5 feet to 3 feet (0.8 to 1.0 m) and in 11 of the 19 test pits at depths ranging from 1.5 feet to 3 feet (0.5 to 1.0 m)(Valera Geoconsultant, 2005).
>
> TSF – A total of seven borings were drilled and 34 test pits excavated in and around the TSF area. Slightly to highly weathered bedrock was encountered at depths ranging from about 2 feet to 19 feet (0.6 to 6 m) below the existing ground surface. Permafrost was encountered in four of the test pits at depths ranging from 2.8 feet to 5 feet (0.9 to 1.5 m) and in five of the borings at depths ranging from 0 foot to 7.2 feet (0 to 1.2 m). In some of the borings, the base of the permafrost was not reached (Valera Geoconsultant, 2005).
>
> Development Rock Dumps – A total of three borings were drilled and 27 test pits excavated. Frozen soils were encountered in approximately half of the north dump area at depths ranging from 1.2 feet to 4 feet (0.4 to 1.2 m). Highly weathered bedrock was present at depths from 4.5 feet to more than 18 feet (1.4 to 5.5 m) in the north dump. Soil conditions found in the south dump indicate weathered bedrock exists at depths between 1.6 feet and 6.5 feet (0.5 to 2.0 m). No test pits in the south dump detected permafrost, but visual observations of the topography and vegetation indicate permafrost may exist near the upper limits of the area (Valera Geoconsultant, 2005).

There are significant areas of thawed ground covering about 53% of the property.

Field investigations and laboratory testing of samples collected for engineering purposes for the various facilities at the proposed Big Hurrah site provide the following information about soils conditions:

A review of the test pit logs indicates that, except in areas that have been disturbed by historic and current exploration activities, a vegetative tundra mat underlain by a thin layer of silt exists across much of the site, similar to conditions at the Rock Creek site. Below this thin layer of silt, silty gravel or silty sand materials generally exist until the weathered bedrock is encountered. This weathered bedrock material consists of coarse gravel materials, with varying amounts of silt and sand, that increase in density and structure with depth. The depth to bedrock in the undisturbed areas varies between 1.6 to 4.0 feet (0.5 to 1.2 m).

The areas previously disturbed are concentrated around the proposed pit, haul roads, shop locations, and the natural creek channels. The development rock dump area is mostly undisturbed. In areas outside of the natural creek channels that have been disturbed, the weathered and competent bedrock has been exposed. The disturbance activity near the natural creek channels consisted of placer mining, leaving the bedrock layer intact and covered with a sand/gravel matrix. The depth to bedrock in these areas varied from 3.3 to 6.6 feet (1 to 2 m). In addition to the exposed bedrock in the disturbed areas, there exist naturally exposed bedrock and talus slopes at the site. These areas are either within the proposed open pit limits or higher on the slopes than was investigated and above the locations of proposed facilities.

Permafrost at the site is discontinuous and identified in only four of the 15 test pits performed by Smith Williams Consultants. The historic investigations did not identify permafrost, but indicate it may be present at the site. The permafrost identified was found at depths ranging from 3.0 to 6.6 feet (0.9 m to 2 m) below the surface (Valera Geoconsultant, 2005).

7.4.2 Consequences

The minimal amount of topsoil and organic material in the area makes stockpiling of topsoil infeasible; however, the project has committed in their reclamation plan to stockpile when feasible and to the extent practicable. Revegetation on minimal organic matter occurs in similar areas where local plant species adapt to the minimal organic material present in these soils.

7.5 HYDROLOGY AND WATER QUALITY

7.5.1 Affected Hydrology

7.5.1.1 Surrounding Water Bodies

Rock Creek

The project site is located in the Snake River Valley, which has a catchment area of 85 square miles (220 square kilometers). The Snake River is located approximately 2.5 miles (4 km) west of the project site. The river's headwaters are in the Kigluaik Mountains to the north/northwest of the project and the river empties into Norton Sound at the Nome port site approximately 11 miles (18 km) south from the Rock Creek confluence.

Three other streams are located in the project area; they are all tributaries that flow westward into the Snake River. Lindblom Creek is to the north, Rock Creek splits the mine site almost

in half, and Glacier Creek is located south of the project site. Lindblom Creek has a smaller catchment than Rock Creek, while Glacier Creek is larger, encompassing the entire east and south side of Mount Brynteson. A few smaller unnamed and seasonal streams also flow throughout the project site. These streams do not transport significant amounts of water. All the small streams travel in a westerly direction and empty into any of the three larger streams previously indicated. No major hot springs are located in the Snake River watershed; however, small springs and seeps are located at the headwaters of Rock Creek and may flow at other locations through the area.

Rock Creek catchment has an elevation gain of 1,300 feet (400 m) from the valley floor, which lies at 100 feet (30 m). The north-south-trending foothills in which the catchment lies have elevations that range up to 2,000 feet (600 m). The catchment area for Rock Creek is approximately 2 square miles (5.2 square km). Glacial, alluvial, and tectonic processes shaped the eastern wall of the Snake River Valley, upon which this catchment lies. The hydrogeology of the Rock Creek Basin is controlled by the surficial and bedrock geology, the topographic setting, as well as the climate and hydrology. Steep cliffs of local bedrock dominate the higher elevations on site. The surface topography quickly shallows over the 2.5 mile (4 km) creekpath which ends in the alluvial plain of the Snake River.

Big Hurrah

The project site is located in the Big Hurrah Creek Valley. Big Hurrah Creek flows about 2.5 miles (4 km) into the Solomon River, which in turn flows into Norton Sound just east of Safety Sound.

The mine site is centered around Little Hurrah Creek, a small stream that flows northerly into Big Hurrah Creek. There is a small unnamed intermittent stream just to the east of Little Hurrah Creek, and Linda Vista Creek runs to the west of Little Hurrah Creek. Both streams flow northerly into Big Hurrah Creek.

7.5.2 Surface Water

7.5.2.1 Rock Creek

Surface water samples were collected at 7 primary stations around the Rock Creek Mine/Mill Complex site. Samples were collected beginning on September 10, 2002, for a single event, then on a weekly basis from July 30, 2003, to December 6, 2004, and on a monthly basis thereafter. While monthly monitoring is ongoing at the site, the data set for this assessment is concluded at May 16, 2005. The total number of samples per site ranges from 48 to 78, with the variation caused by site accessibility, particularly during winter and spring breakup, and the addition of sites midway through the program. All sites, other than RCK1 and RCK2, have more than 60 samples. RCK1 and RCK2 were added midway through the program to provide additional upstream and downstream (respectively) Rock Creek data to augment the data set being collected mid-stream at the Rock Creek, above the road, site.

Sites are representative of local surface waters draining this mineralized zone. Rock Creek joins the Snake River downstream of the proposed project area. A Surface Water Sampling Stations Map is provided as Figure 7.1. Red flags indicate continuous monitoring sites, as

well as water quality monitoring sites, and blue flags indicate water-quality monitoring sites without continuous monitors. Rock Creek dissects the mineral deposit proposed for development. Lindblom Creek and Glacier Creek drain the lands adjacent to the proposed project. Following are the designated sampling locations:

- SABC = Snake River above Balto Creek
- LIND = Lindblom Creek
- ROCK = Rock Creek above the road
- RCK1 - Rock Creek above the road
- RCK2 = Rock Creek below road
- SRBG = Snake River below Glacier Creek
- GLAC = Glacier Creek

Analyses included the following: total and dissolved metals, TDS, and total settleable solids (TSS), alkalinity, anions (chloride, fluoride, sulfate, nitrate, nitrite), mercury, cyanide, ammonia, and total phosphorous. Flow data were also collected and snow surveys conducted.

Surface water quality at the site is summarized in Tables 7-1 through 7-7 below.

Background water quality is below State Water Quality Standards for almost all parameters. The following parameters showed levels elevated above the State Water Quality Standards for drinking water and/or aquatic life:

Arsenic levels are naturally elevated above the State Drinking Water Quality Standard (to be in effect in 2007) of 10 µg/L on a year-round consistent basis at all three Rock Creek stations and in Lindblom Creek. Arsenic levels in Glacier Creek were usually below the State Drinking Water Standard, with the exception of 11 consecutive samples between February 10, 2004, and March 19, 2004. There were only two occasions when arsenic levels in the Snake River exceeded the drinking water standard, and this only occurred downstream of the site. Arsenic levels in Rock Creek and Lindblom Creek did not vary substantially in relation to the seasons, whereas the Glacier Creek exceedences all occurred during the winter months when runoff was minimal and groundwater influence would have been at its height. Arsenic is naturally present in the geology of the area; in fact, a nearby mountain peak is named Arsenic Mountain. Arsenic concentrations in Rock Creek generally increase in relation to the location of the mineral deposit. RCK1 is located upstream of the mineral deposit while ROCK is located in the mineral deposit and RCK2 is located downstream of the mineral deposit. This indicates that exposure to the mineralized zone and/or groundwater emerging from the mineralized zone is influencing the arsenic levels in Rock Creek. The arsenic values in Rock Creek are graphed in relation to one another and presented in Figure 7.2.

Figure 7.1 Rock Creek Surface Water Sampling Stations

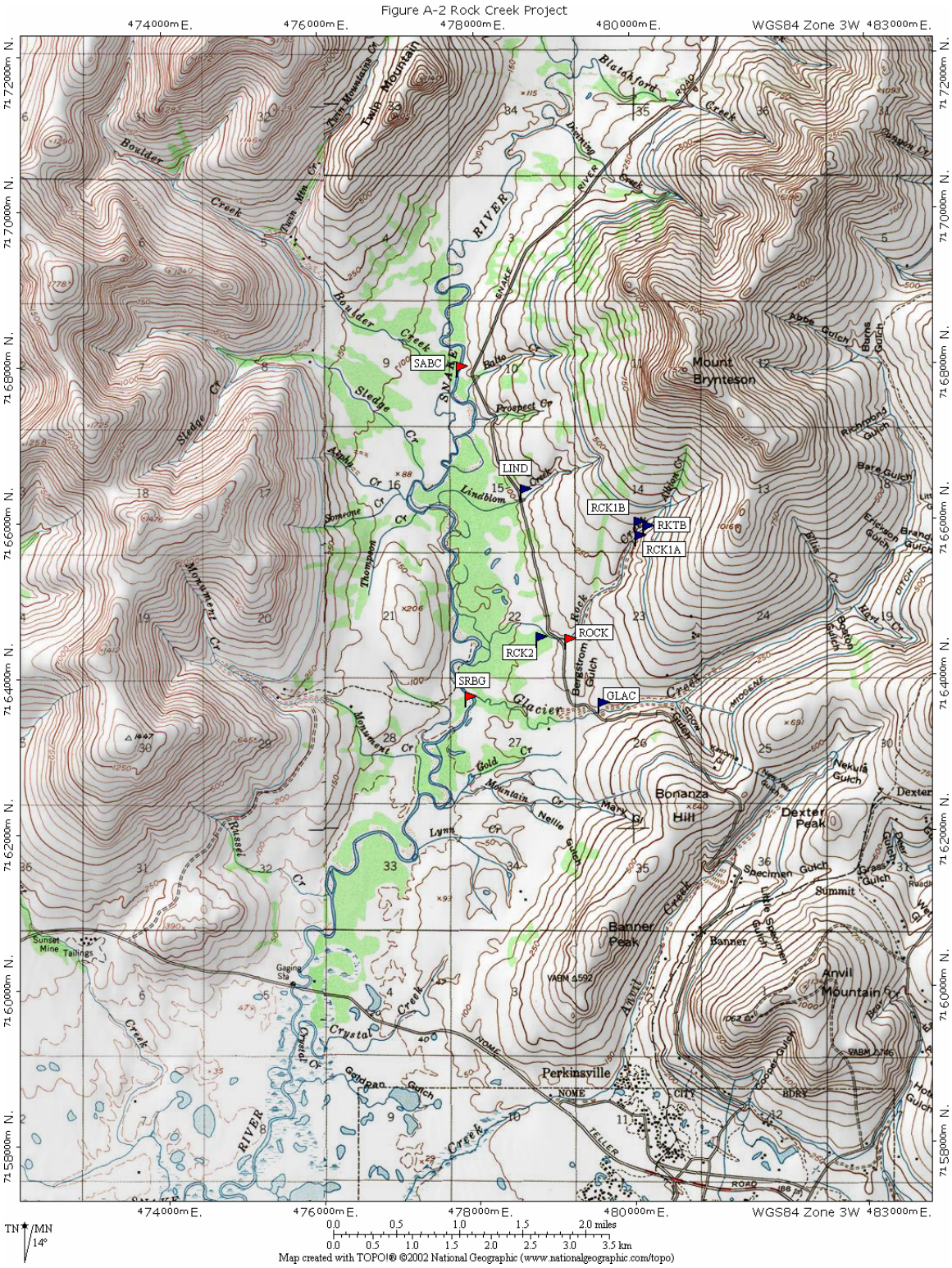
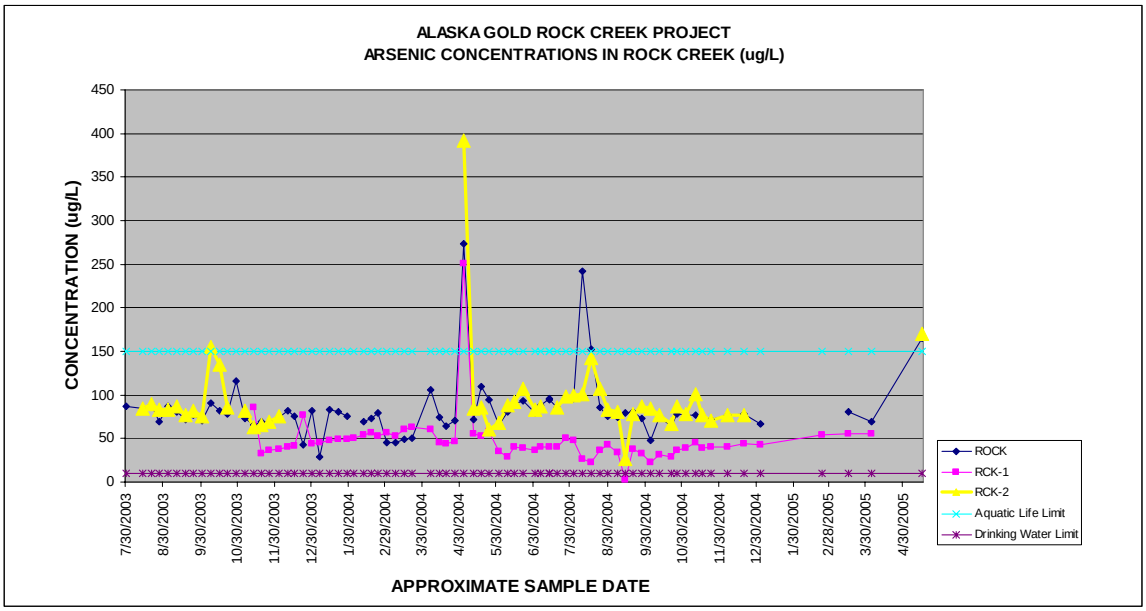


Figure 7.2 Arsenic Concentrations in Rock Creek



There were occasional incidents of other metals besides arsenic being naturally elevated above the state drinking water and/or aquatic life criterion. Elevated levels were primarily noted for aluminum, iron, lead, and a few exceedences of manganese, selenium, and antimony. There were occasional analytical results showing elevated levels of weak acid dissociable (WAD) cyanide; however, in all but one incident, the WAD levels were higher than the total CN levels, indicating analytical error or interference. All of the elevated metal levels occurred between SABC (upstream of the project site in the Snake River, with the majority occurring within Rock Creek, indicating the highly mineralized nature of this watershed.

Elevated metal levels also corresponded with TSS levels in excess of the upper 70th percentile (with only one exception). All samples showing elevated levels of the above mentioned metals were collected either in May, August, or October, all months subject to exceptionally high levels of rainfall. The relation to high TSS and high rainfall indicates that during extreme precipitation events, erosion and the resulting suspended sediment is likely the primary cause for elevated levels of metals other than arsenic. Additional information on water quality at Rock Creek is attached in the Hydrology section of the appendices under the title Rock Creek Surface Water Database and Graphs. Summary statistical graphs for all parameters sampled in the Rock Creek surface water sampling program is provided below in Tables 7-1 – 7-7.

Table 7-1 SABC Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.761	21.758	0.048	0.052	92.9	0.062
Standard Deviation	0.56	4.448	0.01	0.009	12.3	0.053
# of values	75	75	75	28	75	75
Lowest fifth percentile	1.975	14.62	0.032	0.05	71.7	0.05
Minimum	1.76	0.05	0.031	0.05	33	0.038
Maximum	4.03	27	0.1	0.1	106	0.465
# of values undetected	0	1	43	28	0	63
# of values between MDL and PQL	0	0	32	0	0	8
Chronic Aquatic Life Criteria (CALC)	230				>20	1.974
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0028	0.0028	0.536	129.3	1.385	115.21
Standard Deviation	0.002	0.0016	0.349	19.8	3.458	20.24
# of values	75	73	73	75	75	75
Lowest fifth percentile	0.0025	0.0025	0.05	92.6	0.2	85.46
Minimum	0.0025	0.0025	0.05	47.5	0.2	36.79
Maximum	0.02	0.016	1.8	164	23.5	218.52
# of values undetected	66	65	62	0	26	0
# of values between MDL and PQL	8	6	7	0	14	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	1	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-1 SABC Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	15.66	10.97	0.748	0.645	2.549	2.356
Standard Deviation	28.72	6.13	1.066	0.273	0.671	0.517
# of values	75	75	75	75	75	75
Lowest fifth percentile	8.891	10	0.403	0.399	1.637	1.584
Minimum	6.22	7.12	0.32	0.36	1.41	0.548
Maximum	229	60.2	9.74	2.48	5.19	3.96
# of values undetected	61	71	10	12	28	35
# of values between MDL and PQL	8	1	63	61	46	40
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	2	0	0	0	0	0
# of DWS Exceedences	0	0	1	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	8.669	8.392	0.202	0.2	0.177	0.157
Standard Deviation	1.905	1.583	0.024	0	0.135	0.1
# of values	75	75	75	75	75	75
Lowest fifth percentile	5.763	5.629	0.2	0.2	0.05	0.05
Minimum	4.63	3.11	0.146	0.2	0.05	0.05
Maximum	17.8	11.8	0.4	0.2	0.766	0.25
# of values undetected	0	0	74	75	68	74
# of values between MDL and PQL	0	0	1	0	2	0
Chronic Aquatic Life Criteria (CALC)					0.24	0.22
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	40	40
# of DWS Exceedences	0	0	0	0	0	0

Table 7-1 SABC Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	34.159	33.017	0.806	0.674	2.027	2
Standard Deviation	6.02	5.151	0.926	0.621	0.231	0
# of values	75	75	75	75	75	75
Lowest fifth percentile	25.36	24.22	0.411	0.45	2	2
Minimum	10.9	9.8	0.32	0.356	2	2
Maximum	63.9	45.3	5.23	4.21	4	2
# of values undetected	0	0	52	58	75	75
# of values between MDL and PQL	0	0	15	12	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.537	0.497	0.044	0.032	0.116	0.104
Standard Deviation	0.272	0.103	0.081	0.091	0.058	0.024
# of values	75	75	75	75	75	75
Lowest fifth percentile	0.353	0.335	0.015	0.017	0.099	0.1
Minimum	0.319	0.31	0.0126	0.0135	0.065	0.077
Maximum	2.63	1.23	0.492	0.806	0.413	0.287
# of values undetected	56	58	37	64	64	69
# of values between MDL and PQL	17	16	25	8	8	5
Chronic Aquatic Life Criteria (CALC)	8.16	7.83	1		2.60	2.12
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	2	0	0	0

Table 7-1 SABC Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	7.253	6.893	2.522	1.409	0.923	
Standard Deviation	1.322	1.089	3.672	0.774	0.873	
# of values	75	75	75	75	74	
Lowest fifth percentile	5.367	5.211	0.625	0.5	0.5	
Minimum	2.32	2.14	0.5	0.5	0.5	
Maximum	14.3	10.1	26.1	4.06	4.5	
# of values undetected	0	0	5	7	54	
# of values between MDL and PQL	0	0	15	18	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5.133	5.055	0.984	0.958	64.933	64.633
Standard Deviation	0.813	0.472	0.216	0.214	49.93	47.332
# of values	75	75	75	75	75	75
Lowest fifth percentile	5	5	0.679	0.663	15	12.87
Minimum	3.69	5	0.622	0.625	9.6	9.65
Maximum	10	9.09	2	1.69	250	250
# of values undetected	72	74	27	22	72	63
# of values between MDL and PQL	3	1	48	53	2	11
Chronic Aquatic Life Criteria (CALC)			45.67	45.53		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-1 SABC Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss	Silicon Total	
Mean	245.47	237.85	2.529	2.524	2017.5	
Standard Deviation	58.83	33.833	0.529	0.395	99.121	
# of values	75	75	75	75	4	
Lowest fifth percentile	190.4	192.4	2.5	2.5	1923.5	
Minimum	151	167	0.731	1	1910	
Maximum	611	361	5.55	5.09	2150	
# of values undetected	6	5	69	72	4	
# of values between MDL and PQL	69	70	4	2	0	
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	2	1	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.507	0.5	1887.6	1789.1	0.137	0.133
Standard Deviation	0.058	0	550.285	252.06	0.023	0.027
# of values	75	75	75	75	75	75
Lowest fifth percentile	0.5	0.5	1338	1300	0.1	0.095
Minimum	0.5	0.5	1070	1020	0.042	0.0387
Maximum	1	0.5	4760	2240	0.231	0.277
# of values undetected	74	75	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	3.10	2.63				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-1 SABC Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.512	0.533	10.033	9.9	2.539	2.746
Standard Deviation	0.111	0.157	1.453	0.866	1.402	3.948
# of values	75	75	75	75	75	75
Lowest fifth percentile	0.444	0.5	10	10	1	1
Minimum	0.15	0.15	2.5	2.5	1	1
Maximum	1.08	1.3	20	10	6.92	34.1
# of values undetected	65	66	75	75	55	49
# of values between MDL and PQL	8	6	0	0	7	15
Chronic Aquatic Life Criteria (CALC)					104.88	102.57
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.419	1.474	31.824	30.809		
Standard Deviation	0.98	1.161	10.37	9.964		
# of values	75	75	75	75		
Lowest fifth percentile	0.5	0.5	15.02	12.64		
Minimum	0.5	0.355	4.12	4.96		
Maximum	2.5	6.67	57.2	51.7		
# of values undetected	70	71	0	0		
# of values between MDL and PQL	4	2	1	2		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Notes:

#	=	number	ng/L	=	nanograms per liter
%	=	percent	ORP	=	oxygen reduction potential
°C	=	degrees Celsius	PQL	=	practical quantitation limit
µg/L	=	micrograms per liter	SABC	=	Snake River above Balto Creek
Diss	=	dissolved	TDS	=	total dissolved solids
MDL	=	method detection limit	TSS	=	total suspended solids
mg/L	=	milligrams per liter	WAD	=	weak acid dissociable

Table 7-1 SABC Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.73	38.4	7.6	208	212
Standard Deviation	2.03	5.9	0.52	38.7	64.7
# of values	67	49	48	47	34
Lowest fifth percentile	0	32.9	6.69	148	110
Minimum	0	32.6	6.22	70	72
Maximum	12.8	50.1	8.54	263	325
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	1	0	0
# of DWS Exceedences	0	0	3	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.93	1.24	103.4	0.031	6.1
Standard Deviation	1.49	0.53	20.8	0.027	2.3
# of values	42	43	41	2	26
Lowest fifth percentile	0.23	0.59	70	0.014	2
Minimum	0.12	0.28	35	0.0125	1.3
Maximum	6.6	3.00	131	0.05	9.5
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Table 7-2 LIND Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.762	21.269	0.051	0.052	125.7	0.053
Standard Deviation	0.746	5.643	0.017	0.01	28.9	0.012
# of values	67	67	67	24	67	67
Lowest fifth percentile	2.126	9.746	0.034	0.05	65.6	0.042
Minimum	2.03	5.87	0.031	0.05	41	0.032
Maximum	6.09	44.3	0.131	0.1	230	0.1
# of values undetected	0	0	11	24	0	57
# of values between MDL and PQL	0	0	55	0	0	10
Chronic Aquatic Life Criteria (CALC)	230				>20	1.990
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0029	0.0026	0.498	159.8	0.807	147.73
Standard Deviation	0.0017	0.0007	0.189	33.8	1.129	35.04
# of values	67	65	65	67	67	67
Lowest fifth percentile	0.0025	0.0025	0.05	94.2	0.2	75.12
Minimum	0.0025	0.0025	0.05	72.5	0.2	45.38
Maximum	0.015	0.008	1.02	286	4.9	269.19
# of values undetected	58	61	56	0	34	0
# of values between MDL and PQL	5	3	8	0	7	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	3	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-2 LIND Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	12.3	10.3	0.517	0.455	31.66	30.64
Standard Deviation	7.25	1.68	0.494	0.213	5.514	5.717
# of values	67	67	67	67	67	67
Lowest fifth percentile	10	10	0.316	0.319	20.25	20.31
Minimum	6.35	7.22	0.31	0.313	13.1	7.53
Maximum	43.1	20.7	4.2	1.96	48.7	43.7
# of values undetected	53	63	27	25	0	0
# of values between MDL and PQL	8	3	37	41	0	0
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	67	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	6.31	6.197	0.2	0.199	0.16	0.72
Standard Deviation	1.169	1.155	0.01	0.006	0.099	4.6
# of values	67	67	67	67	67	67
Lowest fifth percentile	4.203	4.193	0.2	0.2	0.05	0.05
Minimum	2.95	2.89	0.2	0.153	0.05	0.05
Maximum	10.2	10.8	0.27	0.2	0.25	37.8
# of values undetected	0	0	66	66	65	63
# of values between MDL and PQL	1	1	1	1	1	2
Chronic Aquatic Life Criteria (CALC)					0.22	0.20
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	36	35
# of DWS Exceedences	0	0	0	0	0	0

Table 7-2 LIND Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	44.39	42.32	0.872	0.908	2	2
Standard Deviation	10.46	10.34	1.066	1.072	0	0
# of values	67	67	67	67	67	67
Lowest fifth percentile	22.81	18.12	0.5	0.5	2	2
Minimum	13.6	12	0.311	0.404	2	2
Maximum	79.4	78.1	7.3	7.83	2	2
# of values undetected	0	0	47	45	67	67
# of values between MDL and PQL	0	0	11	10	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.528	0.56	0.029	0.021	0.11	0.109
Standard Deviation	0.192	0.4	0.034	0.011	0.04	0.048
# of values	67	67	67	67	67	67
Lowest fifth percentile	0.348	0.35	0.02	0.02	0.1	0.1
Minimum	0.319	0.32	0.013	0.018	0.07	0.083
Maximum	1.72	2.81	0.268	0.112	0.29	0.466
# of values undetected	31	34	51	64	55	60
# of values between MDL and PQL	34	31	7	2	8	6
Chronic Aquatic Life Criteria (CALC)	7.31	7.01	1		2.21	1.84
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-2 LIND Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	8.94	8.56	2.312	1.402	1.426	
Standard Deviation	2.204	2.164	6.045	5.502	1.537	
# of values	67	67	67	67	66	
Lowest fifth percentile	4.403	4.127	0.484	0.448	0.5	
Minimum	2.66	2.52	0.327	0.4	0.5	
Maximum	17.2	17.2	44.5	43.5	10.7	
# of values undetected	0	0	35	53	29	
# of values between MDL and PQL	0	0	13	12	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5.046	5.056	1.193	1.139	64.77	64.18
Standard Deviation	0.264	0.477	0.376	0.317	47.7	47.81
# of values	67	67	67	67	67	67
Lowest fifth percentile	5	5	0.864	0.795	15	12.13
Minimum	5	4.4	0.755	0.663	15	9.52
Maximum	6.69	8.66	2.9	2.3	250	250
# of values undetected	65	63	15	15	64	57
# of values between MDL and PQL	2	4	49	50	2	9
Chronic Aquatic Life Criteria (CALC)			40.95	40.83		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-2 LIND Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss	Silicon Total	
Mean	280.1	276	2.484	2.468	2710	
Standard Deviation	95.87	100.3	0.289	0.224	161.5	
# of values	67	67	67	66	4	
Lowest fifth percentile	194.7	196	2.5	2.463	2551	
Minimum	155	167	1	1	2530	
Maximum	663	737	4.1	3.1	2920	
# of values undetected	4	3	64	61	4	
# of values between MDL and PQL	59	60	3	6	0	
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	2192.39	2179	0.124	0.12
Standard Deviation	0	0	370.189	407.3	0.028	0.028
# of values	67	67	67	67	67	67
Lowest fifth percentile	0.5	0.5	1756	1590	0.067	0.062
Minimum	0.5	0.5	1320	1260	0.038	0.04
Maximum	0.5	0.5	3950	4420	0.218	0.221
# of values undetected	67	67	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.48	2.11				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-2 LIND Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.574	0.505	9.888	9.888	3.336	2.825
Standard Deviation	0.426	0.088	0.916	0.916	4.383	1.936
# of values	67	67	67	67	67	67
Lowest fifth percentile	0.5	0.5	10	10	1	1
Minimum	0.15	0.15	2.5	2.5	1	1
Maximum	3.74	1.07	10	10	25.3	12.1
# of values undetected	59	60	67	67	45	37
# of values between MDL and PQL	6	6	0	0	11	15
Chronic Aquatic Life Criteria (CALC)					94.03	91.96
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	1	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.462	1.484	42.19	41.05		
Standard Deviation	1.213	1.272	16.69	16.62		
# of values	67	67	67	67		
Lowest fifth percentile	0.5	0.5	13.12	14.36		
Minimum	0.5	0.317	3.13	11.5		
Maximum	7.17	7.53	79.3	91.3		
# of values undetected	64	62	0	0		
# of values between MDL and PQL	2	4	1	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°C	=	degrees Celsius	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
LIND	=	Lindblom Creek	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-2 LIND Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.574	0.505	9.888	9.888	3.336	2.825
Standard Deviation	0.426	0.088	0.916	0.916	4.383	1.936
# of values	67	67	67	67	67	67
Lowest fifth percentile	0.5	0.5	10	10	1	1
Minimum	0.15	0.15	2.5	2.5	1	1
Maximum	3.74	1.07	10	10	25.3	12.1
# of values undetected	59	60	67	67	45	37
# of values between MDL and PQL	6	6	0	0	11	15
Chronic Aquatic Life Criteria (CALC)					94.03	91.96
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	1	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.462	1.484	42.19	41.05		
Standard Deviation	1.213	1.272	16.69	16.62		
# of values	67	67	67	67		
Lowest fifth percentile	0.5	0.5	13.12	14.36		
Minimum	0.5	0.317	3.13	11.5		
Maximum	7.17	7.53	79.3	91.3		
# of values undetected	64	62	0	0		
# of values between MDL and PQL	2	4	1	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-2 LIND Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.3	38.9	7.76	260	217
Standard Deviation	0.69	6.53	0.78	68.3	71.5
# of values	62	43	42	41	29
Lowest fifth percentile	0	32.71	6.71	103	93
Minimum	0	32.5	5.92	91	87
Maximum	3.61	54.8	10.66	384	325
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	7	0	0
# of DWS Exceedences	0	0	7	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	0.85	0.41	127	0.01	5.78
Standard Deviation	0.72	0.19	33.3	0.01	2.47
# of values	34	37	37	2	22
Lowest fifth percentile	0.07	0.19	51.6	0	1.67
Minimum	0	0.16	45	0	1
Maximum	3.41	0.95	181	0.0125	9.8
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
LIND	=	Lindblom Creek	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-3 ROCK Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.735	33.137	0.048	0.052	119.3	0.053
Standard Deviation	0.595	10.155	0.013	0.01	25.9	0.015
# of values	75	75	75	27	75	75
Lowest fifth percentile	2.1	13.15	0.034	0.05	59.6	0.049
Minimum	0.967	6.8	0.031	0.05	31	0.031
Maximum	4.92	54.5	0.1	0.1	160	0.158
# of values undetected	0	0	18	27	0	63
# of values between MDL and PQL	0	0	57	0	0	11
Chronic Aquatic Life Criteria (CALC)	230				>20	1.952
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.003	0.0026	0.505	170.7	7.301	153.09
Standard Deviation	8E-04	0.0006	0.303	39.6	22.936	35.02
# of values	75	73	73	75	75	75
Lowest fifth percentile	0.003	0.0025	0.05	83.1	0.2	78.84
Minimum	0.003	0.0025	0.05	48.8	0.2	36.33
Maximum	0.008	0.007	2.33	245	166	206.76
# of values undetected	67	68	64	0	8	0
# of values between MDL and PQL	6	4	6	0	14	0
Chronic Aquatic Life Criteria (CALC)	0.005					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	2	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-3 ROCK Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	109	10.7	0.865	0.781	83.67	70.23
Standard Deviation	402	4.55	0.322	0.221	35.12	13.76
# of values	75	75	75	75	75	75
Lowest fifth percentile	6.77	6.82	0.5	0.5	47.05	43.62
Minimum	6.23	6.32	0.479	0.337	28.6	34.8
Maximum	3090	40.1	2.08	1.35	273	106
# of values undetected	34	57	9	11	0	0
# of values between MDL and PQL	26	15	48	53	0	0
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	8	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	75	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	5.589	4.125	0.2	0.2	0.152	0.15
Standard Deviation	5.061	0.847	0.02	0	0.106	0.1
# of values	75	75	75	75	75	75
Lowest fifth percentile	3.456	2.357	0.2	0.2	0.05	0.05
Minimum	2.28	0.959	0.2	0.2	0.05	0.05
Maximum	38.3	5.68	0.4	0.2	0.5	0.25
# of values undetected	0	1	74	75	69	73
# of values between MDL and PQL	2	5	1	0	5	2
Chronic Aquatic Life Criteria (CALC)					0.23	0.21
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	36	38
# of DWS Exceedences	0	0	0	0	0	0

Table 7-3 ROCK Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	44.34	42.82	1.105	1.015	2.016	2
Standard Deviation	9.74	9.502	1.205	1.338	0.25	0
# of values	75	75	75	75	75	75
Lowest fifth percentile	22.58	20.93	0.5	0.5	2	2
Minimum	10.8	9.62	0.422	0.371	1.2	2
Maximum	58.4	57.4	6.15	7.77	4	2
# of values undetected	0	0	50	50	74	75
# of values between MDL and PQL	0	0	6	8	1	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.753	0.52	0.249	0.023	0.34	0.105
Standard Deviation	0.783	0.2	0.837	0.012	0.7	0.041
# of values	75	75	75	75	75	75
Lowest fifth percentile	0.342	0.33	0.017	0.02	0.09	0.1
Minimum	0.326	0.31	0.012	0.013	0.07	0.072
Maximum	5.36	1.91	5.07	0.087	4.16	0.453
# of values undetected	21	35	32	67	45	71
# of values between MDL and PQL	45	39	22	2	15	3
Chronic Aquatic Life Criteria (CALC)	7.61	7.31	1		2.35	1.94
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	4	0	3	0
# of DWS Exceedences	0	0	8	0	0	0

Table 7-3 ROCK Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	10.28	9.852	7.32	2.293	1.834	
Standard Deviation	2.696	2.647	13.09	2.533	2.007	
# of values	75	75	75	75	74	
Lowest fifth percentile	5.238	4.562	0.5	0.446	0.5	
Minimum	2.27	2.06	0.318	0.35	0.5	
Maximum	16	15.6	87	14.9	12.4	
# of values undetected	0	0	4	9	23	
# of values between MDL and PQL	0	0	6	17	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	2	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5.017	5.011	1.492	1.223	64.98	63.96
Standard Deviation	0.638	0.292	0.863	0.363	49.85	47.42
# of values	75	75	75	75	75	75
Lowest fifth percentile	5	5	0.874	0.855	15	11.84
Minimum	3.21	3.37	0.67	0.644	15	9.8
Maximum	10	6.81	5.45	2.5	250	250
# of values undetected	72	72	14	16	72	64
# of values between MDL and PQL	3	3	51	57	3	10
Chronic Aquatic Life Criteria (CALC)			42.66	42.53		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-3 ROCK Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss	Silicon Total	
Mean	278.1	257.9	2.521	2.503	2583	
Standard Deviation	94.09	69.03	0.418	0.23	229.4	
# of values	75	75	75	75	4	
Lowest fifth percentile	202.8	204.1	2.5	2.5	2334	
Minimum	190	167	0.766	1	2290	
Maximum	780	647	5	3.66	2850	
# of values undetected	5	4	72	73	4	
# of values between MDL and PQL	67	69	3	2	0	
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	1	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.505	0.499	1997.2	1972	0.13	0.125
Standard Deviation	0.06	0.012	260.242	258.4	0.027	0.027
# of values	75	75	75	74	75	75
Lowest fifth percentile	0.5	0.5	1577	1596	0.07	0.063
Minimum	0.355	0.4	1270	1120	0.036	0.032
Maximum	1	0.5	2760	2610	0.169	0.164
# of values undetected	74	75	0	0	0	0
# of values between MDL and PQL	1	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.70	2.29				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-3 ROCK Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.587	0.526	10.03	9.9	2.705	2.6
Standard Deviation	0.346	0.314	1.453	0.866	2.195	2.619
# of values	75	75	75	75	75	75
Lowest fifth percentile	0.5	0.471	10	10	1	1
Minimum	0.341	0.15	2.5	2.5	1	1
Maximum	3.07	3.18	20	10	11.6	21.9
# of values undetected	65	70	75	75	50	53
# of values between MDL and PQL	6	4	0	0	11	9
Chronic Aquatic Life Criteria (CALC)					97.96	95.8
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	1	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.441	1.411	44.77	41.88		
Standard Deviation	0.996	1.008	17.34	16.65		
# of values	75	75	75	75		
Lowest fifth percentile	0.5	0.5	16.94	11.04		
Minimum	0.5	0.489	2.5	2.5		
Maximum	2.5	2.85	78	76.8		
# of values undetected	73	72	1	1		
# of values between MDL and PQL	1	3	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Notes:

Table 7-3 ROCK Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	5.23	40.98	7.58	278	214
Standard Deviation	13.3	9.44	0.73	78.9	65.6
# of values	68	48	45	46	32
Lowest fifth percentile	0	33.04	6.7	101	108
Minimum	0	32.36	6.33	72	76
Maximum	92.1	61	8.86	399	315
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	2	8	0	0
# of DWS Exceedences	0	0	10	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.4	0.71	135	0.106	6.19
Standard Deviation	1.14	0.59	37.9	0.133	2.91
# of values	37	36	42	2	27
Lowest fifth percentile	0.27	0.28	63.2	0.022	0.9
Minimum	0.07	0.26	36	0.0125	0.02
Maximum	4.6	2.59	193	0.2	11.5
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

#	=	number	ng/L	=	nanograms per liter
%	=	percent	ORP	=	oxygen reduction potential
°C	=	degrees Celsius	PQL	=	practical quantitation limit
µg/L	=	micrograms per liter	ROCK	=	Rock Creek above the road
Diss	=	dissolved	TDS	=	total dissolved solids
MDL	=	method detection limit	TSS	=	total suspended solids
mg/L	=	milligrams per liter	WAD	=	weak acid dissociable

Table 7-4 RCK1 Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.492	27.68	0.047	0.05	122.1	0.05
Standard Deviation	0.587	21.102	0.01	0	26.2	0.003
# of values	61	61	61	13	61	61
Lowest fifth percentile	2.05	8.28	0.032	0.05	67	0.05
Minimum	0.929	4.89	0.031	0.05	34.5	0.035
Maximum	5.25	176	0.086	0.05	150	0.067
# of values undetected	0	0	23	13	0	57
# of values between MDL and PQL	0	0	38	0	0	4
Chronic Aquatic Life Criteria (CALC)	230				>20	1.925
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0026	0.0028	0.57	167.4	3.44	147
Standard Deviation	0.0005	0.0023	0.373	39.9	7.246	33.21
# of values	61	60	59	61	61	61
Lowest fifth percentile	0.0025	0.0025	0.05	87.5	0.2	75.38
Minimum	0.0025	0.0025	0.05	60	0.2	40.84
Maximum	0.0052	0.02	2.71	313	48.4	189.11
# of values undetected	55	56	51	0	3	0
# of values between MDL and PQL	5	3	5	0	8	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	1	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-4 RCK1 Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	47.5	10.4	0.489	0.465	47.42	40.29
Standard Deviation	164	1.93	0.163	0.163	29.43	12.95
# of values	61	61	61	61	61	61
Lowest fifth percentile	6.79	10	0.327	0.324	27.1	21.9
Minimum	6.49	7.48	0.317	0.313	2.35	10.5
Maximum	1220	23	1.16	1.54	251	78.7
# of values undetected	32	55	25	27	0	0
# of values between MDL and PQL	19	5	34	33	1	0
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	5	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	60	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	5.077	4.419	0.2	0.2	0.176	0.18
Standard Deviation	1.632	0.941	0	0	0.103	0.1
# of values	61	61	61	61	61	61
Lowest fifth percentile	3.86	1.87	0.2	0.2	0.05	0.05
Minimum	2.65	1.37	0.2	0.2	0.05	0.05
Maximum	13.4	5.65	0.2	0.2	0.459	0.25
# of values undetected	0	1	61	61	55	61
# of values between MDL and PQL	1	3	0	0	5	0
Chronic Aquatic Life Criteria (CALC)					0.22	0.20
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	37	40
# of DWS Exceedences	0	0	0	0	0	0

Table 7-4 RCK1 Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	43.75	42.15	0.976	0.898	1.991	2
Standard Deviation	9.448	9.33	1.128	1.039	0.069	0
# of values	61	61	61	61	61	61
Lowest fifth percentile	22.9	21.9	0.492	0.5	2	2
Minimum	12.8	11.4	0.324	0.327	1.46	2
Maximum	54.6	52.2	5.88	6.99	2	2
# of values undetected	0	0	41	41	60	61
# of values between MDL and PQL	0	0	6	7	1	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.574	0.81	0.119	0.021	0.17	0.1
Standard Deviation	0.35	2.54	0.411	0.005	0.29	0.009
# of values	61	61	61	61	61	61
Lowest fifth percentile	0.334	0.34	0.017	0.02	0.1	0.1
Minimum	0.321	0.32	0.013	0.013	0.08	0.062
Maximum	2.51	20.3	3.04	0.058	2.27	0.142
# of values undetected	31	38	29	56	50	56
# of values between MDL and PQL	24	22	19	4	4	5
Chronic Aquatic Life Criteria (CALC)	7.33	7.03	1		2.22	1.85
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	1	1	0	1	0
# of DWS Exceedences	0	0	4	0	0	0

Table 7-4 RCK1 Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	9.152	8.825	6.146	3.271	1.331	
Standard Deviation	2.389	2.375	9.283	3.38	1.159	
# of values	61	61	61	61	61	
Lowest fifth percentile	4.41	4.13	0.976	0.5	0.5	
Minimum	2.15	1.92	0.549	0.371	0.5	
Maximum	12.9	12.5	65.4	17.1	4.8	
# of values undetected	0	0	0	3	30	
# of values between MDL and PQL	0	0	6	12	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	1	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5.068	5	1.266	1.151	70.96	71.19
Standard Deviation	0.465	0	0.636	0.359	40.43	40.41
# of values	61	61	61	61	61	61
Lowest fifth percentile	5	5	0.844	0.73	15	10.8
Minimum	5	5	0.749	0.629	15	9.55
Maximum	8.6	5	5.31	2.35	100	100
# of values undetected	59	61	14	14	59	54
# of values between MDL and PQL	2	0	42	45	2	6
Chronic Aquatic Life Criteria (CALC)			41.07	40.95		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-4 RCK1 Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss		
Mean	260	244	2.514	2.519		
Standard Deviation	136.9	92.53	0.168	0.147		
# of values	61	61	61	61		
Lowest fifth percentile	171	169	2.5	2.5		
Minimum	163	153	2.12	2.5		
Maximum	1090	752	3.75	3.65		
# of values undetected	9	9	59	60		
# of values between MDL and PQL	49	50	2	1		
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	1854.59	1800	0.128	0.124
Standard Deviation	0	0	250.796	211	0.03	0.029
# of values	61	61	61	61	61	61
Lowest fifth percentile	0.5	0.5	1520	1470	0.069	0.064
Minimum	0.5	0.5	1170	1090	0.033	0.029
Maximum	0.5	0.5	2700	2390	0.179	0.169
# of values undetected	61	61	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.50	2.12				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-4 RCK1 Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.555	0.499	10	10	2.324	2.394
Standard Deviation	0.256	0.029	0	0	1.592	1.329
# of values	60	61	61	61	61	61
Lowest fifth percentile	0.5	0.5	10	10	1	1
Minimum	0.34	0.394	10	10	1	1
Maximum	2.08	0.623	10	10	12.4	8.87
# of values undetected	52	56	61	61	47	46
# of values between MDL and PQL	5	5	0	0	10	10
Chronic Aquatic Life Criteria (CALC)					94.3	92.23
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	1	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.187	1.188	43.42	41.75		
Standard Deviation	0.959	0.958	14.84	15.89		
# of values	61	61	61	61		
Lowest fifth percentile	0.5	0.5	17.5	12.7		
Minimum	0.314	0.496	14.8	2.5		
Maximum	2.5	2.5	70.5	68.2		
# of values undetected	59	60	0	1		
# of values between MDL and PQL	2	1	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-4 RCK1 Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	2.3	39.1	7.77	268	223
Standard Deviation	4.53	6.54	0.74	68.6	66.6
# of values	56	49	48	48	34
Lowest fifth percentile	0	33.44	6.64	145	109
Minimum	0	33.3	6.26	67	88
Maximum	25.4	53.4	9.01	380	337
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	7	0	0
# of DWS Exceedences	0	0	9	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.74	0.46	130	0	6.36
Standard Deviation	1.09	0.15	33.4	0	3.45
# of values	42	42	42	2	26
Lowest fifth percentile	0.7	0.26	76.1	0	0.53
Minimum	0.36	0.16	33	0	0.03
Maximum	5.9	0.80	181	0	14.7
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	ng/L	=	nanograms per liter
%	=	percent	ORP	=	oxygen reduction potential
°C	=	degrees Celsius	PQL	=	practical quantitation limit
µg/L	=	micrograms per liter	RCK1	=	Rock Creek above the road
Diss	=	dissolved	TDS	=	total dissolved solids
MDL	=	method detection limit	TSS	=	total suspended solids
mg/L	=	milligrams per liter	WAD	=	weak acid dissociable

Table 7-5 RCK2 Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.745	30.163	0.043	0.05	110.9	0.056
Standard Deviation	0.616	9.244	0.011	0	27.2	0.028
# of values	48	48	48	16	48	48
Lowest fifth percentile	2.098	9.778	0.032	0.05	42.9	0.045
Minimum	2.05	6.81	0.031	0.05	32	0.033
Maximum	4.9	53.3	0.1	0.05	166	0.231
# of values undetected	0	0	16	16	0	38
# of values between MDL and PQL	0	0	32	0	0	8
Chronic Aquatic Life Criteria (CALC)	230				>20	2.030
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0027	0.0028	0.56	157.7	15.304	142.3
Standard Deviation	0.0008	0.0013	0.379	39.7	35.135	36.45
# of values	48	48	46	48	48	48
Lowest fifth percentile	0.0025	0.0025	0.05	73.4	0.4	54.93
Minimum	0.0025	0.0025	0.05	45	0.25	35.62
Maximum	0.0078	0.011	1.83	243	162	225.71
# of values undetected	43	43	38	0	1	0
# of values between MDL and PQL	4	4	4	0	3	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	1	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-5 RCK2 Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	192	11.1	0.889	0.807	93.69	70.87
Standard Deviation	570	4.93	0.335	0.208	49.93	13.94
# of values	48	48	48	48	48	48
Lowest fifth percentile	7.42	6.58	0.5	0.5	64.41	39.94
Minimum	6.29	6.23	0.441	0.347	26.1	35.6
Maximum	3380	32.3	2.02	1.28	392	97.9
# of values undetected	7	33	4	6	0	0
# of values between MDL and PQL	18	12	30	35	0	0
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	11	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	48	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	6.095	3.919	0.2	0.201	0.17	0.19
Standard Deviation	5.827	0.888	0.01	0.005	0.096	0.09
# of values	48	48	48	48	48	48
Lowest fifth percentile	3.627	1.749	0.2	0.2	0.05	0.05
Minimum	2.53	1.13	0.14	0.2	0.05	0.05
Maximum	40.2	5.43	0.2	0.238	0.25	0.25
# of values undetected	0	1	47	47	43	47
# of values between MDL and PQL	2	4	1	1	4	0
Chronic Aquatic Life Criteria (CALC)					0.17	0.16
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	28	32
# of DWS Exceedences	0	0	0	0	0	0

Table 7-5 RCK2 Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	41.7	39.99	0.866	0.757	1.998	2
Standard Deviation	10.59	10.23	0.719	0.657	0.115	0
# of values	48	48	48	48	48	48
Lowest fifth percentile	16.05	15.32	0.5	0.5	2	2
Minimum	10.6	10.5	0.409	0.366	1.4	2
Maximum	64.8	60.4	3.99	3.44	2.51	2
# of values undetected	0	0	27	33	46	48
# of values between MDL and PQL	0	0	9	8	2	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.942	0.58	0.388	0.024	0.62	0.102
Standard Deviation	1.107	0.4	1.072	0.013	1.16	0.016
# of values	48	48	48	48	48	48
Lowest fifth percentile	0.341	0.34	0.017	0.02	0.1	0.087
Minimum	0.315	0.31	0.015	0.02	0.07	0.065
Maximum	5.71	2.97	5.48	0.081	6.5	0.18
# of values undetected	5	12	9	43	17	41
# of values between MDL and PQL	35	34	10	0	9	7
Chronic Aquatic Life Criteria (CALC)	5.59	5.37	1		1.48	1.30
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	1	0	4	0	6	0
# of DWS Exceedences	0	0	9	0	0	0

Table 7-5 RCK2 Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	9.259	8.865	14.16	2.347	2.396	
Standard Deviation	2.454	2.397	24.95	2.534	2.069	
# of values	48	48	48	48	48	
Lowest fifth percentile	3.763	3.222	0.924	0.38	0.5	
Minimum	2.22	2.2	0.362	0.315	0.5	
Maximum	15.5	14.5	136	14.1	10.2	
# of values undetected	0	0	0	3	10	
# of values between MDL and PQL	0	0	3	12	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	3	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	4.968	5.06	1.631	1.145	72.54	70.8
Standard Deviation	0.228	0.417	1.263	0.261	39.09	40.42
# of values	48	48	48	48	48	48
Lowest fifth percentile	5	5	0.783	0.904	15	15
Minimum	3.42	5	0.693	0.727	15	11.8
Maximum	5.06	7.89	7.52	1.92	106	100
# of values undetected	46	47	8	12	43	44
# of values between MDL and PQL	2	1	32	36	3	4
Chronic Aquatic Life Criteria (CALC)			31.42	31.33		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-5 RCK2 Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss	Silicon Total	
Mean	288.4	251.6	2.558	2.51	2595	
Standard Deviation	126.7	63	0.397	0.074	304.06	
# of values	48	48	48	48	2	
Lowest fifth percentile	199.7	202.4	2.5	2.5	2401.5	
Minimum	193	165	1.68	2.46	2380	
Maximum	904	587	4.76	3.01	2810	
# of values undetected	0	1	45	46	2	
# of values between MDL and PQL	44	46	3	2	0	
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	1980.21	1917	0.122	0.117
Standard Deviation	0	0	255.622	253.5	0.03	0.029
# of values	48	48	48	48	48	48
Lowest fifth percentile	0.5	0.5	1633.5	1470	0.054	0.048
Minimum	0.5	0.5	1290	1260	0.036	0.035
Maximum	0.5	0.5	2790	2610	0.186	0.177
# of values undetected	48	48	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	1.45	1.23				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-5 RCK2 Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.506	0.51	10	10	2.971	2.112
Standard Deviation	0.044	0.069	0	0	2.44	0.71
# of values	48	48	48	48	48	48
Lowest fifth percentile	0.5	0.5	10	10	1	1
Minimum	0.5	0.5	10	10	1	1
Maximum	0.802	0.978	10	10	14.6	3.89
# of values undetected	47	47	48	48	31	38
# of values between MDL and PQL	1	1	0	0	9	8
Chronic Aquatic Life Criteria (CALC)					72.12	70.53
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.2	1.166	41.48	36.25		
Standard Deviation	0.941	0.953	17.47	16.04		
# of values	48	48	48	48		
Lowest fifth percentile	0.5	0.5	15.09	10.1		
Minimum	0.5	0.474	5.91	2.5		
Maximum	2.5	2.5	88.7	69.2		
# of values undetected	45	47	0	1		
# of values between MDL and PQL	1	1	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-5 RCK2 Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	8.38	43.72	7.79	253	212
Standard Deviation	15.29	9.98	0.83	81.7	81.1
# of values	47	32	29	30	22
Lowest fifth percentile	0.11	32.7	6.61	86.5	88.7
Minimum	0	32.5	6.3	68	81
Maximum	84.5	63.8	8.91	426	326
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	1	8	0	0
# of DWS Exceedences	0	0	9	0	0
Analyte	Velocity	Depth	TDS (field)	Dissolved Oxygen (%)	
Mean	1.78	0.42	137	6.23	
Standard Deviation	1.08	0.13	55	2.83	
# of values	27	27	30	21	
Lowest fifth percentile	0.52	0.23	54.6	1.9	
Minimum	0.35	0.20	42	1	
Maximum	4.8	0.66	354	11.8	
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	
# of DWS Exceedences	0	0	0	0	

Notes:

#	=	number	ng/L	=	nanograms per liter
%	=	percent	ORP	=	oxygen reduction potential
°C	=	degrees Celsius	PQL	=	practical quantitation limit
µg/L	=	micrograms per liter	RCK2	=	Rock Creek below the road
Diss	=	dissolved	TDS	=	total dissolved solids
MDL	=	method detection limit	TSS	=	total suspended solids
mg/L	=	milligrams per liter	WAD	=	weak acid dissociable

Table 7-6 SNBG Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	3.607	20.839	0.047	0.052	91.2	0.052
Standard Deviation	1.087	3.621	0.017	0.01	12	0.011
# of values	71	71	71	25	71	71
Lowest fifth percentile	2.375	14.7	0.032	0.05	67.5	0.05
Minimum	2	6.8	0.031	0.05	41	0.035
Maximum	7.27	32.8	0.166	0.1	123	0.106
# of values undetected	0	0	40	25	0	64
# of values between MDL and PQL	0	0	30	0	0	6
Chronic Aquatic Life Criteria (CALC)	230				>20	2.031
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0027	0.0027	0.477	128.5	1.289	112.18
Standard Deviation	0.001	0.0015	0.214	21.7	2.357	15.15
# of values	70	68	69	71	70	71
Lowest fifth percentile	0.0025	0.0025	0.05	87.5	0.2	81.44
Minimum	0.0025	0.0025	0.033	63.8	0.2	47.63
Maximum	0.009	0.015	1.13	211	10.4	154.83
# of values undetected	66	64	60	0	29	0
# of values between MDL and PQL	3	3	5	0	12	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	2	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-6 SNBG Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	12.7	10	0.493	0.486	6.509	3.984
Standard Deviation	12.8	0.25	0.116	0.073	16.41	10.46
# of values	71	71	71	71	71	71
Lowest fifth percentile	9.52	10	0.362	0.365	1.8	1.675
Minimum	6.46	10	0.34	0.322	1.5	1.56
Maximum	101	11.8	1.08	0.7	88.3	90.6
# of values undetected	58	69	14	21	18	18
# of values between MDL and PQL	9	2	56	50	42	50
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	1	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	3	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	10.26	10.22	0.2	0.2	0.163	0.16
Standard Deviation	4.166	4.033	0.01	0.002	0.1	0.1
# of values	71	71	71	71	71	71
Lowest fifth percentile	4.305	4.56	0.2	0.2	0.05	0.05
Minimum	3.23	2.42	0.2	0.179	0.05	0.05
Maximum	18	18.3	0.26	0.2	0.296	0.25
# of values undetected	0	0	70	70	68	70
# of values between MDL and PQL	0	1	1	1	1	0
Chronic Aquatic Life Criteria (CALC)					0.23	0.21
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	39	38
# of DWS Exceedences	0	0	0	0	0	0

Table 7-6 SNBG Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	33.23	32.06	0.77	0.665	2	2
Standard Deviation	4.358	4.903	0.697	0.577	0	0
# of values	71	71	71	71	71	71
Lowest fifth percentile	24.05	21.55	0.5	0.5	2	2
Minimum	14.4	13.6	0.5	0.315	2	2
Maximum	45	48	4.11	3.84	2	2
# of values undetected	0	0	56	58	71	71
# of values between MDL and PQL	0	0	5	9	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.497	0.49	0.029	0.02	0.11	0.106
Standard Deviation	0.078	0.08	0.036	0.003	0.03	0.037
# of values	71	71	71	71	71	71
Lowest fifth percentile	0.369	0.33	0.015	0.02	0.09	0.1
Minimum	0.316	0.31	0.013	0.013	0.07	0.062
Maximum	0.931	0.91	0.279	0.035	0.34	0.323
# of values undetected	51	54	41	63	59	66
# of values between MDL and PQL	20	17	21	8	11	4
Chronic Aquatic Life Criteria (CALC)	7.83	7.51	1		2.45	2.01
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-6 SNBG Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	7.081	6.857	3.32	2.276	0.957	
Standard Deviation	1.071	1.141	2.817	1.717	0.771	
# of values	71	71	71	71	70	
Lowest fifth percentile	5.205	4.835	0.963	0.519	0.5	
Minimum	2.83	2.78	0.5	0.05	0.5	
Maximum	10.3	10.6	14.3	12.5	3.2	
# of values undetected	0	0	2	4	47	
# of values between MDL and PQL	0	0	4	7	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5.011	5.044	0.998	0.96	64.03	64.45
Standard Deviation	0.283	0.373	0.251	0.182	47.7	47.43
# of values	71	71	71	71	71	71
Lowest fifth percentile	5	5	0.673	0.685	15	14.35
Minimum	3.75	5	0.628	0.646	15	11.5
Maximum	7.01	8.14	2.2	1.56	250	250
# of values undetected	69	70	25	29	69	62
# of values between MDL and PQL	2	1	45	42	2	8
Chronic Aquatic Life Criteria (CALC)			43.85	43.71		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-6 SNBG Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss	Silicon Total	
Mean	242.5	240.1	2.513	2.555	2192.5	
Standard Deviation	30.68	32.31	0.427	0.272	159.45	
# of values	71	71	71	71	4	
Lowest fifth percentile	198.5	195.5	2.5	2.5	2100	
Minimum	171	164	0.845	2.5	2100	
Maximum	344	372	5.62	4.13	2430	
# of values undetected	7	7	70	69	0	
# of values between MDL and PQL	64	64	0	2	0	
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	1	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	2115.07	2100	0.134	0.129
Standard Deviation	0	0	390.94	387.9	0.024	0.025
# of values	71	71	71	71	71	71
Lowest fifth percentile	0.5	0.5	1575	1545	0.094	0.089
Minimum	0.5	0.5	1200	1080	0.045	0.041
Maximum	0.5	0.5	3170	3120	0.178	0.174
# of values undetected	71	71	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.85	2.42				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-6 SNBG Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.518	0.531	9.843	9.886	2.348	2.315
Standard Deviation	0.128	0.175	0.985	0.964	1.915	1.03
# of values	71	71	71	71	71	71
Lowest fifth percentile	0.5	0.5	10	10	1	1
Minimum	0.15	0.15	2.5	1.88	1	1
Maximum	1.23	1.62	10	10	16	5.98
# of values undetected	66	67	70	70	52	44
# of values between MDL and PQL	3	1	1	1	9	14
Chronic Aquatic Life Criteria (CALC)					100.7	98.47
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.487	1.483	31.4	29.91		
Standard Deviation	1.17	1.265	9.877	9.983		
# of values	71	71	71	71		
Lowest fifth percentile	0.5	0.5	16.85	14		
Minimum	0.5	0.457	3.51	8.08		
Maximum	6.63	8.02	54.3	50.3		
# of values undetected	68	68	0	0		
# of values between MDL and PQL	1	2	1	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-6 SNBG Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.62	39.71	7.43	211	218
Standard Deviation	1.14	7.49	0.6	35.5	71.5
# of values	62	48	47	46	33
Lowest fifth percentile	0	32.77	6.58	158	101
Minimum	0	32.36	6.13	88	58
Maximum	6.5	55.6	8.46	306	333
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	2	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.55	1.66	106	0.006	6.43
Standard Deviation	1.32	0.63	19.6	0.009	4.14
# of values	40	41	39	2	25
Lowest fifth percentile	0.25	0.68	76	0.001	0.96
Minimum	0.17	0.52	44	0	0.2
Maximum	6.3	3.08	153	0.0125	19.8
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	ng/L	=	nanograms per liter
%	=	percent	ORP	=	oxygen reduction potential
°C	=	degrees Celsius	PQL	=	practical quantitation limit
µg/L	=	micrograms per liter	SNBG	=	Snake River below Glacier Creek
Diss	=	dissolved	TDS	=	total dissolved solids
MDL	=	method detection limit	TSS	=	total suspended solids
mg/L	=	milligrams per liter	WAD	=	weak acid dissociable

Table 7-7 GLAC Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.554	22.226	0.048	0.052	108.8	0.053
Standard Deviation	0.42	6.741	0.011	0.01	23.2	0.019
# of values	78	78	78	27	78	78
Lowest fifth percentile	2.156	10.881	0.032	0.05	69.4	0.046
Minimum	1.35	0.05	0.031	0.05	34	0.031
Maximum	4.79	44.5	0.102	0.1	244	0.189
# of values undetected	0	1	39	27	0	68
# of values between MDL and PQL	0	0	38	0	0	8
Chronic Aquatic Life Criteria (CALC)	230				>20	1.995
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0025	0.0028	0.48	140.8	0.714	130.63
Standard Deviation	0.0003	0.0014	0.287	32.5	1.848	22.9
# of values	78	76	76	78	78	78
Lowest fifth percentile	0.0025	0.0025	0.05	71.6	0.2	81.06
Minimum	0.0025	0.0025	0.04	18.8	0.2	37.03
Maximum	0.0042	0.012	1.51	191	14.7	160.8
# of values undetected	74	67	68	0	44	0
# of values between MDL and PQL	4	5	5	1	16	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-7 GLAC Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	11.4	11.5	0.468	0.465	6.198	6.137
Standard Deviation	8.14	11.4	0.129	0.109	3.477	3.302
# of values	78	78	78	78	78	78
Lowest fifth percentile	9.68	10	0.328	0.332	2.551	2.5
Minimum	6.82	8.85	0.311	0.326	2.27	2.27
Maximum	71.7	110	1.22	0.868	17.6	16.5
# of values undetected	68	74	21	20	3	4
# of values between MDL and PQL	7	3	56	58	27	31
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	10	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	3.984	4.035	0.2	0.201	0.161	0.16
Standard Deviation	0.977	1.162	0.01	0.018	0.099	0.1
# of values	78	78	78	78	78	78
Lowest fifth percentile	2.585	2.264	0.2	0.2	0.05	0.05
Minimum	1.5	1.5	0.15	0.146	0.05	0.05
Maximum	10.5	11.4	0.2	0.346	0.25	0.25
# of values undetected	1	2	77	75	77	74
# of values between MDL and PQL	6	4	1	3	1	3
Chronic Aquatic Life Criteria (CALC)					0.23	0.21
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	43	42
# of DWS Exceedences	0	0	0	0	0	0

Table 7-7 GLAC Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	37.72	36.22	1.184	0.742	2	2
Standard Deviation	6.512	6.305	2.75	0.735	0	0
# of values	78	78	78	78	78	78
Lowest fifth percentile	23.43	22.73	0.5	0.5	2	2
Minimum	10.9	9.95	0.366	0.314	2	2
Maximum	46.4	44.4	23.7	5.33	2	2
# of values undetected	0	0	55	58	78	78
# of values between MDL and PQL	0	0	10	9	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	1	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.502	0.5	0.033	0.02	0.1	0.121
Standard Deviation	0.177	0.12	0.098	0.002	0.02	0.131
# of values	78	78	78	78	78	78
Lowest fifth percentile	0.332	0.36	0.018	0.02	0.1	0.1
Minimum	0.315	0.31	0.014	0.014	0.07	0.088
Maximum	1.78	1.43	0.88	0.03	0.2	1.19
# of values undetected	50	61	68	74	71	71
# of values between MDL and PQL	27	16	6	4	7	5
Chronic Aquatic Life Criteria (CALC)	7.80	7.48	1		2.44	2.00
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	1	0	0	0

Table 7-7 GLAC Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	8.836	8.444	1.035	0.702	1.064	
Standard Deviation	1.634	1.607	1.452	0.6	1.013	
# of values	78	78	78	78	77	
Lowest fifth percentile	5.489	5.471	0.403	0.354	0.5	
Minimum	2.38	2.21	0.334	0.318	0.5	
Maximum	10.9	10.6	11.4	3.53	5.6	
# of values undetected	0	0	27	32	46	
# of values between MDL and PQL	0	0	34	37	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	4.979	5.049	1.315	1.016	66.18	66.27
Standard Deviation	0.189	0.417	2.507	0.241	46.85	46.91
# of values	78	78	78	78	78	78
Lowest fifth percentile	5	5	0.721	0.657	15	10.47
Minimum	3.33	4.22	0.62	0.625	15	9.46
Maximum	5	8.4	23	1.73	250	250
# of values undetected	77	75	29	31	76	70
# of values between MDL and PQL	1	3	46	47	2	7
Chronic Aquatic Life Criteria (CALC)			43.67	43.54		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-7 GLAC Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss	Silicon Total	
Mean	204.3	202.2	2.495	2.509	2072.5	
Standard Deviation	35.68	33.1	0.213	0.279	121.21	
# of values	78	78	78	78	4	
Lowest fifth percentile	154.6	160.9	2.5	2.5	1934	
Minimum	150	155	1	1	1910	
Maximum	324	299	3.62	4.27	2200	
# of values undetected	12	12	77	75	4	
# of values between MDL and PQL	66	66	1	3	0	
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	1805	1785	0.109	0.106
Standard Deviation	0	0	175.808	175.2	0.018	0.018
# of values	78	78	78	78	78	78
Lowest fifth percentile	0.5	0.5	1548.5	1506	0.071	0.071
Minimum	0.5	0.5	1200	1170	0.036	0.033
Maximum	0.5	0.5	2340	2310	0.136	0.133
# of values undetected	78	78	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.83	2.40				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-7 GLAC Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.516	0.577	9.859	9.904	2.559	2.516
Standard Deviation	0.118	0.309	0.932	0.849	3.139	3.623
# of values	78	78	78	78	78	78
Lowest fifth percentile	0.497	0.5	10	10	1	1
Minimum	0.15	0.5	2.5	2.5	1	1
Maximum	1.32	2.69	10	10	26.8	33.1
# of values undetected	70	72	77	78	63	56
# of values between MDL and PQL	7	1	1	0	7	12
Chronic Aquatic Life Criteria (CALC)					100.3	98.08
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	1.353	1.519	34.46	34.2		
Standard Deviation	0.986	1.362	11.75	12.09		
# of values	78	78	78	78		
Lowest fifth percentile	0.5	0.5	14.47	14.96		
Minimum	0.5	0.5	5.86	9.27		
Maximum	2.5	8.11	56.1	56.8		
# of values undetected	75	74	0	0		
# of values between MDL and PQL	3	1	0	1		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-7 GLAC Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.9	38.94	7.65	234	202
Standard Deviation	4.14	7.73	0.67	51.7	78.3
# of values	68	48	45	45	31
Lowest fifth percentile	0	32.6	6.73	145	67
Minimum	0	32.18	6.02	67	56
Maximum	33.5	62.1	8.8	302	306
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	1	5	0	0
# of DWS Exceedences	0	0	7	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.77	0.75	115	0	6.49
Standard Deviation	1.64	0.31	26.4	0.01	2.37
# of values	39	42	41	3	26
Lowest fifth percentile	0.32	0.33	71	0	2.13
Minimum	0.24	0.30	33	0	1.5
Maximum	6.88	1.57	151	0.0125	10.6
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°C	=	degrees Celsius	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
GLAC	=	Glacier Creek	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

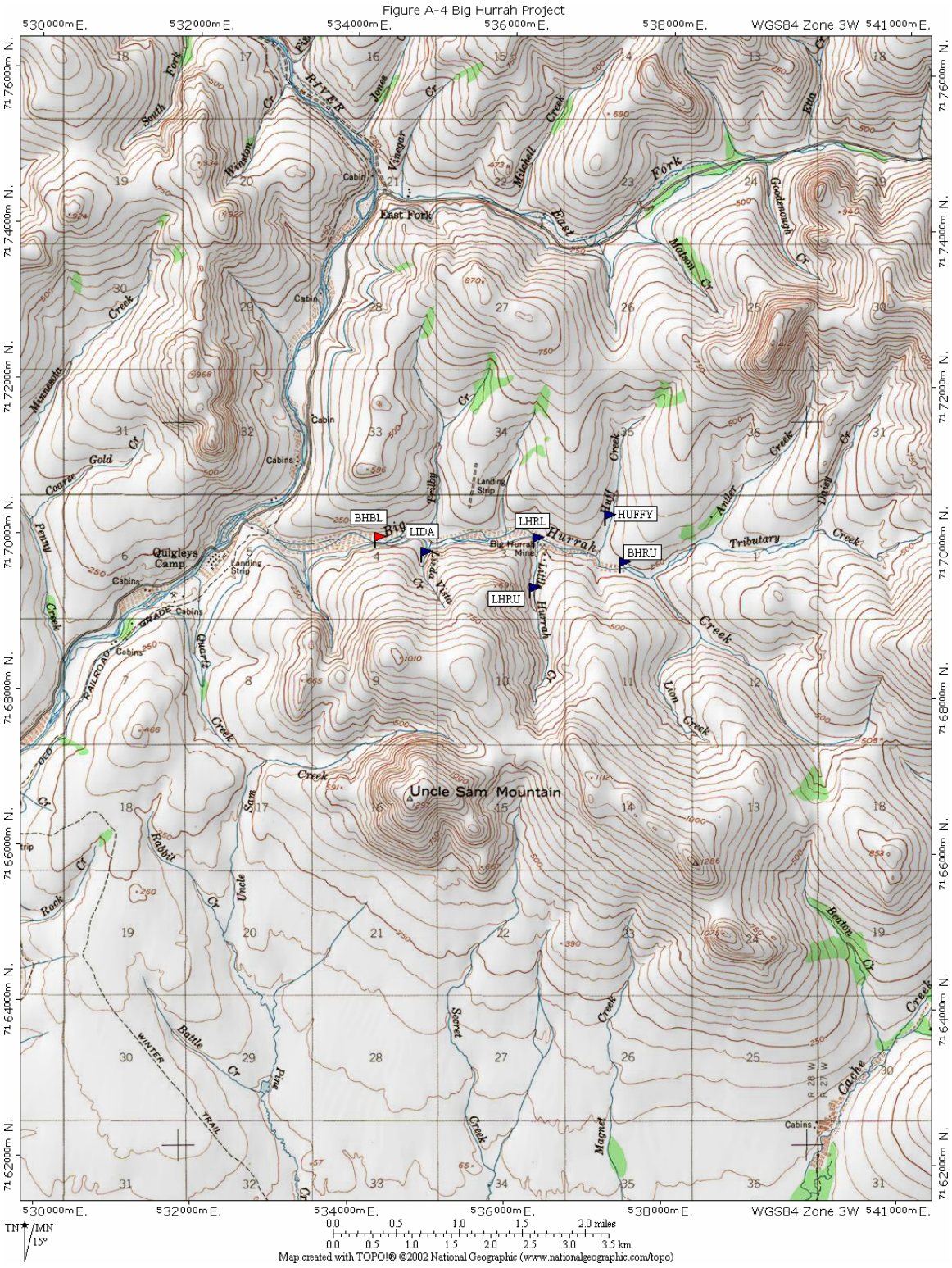
7.5.2.2 Big Hurrah

Several tributaries merge with Big Hurrah Creek and these drainages are the ones to receive the surface water monitoring/sampling procedures. Sites are representative of local surface waters draining this mineralized zone. Little Hurrah Creek joins the Big Hurrah Creek within the proposed project area. A Big Hurrah Surface Water Sampling Stations Map is provided as Figure 7.3. Red flags indicate continuous monitoring sites, as well as water quality monitoring sites, and blue flags indicate water-quality monitoring sites without continuous monitors. In general, the outcrops near the mineralized area are scarce, being limited to the Little Hurrah Creek gully and trenches. The main outcrop near mineralization occurs in a long, deep trench on the west part of the mineralized area, where the fault contact between the Solomon Schist and the Hurrah Slate is exposed. Little Hurrah Creek drains the area of the mineralized deposit that is proposed for development. Linda Vista Creek and Huffy Creek drain the adjacent lands .

Following are the designated sampling locations:

- HUFFY = Huffy Creek
- LHRL= Little Hurrah Creek, Lower
- LHRU = Little Hurrah Creek, Upper
- LIDA = Linda Vista Creek
- BHBL = Big Hurrah Creek, Lower
- BHBU = Big Hurrah Creek, Upper

Figure 7.3 Big Hurrah Surface Water Sampling Stations Map



Unlike the Rock Creek site, there were no arsenic levels above state drinking water standards at any of the Big Hurrah surface water stations. Zinc was the only metal that showed frequent levels in exceedence of state water quality standards and this only occurred in Linda Vista Creek. While a few other metals showed elevated readings, they were isolated occasions that appeared to be anomalies. There was one aluminum level in Upper Big Hurrah Creek, one elevated lead result in Lower Big Hurrah Creek, one elevated mercury reading in Lower Big Hurrah Creek, and one elevated WAD cyanide result in Lower Little Hurrah Creek. Arsenic concentrations in Little Hurrah Creek are presented in Figure 7.4 below. Additional water quality data is attached in the Hydrology section of the appendices under the title Rock Creek Surface Water Database and Graphs. Summary statistics from the Big Hurrah surface water sampling program are presented below in Tables 7-8 through 7-13.

Figure 7.4 Arsenic Levels in Little Hurrah Creek

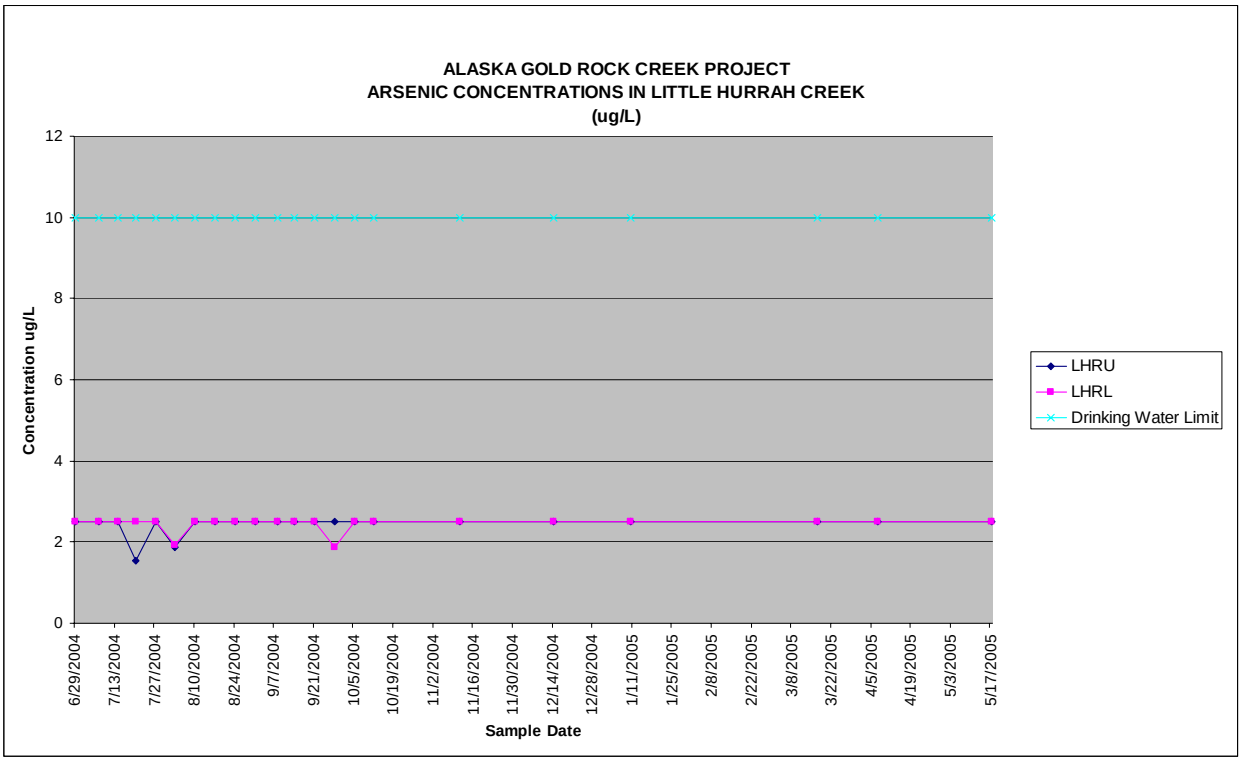


Table 7-8 BHRU Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Bromide (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)
Mean	2.5	16.962	0.047	#DIV/0!	104	0.052
Standard Deviation	0.325	3.201	0.008	#DIV/0!	11.4	0.011
# of values	21	21	21	0	21	21
Lowest fifth percentile	2.23	12.8	0.031	#NUM!	92	0.05
Minimum	2.13	11.8	0.031	0	75.5	0.05
Maximum	3.78	26.5	0.062	0	139	0.1
# of values undetected	0	0	16	0	0	20
# of values between MDL and PQL	0	0	5	0	0	0
Chronic Aquatic Life Criteria (CALC)	230				>20	1.226
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0027	0.0037	0.585	125.6	7.45	119.35
Standard Deviation	0.0006	0.0047	0.363	33.1	32.205	16.29
# of values	21	21	20	21	21	21
Lowest fifth percentile	0.0025	0.0025	0.193	80	0.2	95.34
Minimum	0.0025	0.0025	0.05	11.3	0.2	88.94
Maximum	0.005	0.024	1.74	171	148	167.62
# of values undetected	19	17	15	0	7	0
# of values between MDL and PQL	1	2	1	0	7	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-8 BHRU Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	119	10	0.496	0.5	2.472	2.472
Standard Deviation	500	0	0.017	0	0.129	0.129
# of values	21	21	21	21	21	21
Lowest fifth percentile	8.18	10	0.5	0.5	2.5	2.5
Minimum	6.39	10	0.424	0.5	1.91	1.91
Maximum	2300	10	0.5	0.5	2.5	2.5
# of values undetected	18	21	20	21	20	20
# of values between MDL and PQL	2	0	1	0	1	1
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	1	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	44.9	28.7	0.2	0.2	0.242	0.25
Standard Deviation	72.97	3.142	0	0	0.035	0
# of values	21	21	21	21	21	21
Lowest fifth percentile	24.8	23.9	0.2	0.2	0.25	0.25
Minimum	20.7	23.8	0.2	0.2	0.09	0.25
Maximum	363	38.2	0.2	0.2	0.25	0.25
# of values undetected	0	0	21	21	20	21
# of values between MDL and PQL	0	0	0	0	1	0
Chronic Aquatic Life Criteria (CALC)					0.26	0.24
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	0	21
# of DWS Exceedences	0	0	0	0	0	0

Table 7-8 BHRU Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	38.62	37.44	0.734	0.508	2.154	2
Standard Deviation	4.965	4.88	0.907	0.094	0.705	0
# of values	21	21	21	21	21	21
Lowest fifth percentile	31	31.9	0.5	0.423	2	2
Minimum	28.9	28.7	0.35	0.375	2	2
Maximum	52.5	52.4	4.64	0.896	5.23	2
# of values undetected	0	0	17	16	20	21
# of values between MDL and PQL	0	0	3	5	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	1.125	0.48	0.476	0.02	0.37	0.099
Standard Deviation	2.95	0.06	2.091	0	1.2	0.006
# of values	21	21	21	21	21	21
Lowest fifth percentile	0.369	0.35	0.02	0.02	0.1	0.1
Minimum	0.313	0.33	0.02	0.02	0.07	0.071
Maximum	14	0.54	9.6	0.02	5.6	0.1
# of values undetected	17	17	20	21	18	19
# of values between MDL and PQL	3	4	0	0	1	2
Chronic Aquatic Life Criteria (CALC)	8.96	8.60	1		2.99	2.39
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	1	0	1	0	1	0
# of DWS Exceedences	0	0	1	0	0	0

Table 7-8 BHRU Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	5.545	5.313	16.88	1.117	1.071	
Standard Deviation	0.967	0.897	74.27	2.44	1.638	
# of values	21	21	21	21	21	
Lowest fifth percentile	4.34	4.25	0.5	0.5	0.5	
Minimum	4.06	4	0.39	0.5	0.5	
Maximum	8.85	8.26	341	11.7	7.9	
# of values undetected	0	0	11	16	15	
# of values between MDL and PQL	0	0	7	3	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	1	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	1.626	0.99	100	100
Standard Deviation	0	0	3.091	0.235	0	0
# of values	21	21	21	21	21	21
Lowest fifth percentile	5	5	0.646	0.686	100	100
Minimum	5	5	0.634	0.639	100	100
Maximum	5	5	15.1	1.82	100	100
# of values undetected	21	21	11	12	21	21
# of values between MDL and PQL	0	0	9	9	0	0
Chronic Aquatic Life Criteria (CALC)			50.10	49.95		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-8 BHRU Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	5.545	5.313	16.88	1.117	1.071	
Standard Deviation	0.967	0.897	74.27	2.44	1.638	
# of values	21	21	21	21	21	
Lowest fifth percentile	4.34	4.25	0.5	0.5	0.5	
Minimum	4.06	4	0.39	0.5	0.5	
Maximum	8.85	8.26	341	11.7	7.9	
# of values undetected	0	0	11	16	15	
# of values between MDL and PQL	0	0	7	3	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	1	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	1.626	0.99	100	100
Standard Deviation	0	0	3.091	0.235	0	0
# of values	21	21	21	21	21	21
Lowest fifth percentile	5	5	0.646	0.686	100	100
Minimum	5	5	0.634	0.639	100	100
Maximum	5	5	15.1	1.82	100	100
# of values undetected	21	21	11	12	21	21
# of values between MDL and PQL	0	0	9	9	0	0
Chronic Aquatic Life Criteria (CALC)			50.10	49.95		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-8 BHRU Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.13	41	8.23	231	239
Standard Deviation	0.29	8.09	0.63	35.4	71.6
# of values	20	20	18	19	12
Lowest fifth percentile	0	33.07	7.58	190	129
Minimum	0	32.4	6.26	189	128
Maximum	1.19	56	8.99	339	338
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	5	0	0
# of DWS Exceedences	0	0	6	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.43	1.22	116	0.02	5.02
Standard Deviation	1.07	0.40	17.3	0.01	2.54
# of values	17	16	19	3	12
Lowest fifth percentile	0.04	0.46	98.6	0.01	1.1
Minimum	0	0.46	95	0.0125	1.1
Maximum	3.46	1.61	169	0.025	9.5
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
BHRU	=	Big Hurrah Creek, upper	TDS	=	total dissolved solids
Diss	=	dissolved	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-9 BHBL Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)	
Mean	2.49	19.264	0.049	94.6	0.052	
Standard Deviation	0.211	5.362	0.01	11.4	0.012	
# of values	22	22	22	22	22	
Lowest fifth percentile	2.23	12.295	0.032	74.3	0.04	
Minimum	2.12	11.6	0.031	67.5	0.034	
Maximum	3.15	37.1	0.083	111	0.102	
# of values undetected	0	0	15	0	18	
# of values between MDL and PQL	0	0	7	0	3	
Chronic Aquatic Life Criteria (CALC)	230			>20	1.601	
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0026	0.0027	0.647	125.1	0.839	112.16
Standard Deviation	0.0003	0.0007	0.577	21.8	1.544	15.51
# of values	22	22	21	22	22	22
Lowest fifth percentile	0.0025	0.0025	0.12	94.3	0.2	81.49
Minimum	0.0025	0.0025	0.05	55	0.2	80.78
Maximum	0.0039	0.005	2.74	149	7.3	139.97
# of values undetected	19	19	17	0	8	0
# of values between MDL and PQL	3	2	0	0	6	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-9 BHBL Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	9.83	9.83	0.5	0.495	2.465	2.5
Standard Deviation	0.8	0.79	0	0.023	0.162	0
# of values	22	22	22	22	22	22
Lowest fifth percentile	8.82	10	0.5	0.5	2.5	2.5
Minimum	6.59	6.3	0.5	0.391	1.74	2.5
Maximum	11	10	0.5	0.5	2.5	2.5
# of values undetected	19	21	22	21	21	22
# of values between MDL and PQL	3	1	0	1	1	0
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	28.93	27.91	0.2	0.2	0.25	0.25
Standard Deviation	3.476	2.941	0	0	0	0
# of values	22	22	22	22	22	22
Lowest fifth percentile	25.44	24.81	0.2	0.2	0.25	0.25
Minimum	20.5	19.8	0.2	0.2	0.25	0.25
Maximum	36.9	31.8	0.2	0.2	0.25	0.25
# of values undetected	0	0	22	22	22	22
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)					0.23	0.21
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	22	22
# of DWS Exceedences	0	0	0	0	0	0

Table 7-9 BHBL Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	35.41	34.08	0.508	0.494	2	2
Standard Deviation	5.018	4.98	0.055	0.022	0	0
# of values	22	22	22	22	22	22
Lowest fifth percentile	25.94	25.77	0.497	0.473	2	2
Minimum	25.7	25.2	0.432	0.4	2	2
Maximum	44.1	43	0.744	0.5	2	2
# of values undetected	0	0	19	20	22	22
# of values between MDL and PQL	0	0	3	2	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.487	0.48	0.021	0.02	0.1	0.099
Standard Deviation	0.044	0.05	0.003	0	0.02	0.003
# of values	22	22	22	22	22	22
Lowest fifth percentile	0.37	0.33	0.02	0.02	0.1	0.1
Minimum	0.342	0.32	0.02	0.02	0.09	0.085
Maximum	0.5	0.5	0.034	0.02	0.2	0.1
# of values undetected	20	20	21	22	20	21
# of values between MDL and PQL	2	2	1	0	1	1
Chronic Aquatic Life Criteria (CALC)	7.83	7.52	1		2.45	2.01
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-9 BHBL Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	5.755	5.534	0.918	0.577	1.545	
Standard Deviation	1.136	1.141	0.99	0.192	3.724	
# of values	22	22	22	22	22	
Lowest fifth percentile	4.105	4.041	0.421	0.42	0.5	
Minimum	3.96	3.82	0.403	0.368	0.5	
Maximum	9.05	8.93	4.74	1.09	18.1	
# of values undetected	0	0	12	13	15	
# of values between MDL and PQL	0	0	4	8	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	1.201	1.145	100	100
Standard Deviation	0	0	0.798	0.791	0	0
# of values	22	22	22	22	22	22
Lowest fifth percentile	5	5	0.832	0.788	100	100
Minimum	5	5	0.793	0.786	100	100
Maximum	5	5	4.72	4.62	100	100
# of values undetected	22	22	10	10	22	22
# of values between MDL and PQL	0	0	11	11	0	0
Chronic Aquatic Life Criteria (CALC)			43.87	43.74		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-9 BHBL Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss		
Mean	249.4	249.6	2.5	2.5		
Standard Deviation	37.92	24.27	0	0		
# of values	22	22	22	22		
Lowest fifth percentile	192.4	219.1	2.5	2.5		
Minimum	162	204	2.5	2.5		
Maximum	317	314	2.5	2.5		
# of values undetected	5	5	22	22		
# of values between MDL and PQL	17	17	0	0		
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	1917.27	1863	0.13	0.125
Standard Deviation	0	0	141.023	142.6	0.016	0.016
# of values	22	22	22	22	22	22
Lowest fifth percentile	0.5	0.5	1720.5	1650	0.099	0.097
Minimum	0.5	0.5	1680	1630	0.093	0.091
Maximum	0.5	0.5	2210	2110	0.158	0.155
# of values undetected	22	22	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.85	2.43				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-9 BHBL Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.5	0.5	9.852	10	3.972	3.636
Standard Deviation	0	0.001	0.693	0	4.233	3.682
# of values	22	22	22	22	22	22
Lowest fifth percentile	0.5	0.5	10	10	2.101	2.5
Minimum	0.5	0.494	6.75	10	1.72	2.22
Maximum	0.5	0.5	10	10	18.4	16.8
# of values undetected	22	21	21	22	16	18
# of values between MDL and PQL	0	1	1	0	3	2
Chronic Aquatic Life Criteria (CALC)					100.7	98.52
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	0.5	0.5	29.43	32.35		
Standard Deviation	0	0	8.905	11.17		
# of values	22	22	22	22		
Lowest fifth percentile	0.5	0.5	16.95	15.36		
Minimum	0.5	0.5	15.7	15		
Maximum	0.5	0.5	46.6	54.3		
# of values undetected	22	22	0	0		
# of values between MDL and PQL	0	0	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-9 BHBL Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.42	43.9	8.14	211	234
Standard Deviation	0.89	10.48	0.77	39.7	86.6
# of values	19	22	21	20	13
Lowest fifth percentile	0	32.22	7.32	145	114
Minimum	0	32.1	5.92	111	90
Maximum	3.26	60.4	9.29	274	350
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	2	7	0	0
# of DWS Exceedences	0	0	7	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.67	0.76	105	0.01	6.07
Standard Deviation	0.87	0.38	21.3	0.01	2.68
# of values	17	17	20	4	13
Lowest fifth percentile	0.65	0.32	71.7	0	2.9
Minimum	0.24	0.06	46	0	0.5
Maximum	3.51	1.64	137	0.025	12.4
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
BHBL	=	Big Hurrah Creek, lower	TDS	=	total dissolved solids
Diss	=	dissolved	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-10 LIDA Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)	
Mean	2.541	15.862	0.049	29.9	0.048	
Standard Deviation	0.169	5.925	0.01	5.9	0.005	
# of values	17	17	17	17	17	
Lowest fifth percentile	2.336	6.608	0.033	21.2	0.036	
Minimum	2.32	6.52	0.031	14	0.032	
Maximum	2.96	24	0.066	40	0.05	
# of values undetected	0	0	8	0	15	
# of values between MDL and PQL	0	0	9	0	2	
Chronic Aquatic Life Criteria (CALC)	230			>20	1.870	
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	1	0	
# of DWS Exceedences	0	0	0	1	0	
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0027	0.0026	0.938	56.1	0.568	41.2
Standard Deviation	0.0005	0.0003	0.927	19.5	0.766	13.22
# of values	17	17	16	17	17	17
Lowest fifth percentile	0.0025	0.0025	0.5	22	0.2	21.48
Minimum	0.0025	0.0025	0.5	5	0.2	17.91
Maximum	0.0042	0.0037	3.6	78.8	3.4	59.71
# of values undetected	14	15	12	1	8	0
# of values between MDL and PQL	3	2	1	0	5	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-10 LIDA Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	10.4	10	0.5	0.5	2.374	2.156
Standard Deviation	1.43	0	0	0	0.432	0.462
# of values	17	17	17	17	17	17
Lowest fifth percentile	10	10	0.5	0.5	1.742	1.598
Minimum	10	10	0.5	0.5	1.63	1.59
Maximum	15.9	10	0.5	0.5	3.4	3.19
# of values undetected	14	17	17	17	8	7
# of values between MDL and PQL	3	0	0	0	9	10
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	18.35	17.12	0.2	0.2	0.342	0.34
Standard Deviation	6.537	5.314	0	0	0.138	0.13
# of values	17	17	17	17	17	17
Lowest fifth percentile	8.312	9.112	0.2	0.2	0.157	0.13
Minimum	7.48	8.6	0.2	0.2	0.1	0.08
Maximum	29.9	25	0.2	0.2	0.591	0.49
# of values undetected	0	0	17	17	2	1
# of values between MDL and PQL	0	0	0	0	14	16
Chronic Aquatic Life Criteria (CALC)					0.09	0.08
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	17	16
# of DWS Exceedences	0	0	0	0	0	0

Table 7-10 LIDA Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	10.88	10.31	0.5	0.5	2	2
Standard Deviation	3.406	3.095	0	0	0	0
# of values	17	17	17	17	17	17
Lowest fifth percentile	5.762	5.644	0.5	0.5	2	2
Minimum	4.73	4.9	0.5	0.5	2	2
Maximum	15.6	14.7	0.5	0.5	2	2
# of values undetected	0	0	17	17	17	17
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.472	0.5	0.02	0.02	0.11	0.096
Standard Deviation	0.065	0	0.002	0	0.05	0.01
# of values	17	17	17	17	17	17
Lowest fifth percentile	0.313	0.5	0.02	0.02	0.1	0.069
Minimum	0.312	0.5	0.02	0.02	0.1	0.069
Maximum	0.5	0.5	0.026	0.02	0.31	0.1
# of values undetected	14	17	16	17	14	15
# of values between MDL and PQL	3	0	1	0	2	2
Chronic Aquatic Life Criteria (CALC)	2.51	2.41	1		0.45	0.46
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-10 LIDA Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	3.408	3.221	0.929	0.5	0.669	
Standard Deviation	1.148	1.082	1.261	0	0.322	
# of values	17	17	17	17	17	
Lowest fifth percentile	1.72	1.64	0.41	0.5	0.5	
Minimum	1.48	1.44	0.383	0.5	0.5	
Maximum	5.04	4.92	5.72	0.5	1.3	
# of values undetected	0	0	9	17	13	
# of values between MDL and PQL	0	0	5	0	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	10.74	11.62	100	100
Standard Deviation	0	0	7.294	5.302	0	0
# of values	17	17	17	17	17	17
Lowest fifth percentile	5	5	1.32	3.72	100	100
Minimum	5	5	1	3.72	100	100
Maximum	5	5	21.5	19.5	100	100
# of values undetected	17	17	1	0	17	17
# of values between MDL and PQL	0	0	2	0	0	0
Chronic Aquatic Life Criteria (CALC)			14.20	14.16		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	7	6	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-10 LIDA Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss		
Mean	230.6	229.8	2.5	2.5		
Standard Deviation	37.81	37.69	0	0		
# of values	17	17	17	17		
Lowest fifth percentile	162.6	160.2	2.5	2.5		
Minimum	153	157	2.5	2.5		
Maximum	261	250	2.5	2.5		
# of values undetected	12	13	17	17		
# of values between MDL and PQL	5	4	0	0		
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	1977.65	1958	0.051	0.048
Standard Deviation	0	0	96.665	107.8	0.016	0.015
# of values	17	17	17	17	17	17
Lowest fifth percentile	0.5	0.5	1844	1788	0.026	0.026
Minimum	0.5	0.5	1820	1780	0.023	0.023
Maximum	0.5	0.5	2170	2150	0.073	0.073
# of values undetected	17	17	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	0.29	0.24				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	17	17	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-10 LIDA Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.5	0.5	9.779	10	54.41	55.01
Standard Deviation	0	0	0.912	0	28.99	23.07
# of values	17	17	17	17	17	17
Lowest fifth percentile	0.5	0.5	9.248	10	10.58	17.76
Minimum	0.5	0.5	6.24	10	2.5	16
Maximum	0.5	0.5	10	10	94.8	80.9
# of values undetected	17	17	16	17	1	0
# of values between MDL and PQL	0	0	1	0	0	0
Chronic Aquatic Life Criteria (CALC)					32.55	31.83
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	12	13
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	0.5	0.5	11.18	9.088		
Standard Deviation	0	0	8.967	3.898		
# of values	17	17	17	17		
Lowest fifth percentile	0.5	0.5	3.916	3.14		
Minimum	0.5	0.5	2.5	1.54		
Maximum	0.5	0.5	43	16.6		
# of values undetected	17	17	1	0		
# of values between MDL and PQL	0	0	2	3		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-10 LIDA Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.04	37.78	7.55	86.9	246
Standard Deviation	0.09	3.02	0.52	30.7	106
# of values	15	17	16	16	9
Lowest fifth percentile	0	33.18	6.84	46.3	107
Minimum	0	32.7	6.46	44	92
Maximum	0.36	42.8	8.74	170	367
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	1	0	0
# of DWS Exceedences	0	0	2	0	0
Analyte	Velocity	Depth	TDS (field)	Dissolved Oxygen (%)	
Mean	1	0.06	43.1	5.82	
Standard Deviation	0.9	0.11	15.4	3.15	
# of values	13	13	16	9	
Lowest fifth percentile	0.17	0.01	22.8	2.04	
Minimum	0.1	0.00	22	0.8	
Maximum	2.67	0.42	85	11.1	
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	
# of DWS Exceedences	0	0	0	0	

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
LIDA	=	Linda Vista Creek	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-11 LHRU Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)	
Mean	2.566	21.018	0.05	57.5	0.051	
Standard Deviation	0.17	4.173	0.012	5.3	0.012	
# of values	22	22	22	22	22	
Lowest fifth percentile	2.292	13.28	0.033	47.1	0.05	
Minimum	2.21	12.2	0.033	44	0.032	
Maximum	2.89	30.6	0.092	62	0.1	
# of values undetected	0	0	11	0	20	
# of values between MDL and PQL	0	0	11	0	1	
Chronic Aquatic Life Criteria (CALC)	230			>20	2.028	
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0027	0.0026	0.693	92.6	0.309	76.69
Standard Deviation	0.0005	0.0003	0.65	19.8	0.128	10.12
# of values	22	22	21	22	22	22
Lowest fifth percentile	0.0025	0.0025	0.05	60.6	0.25	57.84
Minimum	0.0025	0.0025	0.05	36.3	0.2	50.33
Maximum	0.0044	0.0037	2.98	128	0.7	91.07
# of values undetected	20	20	19	0	14	0
# of values between MDL and PQL	2	2	0	0	5	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-11 LHRU Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	9.97	10	0.5	0.5	2.427	2.444
Standard Deviation	0.16	0	0	0	0.241	0.22
# of values	22	22	22	22	22	22
Lowest fifth percentile	10	10	0.5	0.5	1.892	1.921
Minimum	9.26	10	0.5	0.5	1.54	1.68
Maximum	10	10	0.5	0.5	2.5	2.7
# of values undetected	21	22	22	22	20	19
# of values between MDL and PQL	1	0	0	0	2	3
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	33.6	32.26	0.2	0.2	0.211	0.21
Standard Deviation	4.655	4.623	0	0	0.074	0.07
# of values	22	22	22	22	22	22
Lowest fifth percentile	25.29	24.9	0.2	0.2	0.067	0.07
Minimum	23.7	22.2	0.2	0.2	0.05	0.07
Maximum	44.4	44.3	0.2	0.2	0.25	0.25
# of values undetected	0	0	22	22	17	17
# of values between MDL and PQL	0	0	0	0	5	5
Chronic Aquatic Life Criteria (CALC)					0.18	0.17
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	17	17
# of DWS Exceedences	0	0	0	0	0	0

Table 7-11 LHRU Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	23.16	22.55	0.485	0.5	2	2
Standard Deviation	2.931	2.815	0.05	0	0	0
# of values	22	22	22	22	22	22
Lowest fifth percentile	17.69	16.74	0.348	0.5	2	2
Minimum	15.2	15.5	0.322	0.5	2	2
Maximum	26.5	26.6	0.5	0.5	2	2
# of values undetected	0	0	20	22	22	22
# of values between MDL and PQL	0	0	2	0	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.53	0.52	0.02	0.02	0.1	0.099
Standard Deviation	0.162	0.07	0	0	0.02	0.003
# of values	22	22	22	22	22	22
Lowest fifth percentile	0.491	0.5	0.02	0.02	0.08	0.1
Minimum	0.423	0.46	0.02	0.02	0.07	0.086
Maximum	1.25	0.78	0.02	0.02	0.2	0.1
# of values undetected	19	19	22	22	18	21
# of values between MDL and PQL	2	3	0	0	4	1
Chronic Aquatic Life Criteria (CALC)	5.84	5.61	1		1.58	1.38
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-11 LHRU Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	4.574	4.417	0.501	0.5	0.55	
Standard Deviation	0.702	0.693	0.055	0	0.213	
# of values	22	22	22	22	22	
Lowest fifth percentile	3.309	3.158	0.5	0.5	0.5	
Minimum	3	2.93	0.334	0.5	0.5	
Maximum	6.04	5.99	0.69	0.5	1.5	
# of values undetected	0	0	20	22	20	
# of values between MDL and PQL	0	0	2	0	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	1.04	1.016	100	100
Standard Deviation	0	0	0.236	0.171	0	0
# of values	22	22	22	22	22	22
Lowest fifth percentile	5	5	0.784	0.796	100	100
Minimum	5	5	0.69	0.727	100	100
Maximum	5	5	1.71	1.58	100	100
# of values undetected	22	22	12	14	22	22
# of values between MDL and PQL	0	0	10	8	0	0
Chronic Aquatic Life Criteria (CALC)			32.83	32.73		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-11 LHRU Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss		
Mean	213.2	232.2	2.5	2.5		
Standard Deviation	45.55	34.54	0	0		
# of values	22	22	22	22		
Lowest fifth percentile	151.2	163.2	2.5	2.5		
Minimum	150	157	2.5	2.5		
Maximum	250	250	2.5	2.5		
# of values undetected	13	17	22	22		
# of values between MDL and PQL	9	5	0	0		
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	1994.55	1957	0.09	0.088
Standard Deviation	0	0	111.001	256.9	0.011	0.011
# of values	22	22	22	22	22	22
Lowest fifth percentile	0.5	0.5	1782.5	1731	0.068	0.066
Minimum	0.5	0.5	1770	1730	0.06	0.06
Maximum	0.5	0.5	2170	3000	0.105	0.107
# of values undetected	22	22	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	1.58	1.35				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-11 LHRU Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.5	0.492	10	9.837	2.589	2.74
Standard Deviation	0	0.039	0	0.765	0.418	0.975
# of values	22	22	22	22	22	22
Lowest fifth percentile	0.5	0.5	10	10	2.5	2.5
Minimum	0.5	0.318	10	6.41	2.5	1.51
Maximum	0.5	0.5	10	10	4.46	6.77
# of values undetected	22	21	22	21	21	18
# of values between MDL and PQL	0	1	0	1	1	3
Chronic Aquatic Life Criteria (CALC)					75.34	73.69
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	0.5	0.5	19.9	19.46		
Standard Deviation	0	0	6.464	5.206		
# of values	22	22	22	22		
Lowest fifth percentile	0.5	0.5	12.32	10.25		
Minimum	0.5	0.5	2.5	9.99		
Maximum	0.5	0.5	31	26.8		
# of values undetected	22	22	1	0		
# of values between MDL and PQL	0	0	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-11 LHRU Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.05	39.49	7.72	159	217
Standard Deviation	0.1	5.2	0.64	25.9	100
# of values	21	22	18	20	14
Lowest fifth percentile	0	32.91	6.53	118	49
Minimum	0	32.4	6.31	111	0
Maximum	0.33	47.5	8.5	219	342
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	1	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.29	0.51	74.5	0	5.43
Standard Deviation	0.74	0.24	21.4	0.01	3.06
# of values	17	18	20	3	13
Lowest fifth percentile	0.43	0.28	53.2	0	0.42
Minimum	0.17	0.03	0	0	0
Maximum	2.83	1.18	110	0.0125	10.1
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
LHRU	=	Little Hurrah Creek, upper	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-12 LHRL Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)	
Mean	2.582	22.704	0.049	62.7	0.058	
Standard Deviation	0.158	4.91	0.006	6.4	0.033	
# of values	23	23	23	23	23	
Lowest fifth percentile	2.341	14.33	0.037	49.2	0.05	
Minimum	2.23	12.6	0.033	47	0.05	
Maximum	2.83	32.4	0.058	70	0.206	
# of values undetected	0	0	13	0	20	
# of values between MDL and PQL	0	0	10	0	2	
Chronic Aquatic Life Criteria (CALC)	230			>20	1.862	
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.003	0.003	0.632	102.9	1.523	83.38
Standard Deviation	0	0.001	0.544	15.2	2.715	11.95
# of values	23	23	22	23	23	23
Lowest fifth percentile	0.003	0.003	0.05	81.4	0.25	61.05
Minimum	0.0025	0.0025	0.05	63.7	0.25	54.07
Maximum	0.0042	0.0053	2.42	124	9.7	100.78
# of values undetected	19	21	20	0	6	0
# of values between MDL and PQL	4	1	0	0	4	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-12 LHRL Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	17.8	10	0.5	0.493	2.447	2.507
Standard Deviation	32	0	0	0.032	0.174	0.076
# of values	23	23	23	23	23	23
Lowest fifth percentile	8.47	10	0.5	0.5	1.978	2.5
Minimum	6.46	10	0.5	0.348	1.87	2.34
Maximum	163	10	0.5	0.5	2.5	2.82
# of values undetected	17	23	23	22	21	21
# of values between MDL and PQL	4	0	0	1	2	2
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	1	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	34.52	34.04	0.2	0.2	0.246	0.23
Standard Deviation	4.923	3.939	0.01	0	0.079	0.07
# of values	23	23	23	23	23	23
Lowest fifth percentile	26.01	28.3	0.2	0.2	0.088	0.06
Minimum	19.5	24.7	0.14	0.2	0.066	0.05
Maximum	40.5	40.9	0.2	0.2	0.516	0.25
# of values undetected	0	0	22	23	20	20
# of values between MDL and PQL	0	0	1	0	2	3
Chronic Aquatic Life Criteria (CALC)					0.19	0.17
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	21	20
# of DWS Exceedences	0	0	0	0	0	0

Table 7-12 LHRL Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	25.37	24.71	0.52	0.5	2	2
Standard Deviation	3.55	3.387	0.125	0	0	0
# of values	23	23	23	23	23	23
Lowest fifth percentile	18.63	18.63	0.5	0.5	2	2
Minimum	16.4	16.7	0.314	0.5	2	2
Maximum	30.4	30.6	1.06	0.5	2	2
# of values undetected	0	0	20	23	23	23
# of values between MDL and PQL	0	0	2	0	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.495	0.48	0.033	0.02	0.11	0.099
Standard Deviation	0.097	0.05	0.058	0	0.04	0.003
# of values	23	23	23	23	23	23
Lowest fifth percentile	0.347	0.36	0.016	0.02	0.09	0.1
Minimum	0.336	0.34	0.014	0.02	0.07	0.087
Maximum	0.881	0.5	0.298	0.02	0.24	0.1
# of values undetected	17	20	16	23	18	22
# of values between MDL and PQL	6	3	5	0	4	1
Chronic Aquatic Life Criteria (CALC)	6.12	5.87	1		1.70	1.46
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-12 LHRL Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	4.856	4.666	0.87	0.564	1.167	
Standard Deviation	0.758	0.743	1.166	0.223	1.591	
# of values	23	23	23	23	23	
Lowest fifth percentile	3.505	3.408	0.382	0.5	0.5	
Minimum	3.18	3.07	0.357	0.5	0.5	
Maximum	6.13	6.11	5.79	1.46	6.85	
# of values undetected	0	0	14	20	16	
# of values between MDL and PQL	0	0	6	1	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	1.616	0.966	100	100
Standard Deviation	0	0	3.075	0.148	0	0
# of values	23	23	23	23	23	23
Lowest fifth percentile	5	5	0.761	0.672	100	100
Minimum	5	5	0.621	0.634	100	100
Maximum	5	5	15.7	1.24	100	100
# of values undetected	23	23	13	15	23	23
# of values between MDL and PQL	0	0	9	8	0	0
Chronic Aquatic Life Criteria (CALC)			34.36	34.26		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-12 LHRL Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss		
Mean	209.8	206.6	2.5	2.5		
Standard Deviation	40.66	43.76	0	0		
# of values	23	23	23	23		
Lowest fifth percentile	155	151.1	2.5	2.5		
Minimum	155	151	2.5	2.5		
Maximum	250	250	2.5	2.5		
# of values undetected	11	11	23	23		
# of values between MDL and PQL	12	12	0	0		
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	2030	1991	0.099	0.096
Standard Deviation	0	0	137.047	146.7	0.013	0.013
# of values	23	23	23	23	23	23
Lowest fifth percentile	0.5	0.5	1788	1755	0.073	0.074
Minimum	0.5	0.5	1770	1730	0.065	0.065
Maximum	0.5	0.5	2330	2350	0.121	0.118
# of values undetected	23	23	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	1.74	1.48				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-12 LHRL Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.5	0.5	9.849	9.848	6.243	2.553
Standard Deviation	0	0	0.726	0.73	14.26	0.21
# of values	23	23	23	23	23	23
Lowest fifth percentile	0.5	0.5	10	10	2.5	2.5
Minimum	0.5	0.5	6.52	6.5	1.68	2.5
Maximum	0.5	0.5	10	10	68.5	3.49
# of values undetected	23	23	22	22	20	21
# of values between MDL and PQL	0	0	1	1	1	2
Chronic Aquatic Life Criteria (CALC)					78.87	77.14
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	0.5	0.5	20.6	22.56		
Standard Deviation	0	0	6.946	5.665		
# of values	23	23	23	23		
Lowest fifth percentile	0.5	0.5	12.43	12.91		
Minimum	0.5	0.5	2.5	10.8		
Maximum	0.5	0.5	31.2	30.8		
# of values undetected	23	23	1	0		
# of values between MDL and PQL	0	0	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-12 LHRL Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	1.01	40.59	7.83	172	238
Standard Deviation	2.48	6.83	0.56	41.3	84.6
# of values	22	23	21	19	13
Lowest fifth percentile	0	32.43	7	129	117
Minimum	0	32.3	6.78	117	100
Maximum	11.06	51.4	8.75	314	345
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	4	0	0
# of DWS Exceedences	0	0	4	0	0
Analyte	Velocity	Depth	TDS (field)	TSS (field)	Dissolved Oxygen (%)
Mean	1.51	0.41	84.1	0.02	6.34
Standard Deviation	1.03	0.16	14.3	0.01	2.7
# of values	17	18	19	5	12
Lowest fifth percentile	0.35	0.23	64.3	0	3.12
Minimum	0.35	0.20	58	0	1.3
Maximum	4.08	0.75	115	0.025	11
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
LHRL	=	Little Hurrah Creek, lower	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

Table 7-13 HUFF Statistics Report

Analyte	Chloride (.1 mg/L)	Sulfate (.1 mg/L)	Fluoride (.1 mg/L)	Alkalinity (20 mg/L)	Ammonia (.1 mg/L)	
Mean	2.643	13.659	0.052	89.5	0.057	
Standard Deviation	0.42	2.669	0.012	11.8	0.027	
# of values	16	16	16	16	16	
Lowest fifth percentile	2.035	8.23	0.034	64.5	0.032	
Minimum	1.96	7.75	0.033	60	0.032	
Maximum	3.7	16.4	0.08	100	0.144	
# of values undetected	0	0	5	0	14	
# of values between MDL and PQL	0	0	11	0	2	
Chronic Aquatic Life Criteria (CALC)	230			>20	1.934	
Drinking Water Standard (DWS)	250	250	4			
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Cyanide (.005 mg/L) Total	Cyanide (.005 mg/L) WAD	Nitrate/ Nitrite (.1 mg/L)	TDS (lab) (50 mg/L)	TSS (lab) (.4 mg/L)	Calculated Hardness
Mean	0.0027	0.0028	0.695	115.7	0.497	100.75
Standard Deviation	0.0006	0.0008	0.508	13	0.48	15.51
# of values	16	16	15	16	16	16
Lowest fifth percentile	0.0025	0.0025	0.5	93.8	0.238	68.32
Minimum	0.0025	0.0025	0.5	90	0.2	63.33
Maximum	0.0047	0.005	2.42	133	2.2	116.27
# of values undetected	13	13	14	0	6	0
# of values between MDL and PQL	3	2	0	0	6	0
Chronic Aquatic Life Criteria (CALC)	0.0052					
Drinking Water Standard (DWS)	0.2		10	500		
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-13 HUFF Statistics Report (continued)

Analyte	Aluminum (20 µg/L) Total	Aluminum (20 µg/L) Diss	Antimony (1 mg/L) Total	Antimony (1 mg/L) Diss	Arsenic (5 µg/L) Total	Arsenic (5 µg/L) Diss
Mean	10.6	9.54	0.493	0.5	2.5	2.5
Standard Deviation	3.38	1.08	0.027	0	0	0
# of values	16	16	16	16	16	16
Lowest fifth percentile	6.87	7.36	0.473	0.5	2.5	2.5
Minimum	6.31	6.28	0.392	0.5	2.5	2.5
Maximum	21.5	10	0.5	0.5	2.5	2.5
# of values undetected	12	13	15	16	16	16
# of values between MDL and PQL	3	3	1	0	0	0
Chronic Aquatic Life Criteria (CALC)	87					150
Drinking Water Standard (DWS)			6		10	
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Barium (3 µg/L) Total	Barium (3 µg/L) Diss	Beryllium (.4 µg/L) Total	Beryllium (.4 µg/L) Diss	Cadmium (.1 µg/L) Total	Cadmium (.1 µg/L) Diss
Mean	15.24	13.65	0.24	0.2	0.238	0.25
Standard Deviation	4.301	1.458	0.17	0	0.048	0
# of values	16	16	16	16	16	16
Lowest fifth percentile	12.23	11.55	0.2	0.2	0.182	0.25
Minimum	12	11.4	0.2	0.2	0.063	0.25
Maximum	30.6	17.6	0.86	0.2	0.273	0.25
# of values undetected	0	0	15	16	13	16
# of values between MDL and PQL	0	0	0	0	3	0
Chronic Aquatic Life Criteria (CALC)					0.20	0.19
Drinking Water Standard (DWS)	2,000		4			
# of CALC Exceedences	0	0	0	0	15	16
# of DWS Exceedences	0	0	0	0	0	0

Table 7-13 HUFF Statistics Report (continued)

Analyte	Calcium (2 mg/L) Total	Calcium (2 mg/L) Diss	Chromium (1 µg/L) Total	Chromium (1 µg/L) Diss	Cobalt (4 µg/L) Total	Cobalt (4 µg/L) Diss
Mean	30.34	29.4	0.521	0.546	2	2
Standard Deviation	4.547	4.333	0.132	0.214	0	0
# of values	16	16	16	16	16	16
Lowest fifth percentile	20.78	20.58	0.46	0.473	2	2
Minimum	19.2	19.3	0.339	0.392	2	2
Maximum	34.9	34.2	0.993	1.34	2	2
# of values undetected	0	0	14	14	16	16
# of values between MDL and PQL	0	0	2	1	0	0
Chronic Aquatic Life Criteria (CALC)			11			
Drinking Water Standard (DWS)			100			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Copper (1 µg/L) Total	Copper (1 µg/L) Diss	Iron (.04 mg/L) Total	Iron (.04 mg/L) Diss	Lead (.2 µg/L) Total	Lead (.2 µg/L) Diss
Mean	0.485	0.45	0.022	0.021	0.13	0.098
Standard Deviation	0.133	0.09	0.01	0.005	0.08	0.007
# of values	16	16	16	16	16	16
Lowest fifth percentile	0.317	0.32	0.013	0.019	0.1	0.093
Minimum	0.311	0.31	0.013	0.015	0.09	0.072
Maximum	0.832	0.58	0.053	0.039	0.41	0.103
# of values undetected	8	7	6	13	13	14
# of values between MDL and PQL	8	9	9	3	1	2
Chronic Aquatic Life Criteria (CALC)	6.74	6.47	1		1.96	1.66
Drinking Water Standard (DWS)	1,000		0.3			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-13 HUFF Statistics Report (continued)

Analyte	Magnesium (.2 mg/L) Total	Magnesium (.2 mg/L) Diss	Manganese (1 µg/L) Total	Manganese (1 µg/L) Diss	Mercury (1 ng/L) Total	
Mean	6.056	5.799	2.479	1.927	1.025	
Standard Deviation	1.023	0.968	1.932	1.403	0.732	
# of values	16	16	16	16	16	
Lowest fifth percentile	3.985	3.925	0.481	0.332	0.5	
Minimum	3.73	3.61	0.424	0.321	0.5	
Maximum	7.06	6.93	6.66	4.82	2.7	
# of values undetected	0	0	1	0	9	
# of values between MDL and PQL	0	0	3	5	0	
Chronic Aquatic Life Criteria (CALC)					770	
Drinking Water Standard (DWS)			50		2,000	
# of CALC Exceedences	0	0	0	0	0	
# of DWS Exceedences	0	0	0	0	0	
Analyte	Molybdenum (10 µg/L) Total	Molybdenum (10 µg/L) Diss	Nickel (2 µg/L) Total	Nickel (2 µg/L) Diss	Phosphorus (30 µg/L) Total	Phosphorus (30 µg/L) Diss
Mean	5	5	1.113	1.071	100	100
Standard Deviation	0	0	0.356	0.271	0	0
# of values	16	16	16	16	16	16
Lowest fifth percentile	5	5	0.734	0.757	100	100
Minimum	5	5	0.72	0.731	100	100
Maximum	5	5	2.14	1.65	100	100
# of values undetected	16	16	6	5	16	16
# of values between MDL and PQL	0	0	9	11	0	0
Chronic Aquatic Life Criteria (CALC)			37.79	37.68		
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-13 HUFF Statistics Report (continued)

Analyte	Potassium (500 µg/L) Total	Potassium (500 µg/L) Diss	Selenium (5 µg/L) Total	Selenium (5 µg/L) Diss		
Mean	220	208.1	2.5	2.5		
Standard Deviation	37.13	41.09	0	0		
# of values	16	16	16	16		
Lowest fifth percentile	161.3	156.3	2.5	2.5		
Minimum	156	151	2.5	2.5		
Maximum	271	250	2.5	2.5		
# of values undetected	7	7	16	16		
# of values between MDL and PQL	9	9	0	0		
Chronic Aquatic Life Criteria (CALC)			5	4.6		
Drinking Water Standard (DWS)			50			
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		
Analyte	Silver (1 µg/L) Total	Silver (1 µg/L) Diss	Sodium (500 µg/L) Total	Sodium (500 µg/L) Diss	Strontium (.01 mg/L) Total	Strontium (.01 mg/L) Diss
Mean	0.5	0.5	2031.88	1955	0.086	0.082
Standard Deviation	0	0	190.271	150.4	0.012	0.012
# of values	16	16	16	16	16	16
Lowest fifth percentile	0.5	0.5	1790	1718	0.061	0.059
Minimum	0.5	0.5	1730	1710	0.057	0.057
Maximum	0.5	0.5	2550	2300	0.099	0.097
# of values undetected	16	16	0	0	0	0
# of values between MDL and PQL	0	0	0	0	0	0
Chronic Aquatic Life Criteria (CALC)	2.11	1.79				
Drinking Water Standard (DWS)	100		250,000			
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0

Table 7-13 HUFF Statistics Report (continued)

Analyte	Thallium (1 µg/L) Total	Thallium (1 µg/L) Diss	Vanadium (20 µg/L) Total	Vanadium (20 µg/L) Diss	Zinc (2 µg/L) Total	Zinc (2 µg/L) Diss
Mean	0.492	0.5	10	10	2.5	2.761
Standard Deviation	0.034	0	0	0	0	1.348
# of values	16	16	16	16	16	16
Lowest fifth percentile	0.467	0.5	10	10	2.5	1.958
Minimum	0.366	0.5	10	10	2.5	1.95
Maximum	0.5	0.5	10	10	2.5	7.77
# of values undetected	15	16	16	16	16	13
# of values between MDL and PQL	1	0	0	0	0	2
Chronic Aquatic Life Criteria (CALC)					86.76	84.85
Drinking Water Standard (DWS)	2					
# of CALC Exceedences	0	0	0	0	0	0
# of DWS Exceedences	0	0	0	0	0	0
Analyte	Tin (5 µg/L) Total	Tin (5 µg/L) Diss	Titanium (5 µg/L) Total	Titanium (5 µg/L) Diss		
Mean	0.5	0.5	26.46	28.02		
Standard Deviation	0	0	9.79	10.82		
# of values	16	16	16	16		
Lowest fifth percentile	0.5	0.5	14.35	14.23		
Minimum	0.5	0.5	11.2	12.8		
Maximum	0.5	0.5	45.8	49.8		
# of values undetected	16	16	0	0		
# of values between MDL and PQL	0	0	0	0		
Chronic Aquatic Life Criteria (CALC)						
Drinking Water Standard (DWS)						
# of CALC Exceedences	0	0	0	0		
# of DWS Exceedences	0	0	0	0		

Table 7-13 HUFF Statistics Report (continued)

Analyte	Turbidity	Temp (°F)	pH	Conductivity	ORP
Mean	0.11	44.38	7.97	193	241
Standard Deviation	0.27	7.62	0.69	35.4	79.9
# of values	16	16	16	16	8
Lowest fifth percentile	0	33.53	6.58	145	131
Minimum	0	32.7	6.57	133	127
Maximum	1.06	54.2	8.68	282	336
Chronic Aquatic Life Criteria (CALC)		59	>6.0 and <8.5		
Drinking Water Standard (DWS)			>6.5 and <8.5		
# of CALC Exceedences	0	0	5	0	0
# of DWS Exceedences	0	0	5	0	0
Analyte	Velocity	Depth	TDS (field)	Dissolved Oxygen (%)	
Mean	2.08	0.52	95.8	5.95	
Standard Deviation	1.12	0.15	16.1	3.37	
# of values	12	12	16	8	
Lowest fifth percentile	0.75	0.41	72	1.54	
Minimum	0.16	0.39	66	0.06	
Maximum	4.31	0.82	131	9.9	
Chronic Aquatic Life Criteria (CALC)					
Drinking Water Standard (DWS)			500		
# of CALC Exceedences	0	0	0	0	
# of DWS Exceedences	0	0	0	0	

Notes:

#	=	number	mg/L	=	milligrams per liter
%	=	percent	ng/L	=	nanograms per liter
°F	=	degrees Fahrenheit	ORP	=	oxygen reduction potential
µg/L	=	micrograms per liter	PQL	=	practical quantitation limit
Diss	=	dissolved	TDS	=	total dissolved solids
HUFF	=	Huffy Creek	TSS	=	total suspended solids
MDL	=	method detection limit	WAD	=	weak acid dissociable

7.5.2.3 Consequences

Runoff

Surface water quality should be minimally impacted. There are no planned surface water discharges at either mine site. Runoff from development rock at both sites is anticipated to be benign (See Section 7.3.2, Acid Rock Drainage and Metal Leaching Potential, for further discussion). Preliminary modeling results using MWMP tests indicate arsenic will not exceed applicable standards. A few metals (antimony and thallium) are elevated, but because the modeling used MWMPs these metals are expected to represent a worst-case scenario. Tailings runoff at the Rock Creek Mine/Mill Complex will be recycled as mill process water.

7.5.3 Pit Lake Modeling

Pit lake modeling was conducted to determine if, at closure when the open pits fill with water, water quality within the lake, and discharged from the lake, will meet water quality standards.

Post-closure pit lake water quality for the Rock Creek and Big Hurrah sites was predicted for the period as the pit lakes filled and for two points in time after the pit lake begins overflowing. These results were compared to applicable water standards and to the range of natural background water quality observed in Rock Creek and Little Hurrah Creek respectively. For Rock Creek, two scenarios were simulated: one with the pit being filled naturally from upstream run-in and groundwater (Base Case), and another with enhanced or rapid filling to reduce the time of pit wall exposure to oxidation (Alternative Case). Two conditions were included. One where surface water entering the pit lake is not impacted from discharging groundwater, and another, where surface water is impacted by groundwater. An alternate case was not developed for the Big Hurrah pit as it is a small pit that will fill quickly.

7.5.3.1 Modeling Process

Modeling Approach

The modeling approach taken for these analyses conceptualizes the pit lake as a completely mixed reactor that results from the volumetric and chemical mixing of inflowing waters with specific chemical compositions. The pit lake is expected to mix seasonally due to wind-driven currents and seasonal changes in temperatures. The hydrologic analysis developed from a site-wide watershed model was based on site-specific precipitation records from the Nome Airport and scaled to conservative site flow measurements. Watershed model results were used as input to the water balance model for the pit lake from the end of mining operations to closure plus 100 years. The geochemical modeling uses geochemical test data to estimate the chemistry of water that contacts site materials and subsequently enters the pit. These chemistry estimates are used in a thermodynamic chemical equilibrium and mixing model to simulate the final composition upon mixing of different waters and the chemical reactions that result. Modeling method details are provided in the following sections.

Hydrologic Model

The hydrologic pit lake water balance model was developed to predict the rate of pit filling through time, the proportion of various inputs to the lake, and the ultimate pit lake water level. The model accounted for pit lake inflow and outflow components as part of a volume balance. Inflows included direct precipitation, Rock Creek surface water, overland flow as pit wall runoff, and groundwater. Outflows included evaporation and pit lake overflow once pit lake water elevation reaches the crest at the southern end of the pit. Surface water and precipitation inflows were estimated based on Nome Airport mean monthly rainfall records, scaled by a factor of 2. This multiplier was based on measured flows on and around the Rock Creek and Big Hurrah project areas. The multiplier is considered highly conservative, as additional precipitation analyses conducted after the modeling, based on more extensive precipitation data rather than regional stream flow data, predicts a multiplier at Rock Creek of 1.7. Groundwater inflow was based on preliminary aquifer testing and basin-scale water accounting calculations. The points of time selected for the geochemical modeling corresponded to the 1/3-full lake, 2/3-full lake, full without overflow, and approximately 40 years after filling with overflow. For the Base Case model, these times were 0.4, 1.4, 3.3, and 43 years, and for the Alternative Case the simulation times were 0.3, 0.7, 1.6, and 43 years.

Geochemical Model

PHREEQC (Parkhurst and Appelo, 1999) was used for all geochemical speciation, mixing, and reaction modeling conducted for this assessment. PHREEQC is an industry standard computer program used worldwide for conducting geochemical calculations for predicting the chemistry of natural or impacted waters in the environment. For this assessment, geochemical modeling was used to predict the composition of the pit lake water through time after operations cease and pit dewatering wells are turned off. As the pit lake fills, and eventually overflows, the composition of each of the water balance components mixes and reactions with rock and air occur, resulting in evolving pit lake water quality. Pit wall chemical reactions that occur during pit wall runoff and pit wall flooding as the pit lake fills occur in the damaged rock zone (DRZ) of the pit wall and may contribute significantly to the overall solute loading to the pit lake. The DRZ is conceptualized as the surface layer of the pit wall that has been damaged or cracked during mining, which may significantly increase the porosity and reactive surface area. Site-specific information was used as input to the model when available, including the average composition of surface and groundwater, the composition of water equilibrated with the rock types, and the volumes and surface areas of the pit. It was assumed that a uniform mixture of the rock types in their relative percentages from the entire pit will be exposed at all times through mining and closure. Site specific humidity cell test (HCT) results were used for the Rock Creek and Big Hurrah pit models.

Pit Lake Area Estimation

The geochemical modeling requires estimates of the plan-view and actual (perpendicular) areas of the entire pit and the pit lake at each of the geochemical modeling simulation times. The plan areas were estimated from site topographic maps, and the actual area is the surface area of the exposed surface of the pit walls at a perpendicular to the pit wall angle. The site plan was used to calculate these areas and associated incremental volumes as a function of

elevation in the pit. The pit volume and stage data was used to determine elevations for the 1/3-full, 2/3-full, and full-pit lake area calculations.

Water Quality of Pit Lake Inflows

Specific water compositions were assigned to the inflow and outflow waters included in the pit lake water balance model. Rainfall was simulated as pure water equilibrated with atmospheric gases.

Groundwater inflow to the Rock Creek lake was assumed to be represented by the average composition of samples collected from Rock Creek site monitoring well MW03-03 from January 2004 to November 2005. The water chemistry of inflow from Rock Creek was calculated as the average chemical composition of samples collected upstream of the pit (at the location named ROCK1) from October 2003 to January 2005. Both the Rock Creek surface water and groundwater are circum-neutral pH, calcium-bicarbonate waters with excess alkalinity. However, the groundwater does have a higher sulfate concentration than the surface water, and both the surface and groundwater compositions exceed the arsenic drinking water standard. Precipitation that lands on the pit walls and overland flow into the pit (not associated with Rock Creek) was considered pit wall runoff. Pit wall runoff is simulated to react with minerals contained in the exposed pit walls. The pit wall runoff and the submerged pit wall recirculation water compositions were estimated from HCT laboratory tests scaled to field conditions and climate.

Groundwater inflow to the Big Hurrah lake was assumed to be represented by the composition of samples collected from a well at Big Hurrah Camp (Camp Well #1) in May 2005. The water chemistry of inflow from the Little Hurrah Creek was represented by the chemical composition of samples collected upstream of the pit in June 2005. Both the Little Hurrah Creek surface water and groundwater are circum-neutral, calcium-bicarbonate waters with alkalinity values of 62.7 ug/L in Little Hurrah Creek surface water and 229 ug/L in the groundwater source at Big Hurrah Camp well. Groundwater at Big Hurrah contains elevated concentrations of iron, magnesium, manganese, sulfate, strontium, and zinc and exceeds drinking water standards for arsenic.

HCTs are kinetic tests commonly used for estimating weathering rates under accelerated weathering conditions. Approximately 2.6 pounds (1.2 Kg) of sample, crushed to minus 0.25-inch (6.35 mm), is subjected to weekly wet-dry cycles, then flushed with water. The water is analyzed and the time-series chemistry data are used to estimate the short- and long-term weathering rates of the sample and to estimate the chemistry of water that would contact similar materials on the mine site. These estimates are used to predict the water chemistry of pit wall runoff and waste rock and tailings seepage by applying scaling calculations and site-specific climate data. Weeks 21 to 24 composite samples from Rock Creek were selected to represent long-term behavior. Weeks 17 to 20 composite samples from Big Hurrah were selected to represent long-term behavior. The HCTs resulted in circum-neutral pH, calcium-bicarbonate waters with excess alkalinity for all rock types. However, there were some rock types at Rock Creek that had HCT data that exceeded the drinking water standards for arsenic, antimony, and thallium. At Big Hurrah, HCT results indicated exceedances of applicable standards for cadmium, copper, and lead. HCT results for each rock type were scaled to field

conditions and combined in proportion to their abundance in the pit walls using the geochemical model, producing an estimate of the bulk pit wall runoff water chemistry.

Scaling to Pit Wall Runoff and Submerged Mixing

Laboratory testing is conducted under controlled and specific conditions including, in the case of HCTs, the grain size and volume of water used. Because test samples and water volumes are different in the field than in the laboratory, test results should be adjusted (scaled) to account for these differences. The HCT results were scaled to the site-specific field conditions by the relative change in rock surface area and volume of water flushed over the rock. This scaling was conducted for both the unsubmerged pit wall runoff and the water that enters the lake from the pit wall after submergence. The HCT concentrations were multiplied by the water flushed through the cell, and divided by the surface area per unit mass and the pore volumes flushed during the laboratory test, which resulted in mass of solute per unit surface area per pore volume of water flushed. The test surface area per unit mass for each of the rock types was estimated from the particle size analysis. The specific surface area of HCT material was assumed to be 86 square feet per pound (ft^2/lb) (17.7 square meters per kilogram [m^2/kg]) for all rock types. The HCT samples contained from 3.22 to 4.09 pounds (lbs) (1.46 to 1.854 kg) of rock in the cells, and over the 24 weeks 4.5 to 4.8 gallons (17.2 to 18.0 liters) were flushed through the cells.

The rates were converted back to field scale concentrations for the unsubmerged pit wall runoff by multiplying by the pit wall reactive surface area and pore volumes and dividing by the total volume of runoff for the simulated period of time. The volume of rock mass that contributes to mass loading to the pit lake was estimated by using an oxygen diffusion model that predicts the extent of pyrite oxidation into the pit wall as a function of moisture content, porosity of the pit wall, pyrite content, and time. The results indicated a production zone ranging from 2.8 to 4.2 feet (0.9 to 1.3 m), depending on the time of exposure of the pit walls. The field scaling of the HCT data assumed that the DRZ porosity was 0.1, the rock density was 149 pounds per cubic foot (lb/ft^3) (2410 kg per cubic meter [kg/m^3]) and the specific surface area was 1.5 ft^2/lb (0.31 m^2/kg). Scaling was updated for each model time period.

A similar analysis was prepared for the submerged pit wall. The laboratory flux rate was converted to the field scale, with the submerged pit surface area and two submerged pit wall pore volumes for the volume of water passing through the submerged pit surface area. Two pore volumes were assumed to be mobilized from the submerged pit wall damaged rock zone. After scaling, the charge balance for each solution was checked. A charge balance is a comparison of the sum of the cations compared to the sum of the anions, which confirms the electroneutrality requirement for natural waters. The geochemical model was used to modify the concentration of an element in order to correct for slight differences in the charge balance. Chloride and sodium were used to adjust the charge balance of the input waters, because these elements do not play critical roles in geochemical reactions of concern for the Rock Creek pit lake simulations.

Pit Lake Modeling Process

The geochemical modeling process involved a series of solution mixing, chemical reactions, and mineral surface adsorption modeling to predict the pit lake composition at each selected output time. The process included:

- Developing individual, charge-balanced waters that are representative of contact waters at the Rock Creek site;
- Mixing the individual components of pit wall runoff, in proportion to their quantities in the pit wall, to estimate an average pit wall runoff chemistry;
- Mixing individual components of the flushed DRZ chemistry in proportion to their quantities to estimate average chemistry of water flushed from the damaged rock zone;
- Mixing the pit wall solutions with the groundwater, surface water, and rainfall according to proportions from the pit lake water balance model;
- Removing pure water from the pit lake to account for evaporation in quantities estimated from the pit lake water balance;
- Equilibration of the pit lake water with likely mineral phases and atmospheric gases available for reaction (ferrihydrite, oxygen, and carbon dioxide); and
- Adsorption of specific compounds (arsenic, barium, lead, cadmium, copper, nickel, calcium, phosphate, zinc, beryllium, and sulfate) from the pit lake onto ferrihydrite according to Dzombak and Morel (1990).

The result of the geochemical modeling was a pit lake solution chemistry after a given time period. This procedure was then repeated for each time period. The new solution chemistry from each time period was mixed with the pit lake composition from the previous time step.

The results of the water-balance model include pit lake volume and stage elevation for each month after the end of mining operation. Additionally, the volumes into and out of the pit lake were calculated for each component, and the pit lake inflow mixture percentages were developed for use in the geochemical model.

7.5.3.2 Pit Lake Modeling Results

Rock Creek Pit Lake

The Rock Creek pit lake fills after 3.3 years. If surface drainage is redirected into the pit, a likely scenario, the pit fills after 1.6 years. The Big Hurrah pit, which is a relatively small pit, fills after 0.3 year. In all cases and time steps at both sites, surface water is the most significant inflow component, and groundwater and pit wall runoff constitute a minor fraction of the inflow to the pit.

For both the rapid filling and normal filling scenarios, two geochemical conditions were simulated. This first scenario is a conservative condition where the existing water quality for Rock Creek inflow is used. The second scenario is an expected condition where the Rock Creek water flowing into the pit lake is pure runoff unimpacted by discharging, mineralized groundwater. This is the expected condition after mining because the existence of the pit will lower the groundwater elevation upgradient of the pit, thereby reducing, and probably eliminating, upwardly discharging groundwater to Rock Creek. With the removal of the groundwater component, Rock Creek will consist of entirely clean runoff water.

Conservative Condition

The predicted lake compositions for both normal and rapid fill were similar. Both cases had circum-neutral pH values throughout the modeled time period with a range of 7.8- 7.9 and were of a calcium-bicarbonate water type with alkalinities ranging from 113-116 mg/l.

Many of the metals were predicted to have relatively low concentrations in both the normal and rapid fill cases. Many of the metals concentrations were predicted to decrease over time for the Alternative Case, due primarily to ongoing dilution of pit wall runoff with Rock Creek inflows and sorption to ferrihydrite. For the normal fill case, some constituents, including chloride and sulfate, were predicted to increase in concentration over time, interpreted to be a function of less Rock Creek inflow compared to evaporative losses. The rapid fill case did not significantly improve the pit lake water quality compared to the normal fill case.

For both cases, the pit lake concentration only exceeded the applicable water quality standard for arsenic. The normal fill case arsenic decreases from 0.027 to 0.025 mg/l over the 43 years, the rapid fill case arsenic decreases from 0.025 to 0.024 mg/l over the 43 years, compared to the arsenic standard of 0.01 mg/l.

The mean Rock Creek arsenic concentration at the ROCK1 sampling station is 0.032 mg/l, which is a reasonable estimate of the background surface water concentrations at the site. The predicted pit lake arsenic concentrations, for both cases at all time steps, was predicted to be lower than the mean and lowest 5th percentile background surface water concentrations at the ROCK station due to dilution from inflowing groundwater and sorption to ferrihydrite. Application for a site specific background criteria will be required.

These results suggest that the pit lake will not significantly impact the surface water quality at the site after closure and may improve water quality from dilution with groundwater. Since, most of the water will flow from Rock Creek into the pit lake during spring runoff when concentrations are the lowest, predicted concentrations will likely be lower than predicted in this conservative condition. Additionally, the rapid pit filling closure scenario simulated with the Alternative Case model is not recommended for closure design, because it did not significantly improve water quality.

Expected Condition

The predicted pit lake compositions for both normal and rapid fill models were similar. Both Cases had circum-neutral pH values throughout modeled time period, with a range of 7.3 to 7.4, and were of a calcium-bicarbonate water type with alkalinities ranging from 31- 42 mg/l. Dissolved concentrations of all constituents were low. No constituents were predicted to exceed standards or background concentrations in Rock Creek. Concentrations were not predicted to change significantly through time.

The result of the expected case indicate that the pit lake will not impact the surface water quality at the site after closure and may improve water quality because of reducing or eliminating groundwater discharge to Rock Creek over the long term. Additionally, the rapid

pit filling closure scenario simulated with the Alternative Case model is not recommended for closure design, because it did not significantly improve water quality.

A Sensitivity Run was included, whereby groundwater inflow was increased and the representative groundwater chemistry contained the maximum measured value for arsenic concentration. The results indicate overall good water quality with the exception of arsenic and thallium exceedances. The predicted arsenic and thallium concentrations do not exceed the average background concentrations measured at Rock Creek. The discharge from the pit lake, along with clean surficial runoff, will dilute the creek water resulting in improved water quality from existing pre-mining conditions.

Big Hurrah Pit Lake

Metal concentrations in Big Hurrah pit lake are relatively low, due to the low metal concentration in the surface water contribution, which dominates the pit lake chemistry. Groundwater entering the pit contained the highest metal concentrations, but was such a small percentage of the total inflow of the pit lake that the effects of the groundwater composition were insignificant. Another contributing factor to the water chemistry is the rapid filling of the pit, submerging exposed wall rock in a short time, limiting the pyrite oxidation process. The pit filled within approximately one month's time, during the spring breakup. This high influx of buffered surface water diluted any potential contaminants to a level that is in compliance with current drinking water standards. The groundwater arsenic concentration at the Big Hurrah Camp sampling station is 0.079 mg/L, which appears to be a reasonable estimate of the background groundwater concentrations at the site. The predicted pit lake arsenic concentrations at each of the time steps was predicted to be lower than the background groundwater concentrations, due to dilution from inflowing surface water and sorption to ferrihydrite. These results suggest that the pit lake will not significantly impact the surface water quality at the site after closure, due to the rapid filling of the lake, limiting exposure of pit wall rocks, and the dilution of potential contaminants by neutral, high-buffering surface water entering the pit during heavy precipitation events.

Pit Lake Management

On the basis of this preliminary assessment, Rock Creek pit lake water quality can be managed so that applicable water quality standards are not exceeded. The expected case whereby unimpacted surface water enters the pit from Rock Creek after closure, indicates water quality in the pit will be dominated by surface flows and that the water quality will be better than that currently observed in Rock Creek.

The Big Hurrah pit lake water quality can be managed so that applicable water quality standards are not exceeded for all constituents. The high volume of surface water runoff during the spring months after mine closure fills the pit lake rapidly, reducing the time that reactive pit walls are exposed to oxygen. This reduces the total chemical mass load to the pit, and aids in the dilution of potential contaminants introduced to the system by inflowing groundwater. The groundwater contribution to the pit accounts for less than 1% of the total inflow, and therefore plays an insignificant role in the composition of the pit lake water.

7.5.4 Groundwater

7.5.4.1 Rock Creek Mine/Mill Complex

Rock Creek is a tributary of the Snake River, situated in the north-south-trending foothills of the Kigluarik Mountains. The project area is located near the middle of the Snake River basin and local surface water is drained by Rock Creek and its tributary, Albion Creek. Topography is moderately steep (up to 15% grade) along Rock Creek, with steeper slopes approaching 38% grade near the top of the catchment. The catchment area is approximately 2 mi^2 (5 km^2).

Glacial, alluvial, and tectonic processes shaped the eastern wall of the Snake River Valley, upon which this catchment lies. The hydrogeology of the Rock Creek Basin is controlled by the surficial and bedrock geology, the topographic setting, as well as the climate and hydrology.

Within the Rock Creek drainage, the dominant bedrock is a well foliated, "wavy" banded, quartz-muscovite schist containing varying proportions of carbonate graphite/carbon and chlorite. Outcrops and near-surface bedrock are highly weathered and fractured. Drilling with a reverse circulation (RC) air rotary rig results in significant water return in many of the drillholes at full depth. This indicates at least moderate bedrock permeability over a significant portion of the site. Overburden materials include silts formed as a weathering profile overlying the schist, as well as glacial, alluvial, and colluvial materials. Sands and gravels have been observed at some locations on the lower slopes. The bottom of Rock Creek Valley is infilled with sand and gravel. This material has been reworked with a dredge for some distance upstream. West of the Rock Creek site, the Snake River Valley has been infilled, primarily with alluvium. The remnants of abandoned and infilled channels are apparent on the valley floor. Silt infill, as well as channel and bar sands, is expected. Sand and gravel deposits are codepositional and overlie the Snake River alluvium as fans from Lindblom Creek, Rock Creek, and Glacier Creek. MW03-06, drilled through the Rock Creek Fan, penetrated 35 ft (10.7 m) of sand and gravel overlying silt and clay, finally encountering bedrock at a depth of 61 ft (18.6 m).

Sources of groundwater recharge include snowmelt, rainfall, and potential at sites where streams or other surface water features are perched above the water table. Precipitation has been recorded at the Nome Airport since 1906. Correlation of the airport precipitation data with measured stream flows indicates that the average site precipitation is about 2.0 times the Nome Airport precipitation. This results in an average annual precipitation of approximately 40 inches (102 cm) at the site. The Snake River hydrograph indicates that peak flows occur both with snowmelt and with late summer and fall storms.

There are no evaporation data available for the site or the airport. Evapotranspiration in the area has not been studied in detail, however, the actual evapotranspiration in the Nome area is calculated to be 14 inches/year (35.6 cm/year) based on Thornthwaite's classification. A study of thermokarst ponds in the Council area, about 75 miles (120 km) northeast of Nome, by Fraver (2003), included evaluation of evapotranspiration. Extrapolation of the results from that study indicated an annual evapotranspiration of about 14 inches (35.6 cm) for ponds, 10 inches (25.4 cm) for wetlands, and 7 inches (17.8 cm) for uplands. This precipitation and evaporation information indicates there is a significant quantity of water available for runoff and groundwater recharge in the area.

Groundwater recharge often initiates as surface infiltration. The infiltrated water may be transmitted downslope as interflow (or very shallow groundwater) or percolate to the groundwater table. There is a significant quantity of water that transmits down the slope as interflow, with visible discharge from the banks of Rock Creek. This flow path results in a significant retention of storm water, probably reducing the peaks from rainfall events. Some of this retention is within the tundra grasses and some is within the overburden and near surface-fractured rock.

Water entering the groundwater system travels to discharge locally within the creeks or further to discharge into the Snake River alluvium. The local discharge of deeper groundwater into Rock Creek is apparent from the presence of winter base flow, artesian flow from open drill holes, and from the chemistry of Rock Creek water. The estimated annual infiltration in the Rock Creek Basin is approximately 8 inches (20.3 cm), based on rainfall, estimated evapotranspiration, and limited runoff measurements. The presence of permafrost over the catchment would significantly reduce groundwater recharge.

There is a significant quantity of groundwater moving downstream in the alluvium within Rock Creek Valley. The permeability of this alluvium was probably enhanced by dredging operations. Groundwater within this alluvium includes direct precipitation, interflow from upper slopes, and groundwater discharged from depth. The water character is expected to be similar to the character of the creek water, although there may be a higher percentage of deep groundwater.

Groundwater enters the Snake River Valley as direct precipitation, as discharge of deep groundwater into the alluvium, and as stream recharge of alluvial fans. The sand and gravel fans (Rock Creek, Lindblom Creek, and Glacier Creek) transmit considerable water as a result of higher hydraulic conductivity and gradients than the underlying Snake River alluvium. As a result, groundwater discharge is expected into the alluvium, channels, and ponds surrounding the fans.

The groundwater table is expected to be a muted image of the ground topography. This is the case throughout most of the Rock Creek Basin (See Figure 1.1). However, given the locally moderate permeability of the bedrock, the groundwater levels exhibit more variation than expected. This is probably the result of compartmentalization of the groundwater by low permeability faults in the proposed mine area. Ongoing compressive tectonic events have produced faulting at Rock Creek. Three north-striking faults are the Anvil Fault, Brynteson Fault, and the Upper Albion Creek Fault. In the southern part of the resource area, the Sophie Gulch that trends west-northwest is a low-angle normal fault. The faults have demonstrated the ability to compartmentalize groundwater through low-permeability gouge zones and high-permeability fractures. Such compartmentalization has been observed during long-term pumping tests conducted in these zones. Significantly different aquifer responses were observed over short distances from the pumping wells suggesting barriers and conduits of flow are present. The bulk hydraulic conductivity of the bedrock, including the fault barriers, is estimated to be about 3.3 X 10-6 meters per second (m/s) (3.3 X 10^{-6} ft per second [fps]).

A baseline groundwater monitoring program was initiated in October 2003 and has continued on a quarterly basis through 2005. The objective of the monitoring program was to document the existing, natural groundwater chemistry and flow regime within the areas in which mine

development is proposed. The open pit, development rock storage, and tailings storage are the three mine facilities that will have the greatest effect on groundwater. Hydraulic testing was also conducted to determine aquifer properties. Sampling from these wells has provided an indication of pre-mining geochemistry in areas that will be most affected by mine operations.

Seven monitoring wells, summarized on Table 1.1, and seven additional test holes were completed between 2003 and 2004 (Figure 1.1). Well sites are located upgradient and downgradient of the proposed mine facilities. These well sites were selected to represent groundwater quality in alluvium, shallow bedrock, and deep bedrock.

Groundwater samples were collected from each of the seven monitoring wells using the methods outlined in the project Quality Assurance Plan (WMCI, 2003). Water levels were measured in each well to determine the relative change in groundwater elevation from seasonal changes in precipitation.

All monitoring wells were installed with 40 ft (12.2 m) of 0.2-inch (5 mm), factory-slotted, 4-inch-diameter (10-cm-diameter) polyvinyl chloride (PVC) screen. T&J Drilling constructed the wells in 8-inch (20 cm) boreholes using an exploration air rotary rig.

Bedrock was intercepted in all of the test holes and was screened in all of the monitoring wells except MW03-06. The bedrock consists primarily of fractured, carbonate-rich schist which is highly weathered at the surface.

Figure 7.5 Rock Creek Site Map and Monitoring Well Locations

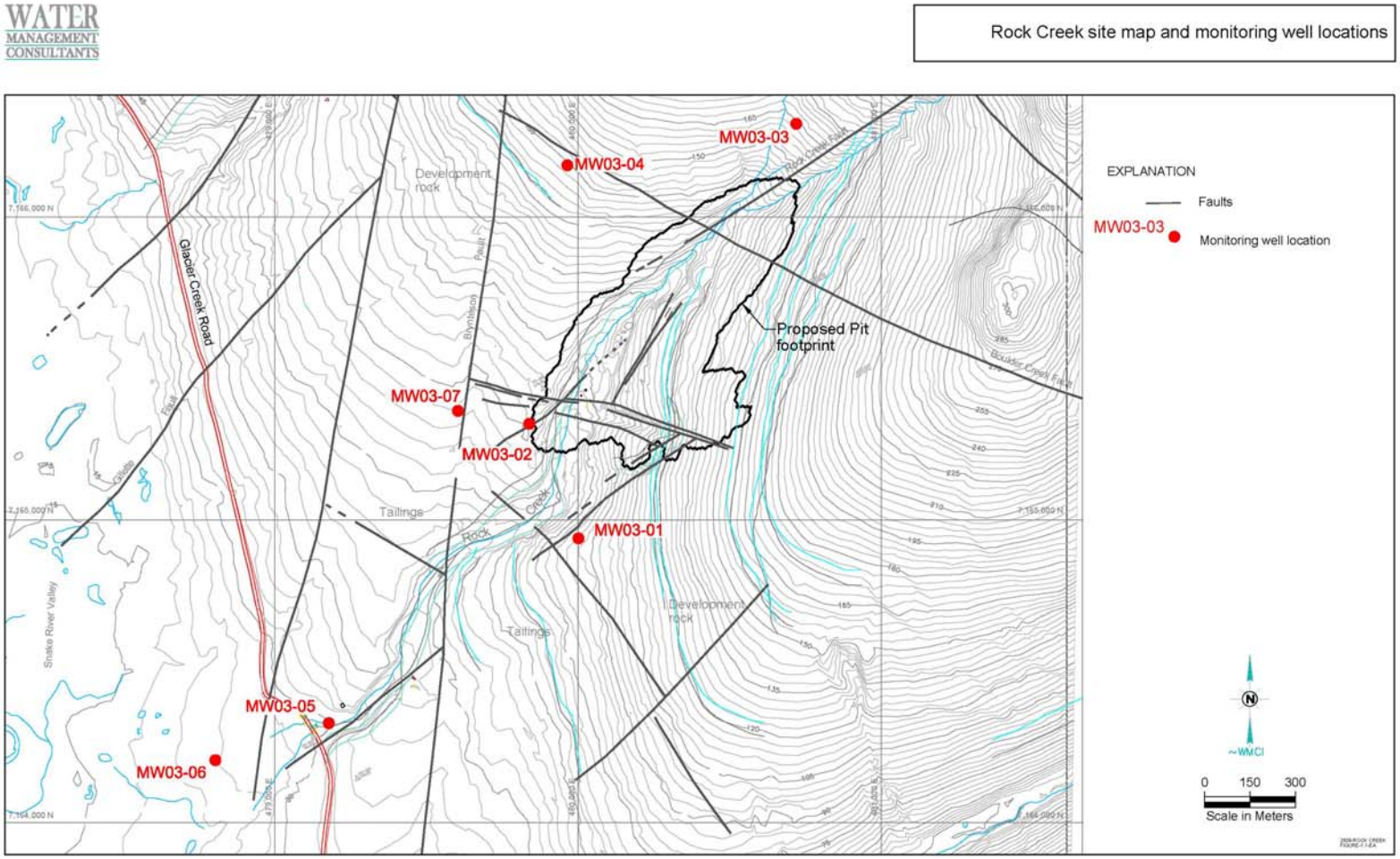


Table 7-14 Monitoring Well Descriptions

Well ID	UTM Easting (m)	UTM Northing (m)	Collar Elevation (above mean sea level)	Purpose	Total Depth Drilled	Top of Screen	Bottom of Screen	Top of Filter Pack	Bottom of Filter Pack	Depth of Pump
MW-03-01	480011	7164903	283.8 ft (86.49 m)	Monitors areas upgradient from the proposed tailings facility.	80.0 ft (24.39 m)	45.0 ft (13.72 m)	65.0 ft (19.82 m)	35.0 ft (10.67 m)	79.0 ft (24.09 m)	60.0 ft (18.29 m)
MW-03-02	479855	7165284	246.7 ft (75.2 m)	Monitors downgradient from the mineralized zone. Will be used to quantify the quantity of groundwater that flows from the mineralized zone to the Snake River alluvium.	150.0 ft (45.73 m)	98.7 ft (30.09 m)	138.7 ft (42.29 m)	89.0 ft (27.13 m)	138.7 ft (42.29 m)	140.0 ft (42.68 m)
MW-03-03	480751	7166260	532.5 ft (162.3 m)	Monitors upgradient from the mineralized zone	120.0 ft (36.59 m)	98.0 ft (29.88 m)	118.0 ft (35.98 m)	90.0 ft (27.44 m)	122.0 ft (37.2 m)	100.0 ft (30.49 m)
MW-03-04	479994	7166135	436.6 ft (133.08 m)	Monitors areas upgradient from the proposed waste rock facilities.	70.0 ft (21.34 m)	46.0 ft (14.02 m)	66.0 ft (20.12 m)	41.0 ft (12.5 m)	70.0 ft (21.34 m)	60.0 ft (18.29 m)
MW-03-05P	479159	7164301	98.3 ft (29.97m)	Monitors areas downgradient from the proposed tailings facility.	285.2 ft (89.94 m)	164.0 ft (50.00 m)	174.0 ft (53.05 m)	163.0 ft (49.70 m)	175.0 ft (53.35 m)	None
MW-03-05	479178	7164306	101.4 ft (30.9 m)	Monitors areas downgradient from the proposed tailings facility.	88.7 ft (27.04 m)	68.0 ft (20.73 m)	88.0 ft (26.83 m)	63.0 ft (19.21 m)	88.0 ft (26.83 m)	80.0 ft (24.39 m)
MW-03-06	478802	7164190	73.5 ft (22.39 m)	Monitors alluvium downgradient from the mine area.	25.0 ft (7.62 m)	16.0 ft (4.88 m)	26.0 ft (7.93 m)	11.0 ft (3.35 m)	30.0 ft (9.15 m)	20.0 ft (6.1 m)

Notes: *UTM coordintes using NAD 27 Zone 3.

ft = feet

m = meters

Two wells were installed to document groundwater quantity and quality within the shallow bedrock and alluvium of Rock Creek and the Snake River. The downgradient tailing facility well (MW03-05) documents the groundwater quality in the bedrock just before it reaches alluvium, and MW03-06 documents the groundwater in the alluvium closer to the Snake River.

Water quality samples were collected and analyzed from each of the seven monitoring wells on a quarter-annual basis using the methods outlined in the project Quality Assurance Plan (WMCI, 2003). The purpose of this study was to document natural groundwater quality conditions in sufficient detail to identify seasonal fluctuations. Field measurements of pH, electrical conductivity, temperature, oxidation reduction potential, ferrous iron, and depth to water were made at the time of, or before, sample collection.

Water samples were tested for total metals, pH, alkalinity, ammonia, chloride, total and WAD cyanide, fluoride, nitrate, nitrite, total phosphorous, sulfate, silicon, and TDS. Samples are continuing to be collected from the wells for water quality analysis.

Rock Creek groundwater chemistry data are presented in the Hydrology Section of the appendices. Cyanide, silicon, and mercury data were not available in the October sampling round, because of holding time and analytical issues.

Metals concentrations are variable across the site, with elevated arsenic, iron, and manganese (compared to drinking water standards) in most wells, except for MW03-04. Arsenic concentrations tend to increase near the proposed open pit, reflecting the increase in natural mineralization in the area. Arsenic concentrations range from 1.83 µg/L in Well MW03-04 to 1,350 µg/L in Well MW03-02, adjacent to the proposed pit site.

Groundwater types were generally uniform across the site, consisting of calcium-bicarbonate water in all wells, except for MW03-02 and MW03-05. Samples taken from these wells showed higher concentrations of calcium, magnesium and sulfate. Both wells represent groundwater in the pit area and immediately downgradient of the proposed pit and reflect the natural influence of mineralization on groundwater chemistry. Groundwater samples from these two wells also show elevated TDS. TDS from all wells ranges from 139 to 728 mg/L. Groundwater pH ranges from 6.9 to 8.1, although pH values at MW03-02 were lower than at the other wells.

Water levels were monitored in each well to measure the relative change in groundwater elevations from seasonal changes in precipitation. Very little change in the groundwater elevation was observed at Rock Creek. Over an 18-month period from 2004 to 2005, groundwater elevations at the seven wells fluctuated an average of 6.0 ft (1.82 m). Records show Well MW03-05 exhibited the smallest change in seasonal water elevation (2.5 ft [0.77 m]) and Well MW03-01 had the largest change in elevation (10.5 ft [3.21 m]).

Groundwater chemistry at Rock Creek can be generally categorized into three types reflecting the water's origin, influence of natural mineralization, and subsequent chemical attenuation and/or dilution.

The first category is upgradient groundwater dominated by snowmelt. This groundwater is represented by MW03-04 and did not exceed the primary or secondary drinking water standards during the baseline sampling.

The second groundwater category is characterized by water adjacent to and influenced by the ore body. MW03-02 is closest to the ore body and was most influenced by the mineralization, resulting in higher TDS, major ions, and metals concentration (antimony, arsenic, iron, and manganese). These influences decrease with increasing distance from the ore body in wells MW03-01 and MW03-07.

The third type represents groundwater influenced by mineralization but which has subsequently flowed downgradient of the proposed mine area where the water reflects chemical attenuation and/or dilution. This has resulted in naturally lower major ions and metal concentrations, as observed in MW03-05 and NW03-06.

Trends in the groundwater flow regime were identified in the data from recovery tests and observations made during drilling of the monitoring wells. Response testing conducted at every monitoring well provided the data to estimate hydraulic conductivity. Monitoring Well MW03-06, within the alluvium of the Snake River Valley, recovered too quickly to obtain sufficient data for analysis. We assume the conductivity would be on the order of 3.3×10^{-4} fps (10^{-4} m/s) because of the nature of the alluvial material. In the upper pit (MW03-03, MW03-03P, MW03-04, MW03-04P, and Pit04-01) higher flows were observed than in the downgradient wells (MW03-01, MW03-02, and MW03-07). Two tests were run for MW03-04. Hole development during one of the tests could have caused the increase in hydraulic conductivity estimates. The higher hydraulic conductivity is consistent with the quantity of water encountered during drilling.

Water quality samples were collected and analyzed from each of the monitoring wells on a quarter-annual basis to document natural groundwater quality conditions in sufficient detail to identify seasonal fluctuations. Field measurements of pH, electrical conductivity, temperature, oxidation reduction potential, ferrous iron, and depth to water were made at the time of, or before, sample collection. Samples are continuing to be collected from the wells for water quality analysis. Additional information of groundwater at Rock Creek is attached in the Hydrology Section of the appendices under Rock Creek Interim Baseline Groundwater Summary and Rock Creek Groundwater Database.

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7.5.4.2 Big Hurrah

The proposed mining site is located at confluence of the Big Hurrah and Little Hurrah creeks. The topography in the Big Hurrah Valley is moderately steep, approaching a 30% grade, with steeper rock slopes along sections of Little and Big Hurrah creeks. A thin soil overburden covers most of the slopes.

The bottom of Little Hurrah Creek consists of thin alluvial/colluvial deposits. The underlying rock consists of predominately structurally complex schist and marble with abundant alteration-related carbonate, quartz, and graphite associated with secondary gold mineralization along the veins. These mineralization zones consist of subparallel ribbons and stockwork quartz veins ranging in thickness from approximately a tenth of an inch to 2 inches

(a few millimeters to 5 centimeters). Gold often occurs along with graphite, scheelite, pyrite, or arsenopyrite and sulfide content averages about 1%.

Sources of groundwater recharge include rainfall and snow melt. Long term precipitation data are not available. A weather station was installed at the project site in the spring of 2005. Average monthly temperature and rainfall from the Nome Airport were used as the long-term record for the Big Hurrah. The temperatures range from a maximum of 50°F (10°C) to a low of 9°F (-13°C) in January. The mean annual precipitation is approximately 41 inches (1.04 m), with the majority occurring between July and October.

Groundwater primarily flows through interconnected bedrock features in the project area from snowmelt and rainfall recharge areas located in the upper watershed south of the project area. The groundwater flows to discharge areas along Big Hurrah Creek, with some shallow water discharges occurring in a few areas on the slopes and along the banks of Big Hurrah Creek.

A baseline groundwater monitoring program was initiated in March 2005. As with Rock Creek, the objective of the Big Hurrah monitoring program was to document the existing natural groundwater chemistry and flow regime within the areas in which mine development is proposed. The open pit, development rock storage, and tailings storage are the three mine facilities that will have the greatest affect on groundwater. Hydraulic testing was also conducted to determine aquifer properties. Water samples from the wells provided baseline groundwater water chemistry before mining operations.

There are currently nine monitoring wells at six locations designed to collect baseline groundwater chemistry and water level data upgradient and downgradient of the proposed mining facilities in the surficial and deep hydrystratigraphies (Figure 1.2). The description of the monitoring wells is found in Table 1.2.

Since October 2004, groundwater elevation measurements have been collected. Groundwater flow occurs primarily through interconnected bedrock fractures and the underground workings. The water levels mimic surface topography. Measured water levels appear to fluctuate with seasonal precipitation. Upward gradients are observed along the Big Hurrah Creek, suggesting groundwater discharge and gaining stream reach in the project area. Other baseline data were collected in addition to water elevations. Data for well depth, well purging volumes, groundwater temperature, pH, conductivity, oxidation-reduction potential, and ferrous iron concentration were collected during each sampling event.

Groundwater samples were collected from each monitoring well using methods outlined in the project Quality Assurance Project Plan (QAPP) (WMCI, 2003). Water samples were tested for total metals, pH, alkalinity, ammonia, chloride, total and WAD cyanide, fluoride, nitrate, nitrite, total phosphorous, sulfate, silicon, and TDS. Each dissolved metals sample was collected by passing the water sample through a 0.45-micrometer filter. Samples were preserved according to standard protocols where each sample was labeled with the well identification number, stored, and shipped in a cooler to SGS Environmental Services in Anchorage at 4°C. The samples were analyzed by SGS using standard methods.

Figure 7.6 Big Hurrah Preliminary Site Layout and Monitoring Well Locations

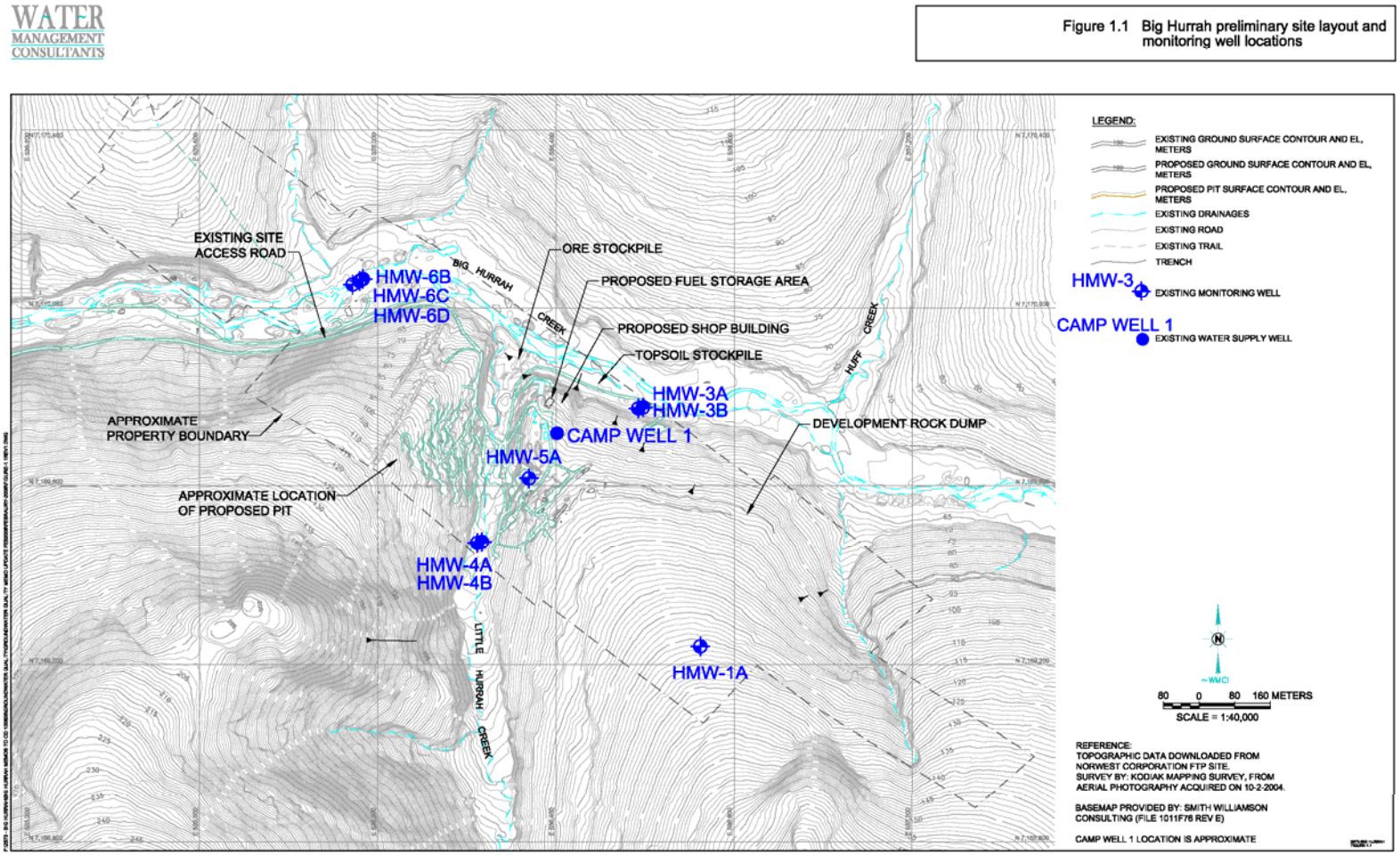


Table 7-15 Monitoring Well Descriptions

Well ID	UTM Easting (m)	UTM Northing (m)	Collar elevation (amsl)	Purpose	Total depth drilled (m)	Top of screen	Bottom of screen	Top of filter pack	Bottom of filter pack	Depth of pump
HMW-1A	536701.90	7169121.55	398.6 ft (121.5 m)	Upgradient of development rock facility	140.0 ft (42.67 m)	116.8 ft (35.60 m)	136.8 ft (41.69 m)	116.0 ft (35.36 m)	Not Available	130.0 ft (39.62 m)
HMW-3A	536639	7169730	212.2 ft (64.7 m)	Downgradient of development rock facility - deep	215.0 ft (65.53 m)	180.6 ft (55.05 m)	210.6 ft (64.19 m)	161.0 ft (49.07 m)	Not Available	200.0 ft (60.96 m)
HMW-3B	536623	7169727	213.2 ft (65.0 m)	Downgradient of development rock facility - shallow	50.4 ft (15.36 m)	40.4 ft (12.31 m)	50.4 ft (15.36 m)	29.0 ft (8.84 m)	Not Available	41.0 ft (12.50 m)
HMW-4A	536189.92	7169475.03	208.3 ft (63.5 m)	Upgradient of the pit - deep	165.0 ft (50.29 m)	131 ft (39.93 m) and 70.0 ft (21.34 m)	151.0 ft (46.02 m) and 80.0 ft (24.38 m)	63.0 ft (19.20 m)	Not Available	141.0 ft (42.98 m)
HMW-4B	536208.21	7169442.33	208.3 ft (63.5 m)	Upgradient of the pit – shallow	12.0 ft (3.66 m)	4.00 ft (1.22 m)	10.0 ft (3.05 m)	2.00 ft (0.61 m)	Not Available	No Pump
HMW-5A	536289.27	7169632.51	216.7 ft (66.04 m)	Monitor historical workings impact in/near pit	200 ft (60.96 m)	115 ft (35.05 m) and 180 ft (54.86 m)	145 ft (44.20 m) And 200 ft (60.96 m)	87.0 ft (26.52 m)	Not Available	194 ft (59.13 m)
HMW-6B	535876	7169963	161.4 ft (49.2 m)	Downgradient of mine facilities – deep	55.0 ft (16.76 m)	38.3 ft (11.68 m)	49.3 ft (15.03 m)	32.0 ft (9.75 m)	Not Available	44.0 ft (13.41 m)
HMW-6C	535904	7169956	169.0 ft (51.5 m)	Downgradient of mine facilities - shallow	12.0 ft (3.66 m)	1.3 ft (0.41 m)	11.4 ft (3.46 m)	Surface	Not Available	8.9 ft (2.71 m)
HMW-6D	535903.64	7169956.16	229.2 ft (69.85)	Downgradient of mine facilities	9.50 ft (2.90 m)	3.50 ft 1.07 m	9.50 ft (2.90 m)	2.00 ft (0.61 m)	Not Available	8.00 ft (2.44 m)

Notes: *Collar elevations for HMW-1A, HMW-4A, and HMW-4B are estimates from the topographic map. Ft = feet, m = meters

Groundwater from the four wells at Big Hurrah consists primarily of calcium-magnesium bicarbonate water. Groundwater with higher levels of calcium magnesium bicarbonate sulfate have been in contact with or immediately downgradient of mineralized zones. Metals concentrations are variable across the site with elevated arsenic (compared to drinking water standards) in wells HMW-5A and Camp Well 1. Wells HMW-5A, HMW-6B, HMW-6C, and Camp Well 1 contain elevated manganese concentrations. The higher concentrations of arsenic, manganese and TDS at Camp Well 1 reflect the increased natural mineralization in this area. No long-term water quality trends are apparent at this time.

Arsenic values range from 1.5 µg/L at HMW-3B to 79.3 µg/L at Camp Well 1. These levels are well below standards for EPA and the Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances. A 1-hour average of 340 µg/L for dissolved arsenic is considered acute, and concentrations of 150 µg/L or less are chronic. Concentrations at or above 0.010 mg/L do not meet EPA drinking water standards.

Groundwater flow in the historic adit at the mine site was recorded to be approximately 150-200 gpm (9.5-12.7 liters per second [L/s]). An injection well drilled at Big Hurrah, outside of the pit area during the summer of 2005 produced 450 gallons per minute (28.3 L/s) indicating a high water volume capacity. The water produced from the injection wells was absorbed readily into the surrounding tundra. Groundwater flow tests are ongoing at Big Hurrah.

Additional groundwater information is attached in the Hydrology Section of the appendices under Interim Baseline Groundwater Summary for Big Hurrah and Big Hurrah Groundwater Database and in the report titled Rock Creek Mine Water Balance Analysis.

7.5.4.3 Groundwater Consequences

Groundwater will be intercepted above the mineralized zone, minimizing potential natural pollution as well as minimizing contact with exposed ore. Groundwater not utilized in process make-up water would then be reinjected into the groundwater system. The alluvial fan appears to have a high capacity for accepting injection water and will abe accessed through an infiltration gallery. Additional injection wells will be located on site for additional capacity. Treatment of naturally elevated arsenic, antimony, manganese, iron, TDS and sulfate concentrations may be required to meet Class V injection well permit requirements.

At Big Hurrah, there is no mill to use the pit dewatering water. Groundwater will be intercepted above the mineralized zone and then either reinjected into the groundwater system.

7.5.5 Water Balance

7.5.5.1 Affected Environment

Surface water flows along natural drainage patterns and through the wetlands scattered about the tundra in the Rock Creek basin. Groundwater appears to contribute the majority of flow during dry and cold periods with precipitation and snow melt contributing to peak flows. Rock Creek average monthly flow rates are estimated for January through December as follows:

- January 190 gpm (12 L/s)
- February 100 gpm (7 L/s)
- March 50 gpm (3 L/s)
- April 170 gpm (11 L/s)
- May 3950 gpm (249 L/s)
- June 900 gpm (57 L/s)
- July 940 gpm (59 L/s)
- August 2060 gpm (130 L/s)
- September 2080 gpm (131 L/s)
- October 860 gpm (54 L/s)
- November 540 gpm (34 L/s)
- December 320 gpm (20 L/s).

Groundwater sources have not been impacted by the historical mining and exploration at the site and there are no present or past man-made interceptors in the groundwater regime.

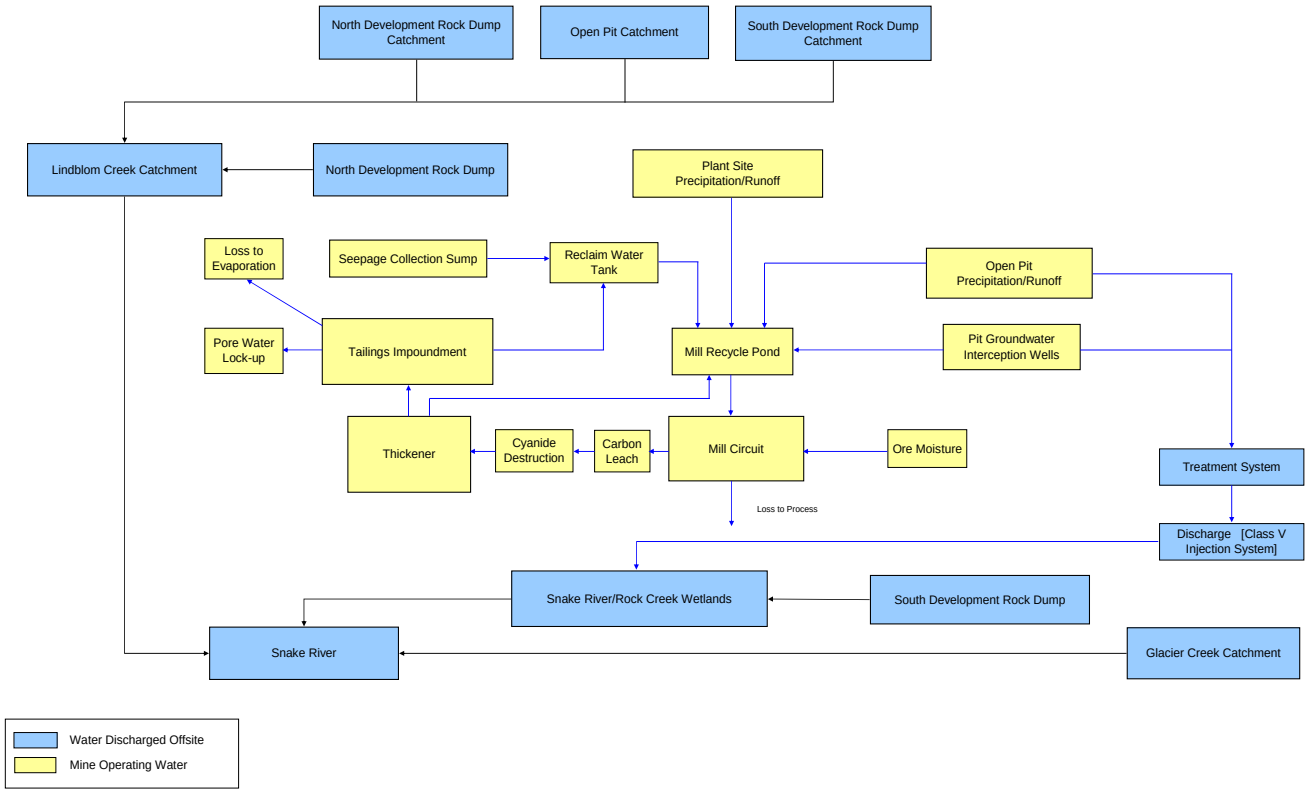
7.5.5.2 Consequences

Water balance modeling was conducted to determine the use, flow and management of surface and groundwater after development. Site-wide water balance modeling was performed by Water Management Consultants (WMC) which incorporated all process and environmental components at the project site. This site-wide water balance was complemented by a process solution system analysis for the tailings storage facility performed by Ecological Resource Consultants, Inc. (ERC). The purpose of the process solution system analysis is to predict solution storage volumes and reclaim solution availability at the tailings storage facility throughout the intended life of mine operations.

Water Balance Components

The water balance incorporates all water inputs into the system including pit dewatering wells and meteorological water. The site wide water balance also tracks free water/solution within the tailings storage facility with the process solution system analysis prepared for the tailings storage facility providing a more detailed estimation of the solution within the process system. Figure 7.7 shows a schematic of the overall flow diagram as modeled in the water balance.

Figure 7.7 Rock Creek Flow Diagram



Model Assumptions/Inputs

Hydrometeorology

Regional climate data has been evaluated to estimate an extended monthly precipitation and temperature dataset for the Rock Creek site. Precipitation frequency analysis has been completed on the precipitation dataset to estimate average, and wet and dry values for various return periods.

The regional data utilized for this task were as follows:

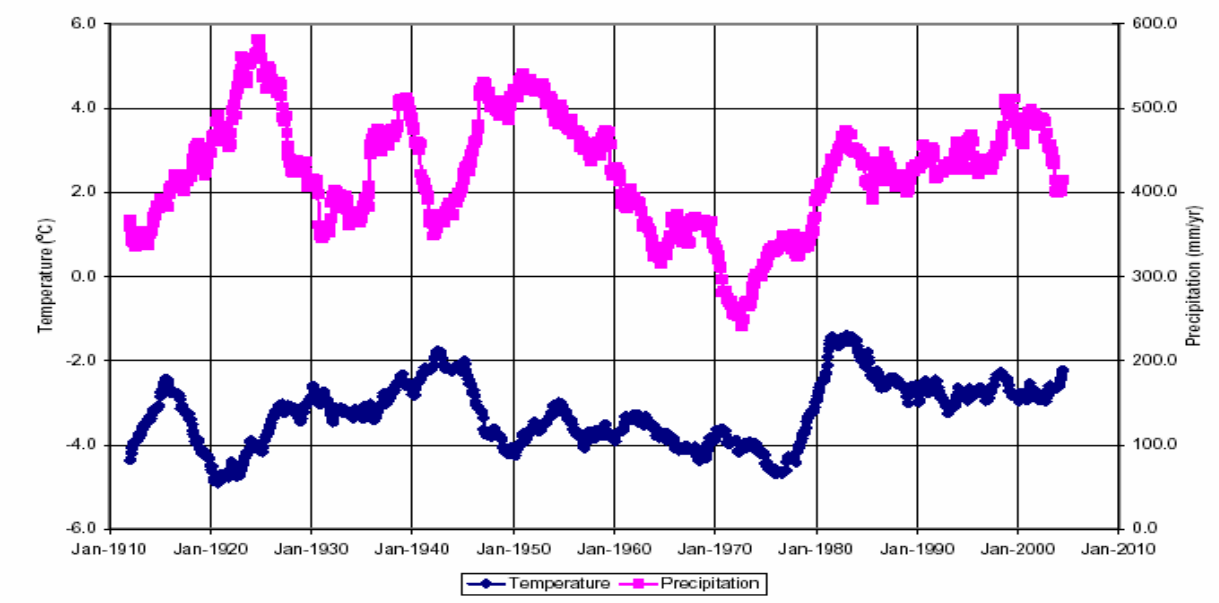
- Daily precipitation and temperature data from the Nome Airport weather station in Nome, AK from 1907 through 2003 (National Climatic Data Center);
- Daily precipitation data for 2005 from an on site meteorological station;
- Stream gage data from the Snake River for the years 1965 through 1991 (Hydraulic Unit Code: 19010504, USGS); and
- Stream gage data for a few recent dates for Rock Creek, Lindblom Creek, Snake River and Glacier Creek.

Precipitation reaches a maximum in late summer and drops to a minimum in April and May. The moderating influence of open water of Norton Sound is effective from early June to about the middle of November. Overcast conditions are common during July and August. Temperatures generally remain well below freezing from the middle of November to the latter part of April. Snow begins to fall in September, but usually does not accumulate on the ground until the first part of November. The snow cover decreases rapidly in April and May, and normally disappears by the middle of June. Severe wind storms are common.

Temperature

The average monthly temperatures for the Nome Airport are presented on Table 7.18. The site temperatures at lower elevations are expected to be similar to Nome, as the site is fairly close to Norton Sound. To develop an understanding of historical climate trends, a graph displaying the five year running average for the Nome airport temperature was developed and is shown of Figure 7.8. Based on Figure 7.8, a cooler period (about -4°C) was present from about 1950 to 1975). The most striking feature of the Nome record and other records in Alaska is the sudden warming in the late 1970's (see Papineau). Using the data presented in Figure 7.8, adjustments were made to account for the elevation at the site.

Figure 7.8 Five Year Running Average of Nome Precipitation and Temperature



Precipitation Values

Precipitation has been measured at Nome since 1906, an excellent historical record for mine design. The average monthly precipitations are presented in Table 7.16. As illustrated on Figure 7.8, the precipitation record indicates wet periods from 1920 to 1925 (average of about 550 mm/year) and 1942 to 1952 (average of about 500 mm/year) and a dry period from 1960 to 1980 (average of about 320 mm/year). Average Nome Airport precipitation from 1985 through 2005 was 441 mm.

Table 7-16 Average Monthly Temperature and Precipitation at Nome Airport

Month	Temperature (°F)	Temperature (°C)	Precipitation (inches)	Precipitation (mm)
January	8.4	-13.1	1.0	24.4
February	8.6	-13.0	0.8	20.7
March	10.6	-11.9	0.7	18.5
April	20.3	-6.5	0.7	17.9
May	35.2	1.8	0.7	17.6
June	46.2	7.9	1.1	27.0
July	50.5	10.3	2.3	59.2
August	49.6	9.8	3.3	84.0
September	42.1	5.6	2.5	64.3
October	28.8	-1.8	1.5	38.2
November	17.1	-8.3	1.1	27.2
December	9.1	-12.7	1.0	24.3
Annual			**16.7**	**423.3**

Notes:

mm = millimeters

Benning and Yang (2005) describe an evaluation of the Nome airport precipitation data based on studies comparing the catch of precipitation using various gage types. They describe the results of applying an algorithm developed for comparing the gage used at Nome with a gage with extensive wind shielding. The findings of the study indicate that the Nome gage has significant undercatch as there is no wind shield on the Nome gage, and the gage is on top of a building where it is exposed to high wind. They report that the actual precipitation at Nome was 1.3 to 4.8 times the measured precipitation, with the larger factors for winter months. The calculated average adjustment is about 4.1 in winter and 1.5 in summer. In summary, the published paper implies a potential for measured snowfall at Nome to be much less than the actual snowfall. Flow data from the Snake River catchment, which may be subject to orographic effects, generally supports the papers results. However, such a high winter multiplier is not supported by measured Snake River Flows. The paper provides a reminder that snow control may be important. The pit could provide an excellent snow trap if snow fences are not installed. Snow load, particularly in the plant site area might be evaluated at the end of winter and snow removed if required to help with the overall water balance.

There is now more than one year of precipitation data collected at the Rock Creek site climate station. That information, reported as monthly precipitation on Table 7.17, indicates that monthly site precipitation is 0.6 to 2.5 times Nome, with an average over the year of 1.7 times Nome. A plot illustrating the monthly rainfall at the two sites, presented as Figure 7.9,

illustrates that the multiplication factor increases significantly with precipitation depth. The wet months were September, August, October, and July.

Table 7-17 Comparison of 2005 Nome and Rock Creek Recorded Precipitation

Month	Nome Airport (mm)	Rock Creek (mm)	Ratio
September '04	16	20	1.3
October '04	70	109	1.6
January '05	5	11	2.2
February '05	21	22	1.0
March '05	12	8	0.7
April '05	8	4	0.5
May '05	27	47	1.7
June '05	22	21	1.0
July '05	41	68	1.7
August '05	74	133	1.8
September '05	123	302	2.5
October '05	41	69	1.7
November '05	10	9	0.9
December '05	11	13	1.2
Average			**1.7**

Notes:

mm = Millimeters

A precipitation frequency analysis was completed for the wet and dry distribution of the Nome airport annual precipitation over the 96-year period of record from 1907 through 2003. Listed in Table 7-18 are the average, 5, 10, 50, 100, and 200-year return period annual wet and dry precipitation levels for the Nome airport. For comparison, the Nome airport minimum annual precipitation recorded was 7.4 inches (188 mm) and the maximum annual precipitation recorded was 29.5 inches (749 mm). The site return precipitation predictions were derived by multiplying the airport data by 1.7.

Table 7-18 Estimated Rock Creek Annual Precipitation Distribution

	Wet Annual Precipitation		Dry Annual Precipitation	
Return Period (years)	(inches)	(mm)	(inches)	(mm)
Average	28.4	722	28.4	722
5	34.8	884	21.5	547
10	38.4	976	18.7	476
20	41.5	1054	16.7	425
100	47.4	1205	13.5	343
200	49.7	1263	12.5	318

The distribution of precipitation to snow and rainfall assumed that all precipitation fell as rain if the average monthly temperature was greater than 2°C and all as snow if the average monthly temperature was below -2°C. In between the ratio of precipitation as snow was varied linearly with the temperature between -2°C and 2°C.

Sublimation

Sublimation is complex and requires tabulation of a number of variables for a rigorous determination. In the analysis, it was assumed that the maximum sublimation was 0.3 mm/day. Sublimation was allowed in the months November through April. Although sublimation rates may be high during snowmelt, the sublimation is often countered by nighttime condensation into the snow pack. Sublimation therefore was not considered for May and June. The snow was assumed to sublimate at the set rate until none remained on the ground.

Evapotranspiration and Evaporation

There is no evaporation data available for the site or the airport. Evapotranspiration in the area has not been studied in detail. Munter et al. (1991) quoting Patric and Black (1968) calculated the actual evapotranspiration in the Nome area to be 14 inches/yr based on Thornthwaite's classification. A study by Fraver (2003) of thermokarst ponds in the Council area, about 75 miles northeast of Nome, included evaluation of evapotranspiration. Extrapolation of the results from that study indicated an annual evapotranspiration of about 14 inches (356 mm) for ponds, 10 inches (254 mm) for wetlands and 7 inches (178 mm) for uplands. This precipitation and evaporation information indicates there is a significant quantity of water available for runoff and groundwater recharge in the area. The average monthly potential evapotranspiration (PET) and estimated actual evapotranspiration (AET) for this study is illustrated on Table 7.19.

Table 7-19 Calculated Average Evapotranspiration (inches)

	PET		Natural AET	
Month	**< 1,000 ft**	**> 1,000 ft**	**< 1,000 ft**	**> 1,000 ft**
January				
February				
March				
April				
May	1.3	1.0	0.5	0.5
June	4.3	4.3	1.6	1.7
July	5.0	5.0	2.0	2.1
August	4.0	4.0	1.8	1.8
September	2.0	2.2	1.0	0.9
October				
November				
December				
Annual	16.6	16.5	6.9	7.0

Note:

mm = Millimeters

Water Management

To minimize fresh surface water runoff from passing through the mine site, surface water from upslope will be diverted through a ditch to Lindblom Creek. Within the mine site, interception ditches will be constructed downstream of the development rock stockpiles to route this water to Lindblom Creek or Rock Creek. Water will not be diverted to Glacier Creek.

Groundwater moving towards the pit will be intercepted with perimeter pumping wells. Well water required to meet process needs will be pumped to the mill and the remainder will be treated to meet applicable water quality standards and reintroduced to the groundwater through a Class V injection system.

Water used in the process will be recycled except for process losses. Much of the water will be recovered from the slurry at the mill in a thickener. The tailings will be transported to the tailings area as a paste in a pipeline. Supernatant will be recovered from the tailings pond with a reclaim pump. Temporary excess water from snowmelt and rainfall will be stored in the tailings facility. This stored water will be used as process water during dry periods. Process losses will be made up from sources of water on site. Site wide and tailings water management is conceptualized on Figure 7.7

The losses within the mill and tailings circuit will include:

- Water in the tailings pores;
- Evaporation from the tailings pond and from moisture on the exposed tailings sand;
- Seepage from the tailings area;
- Minor losses within the mill; and
- Minor losses to the foundation pore spaces.

The losses will be made up from:

- Direct precipitation and snowmelt within the tailings area during the ice free period;
- Moisture content of the ore;
- Runoff collected from the plant site area;
- Mine water pumped from sumps in the open pit;
- Seepage recovery from the toe of the tailings dam;
- When required, water from the open pit groundwater interceptor wells will be used in processing. The remainder of the open pit well water will be treated and re-injected to the groundwater.
- When additional make-up water is required, water supply wells will be used.

Groundwater

Recharge areas on the slopes of the upper watershed provide water for creeks, alluvium and deeper groundwater. Shallow groundwater travels down the valley across an alluvial fan and discharges to surface water and alluvium of the Snake River. Excavation of the pit will intersect these groundwaters.

As the pit depth increases, groundwater will be pumped to keep the groundwater level below the bottom of the pit. Storage properties of the aquifer will determine how much water is released from an area by gravity drainage due to a decline in the water table. The pumping will also cause a cone of depression so that the groundwater catchment area of the pit will increase. As a result some areas that were initially not in hydraulic communication with the pit will become sources of pit inflows.

The surface geology and vegetation effect groundwater recharge rates. The site is similar to that of most high latitude regions with low lying shrubs and grass (tundra) cover over most of the area except for some bedrock outcrop on the high steeper slopes. Vegetation can store precipitation allowing a longer time period for evaporation and recharge.

The primary bedrock geologic units in the pit area are calcareous schists and marbles from the Nome Group. Fractures in the bedrock are the primary matrix for the transportation of groundwater towards the pit. Hydraulic heterogeneities, low permeable gouge zones and high permeability fractures through bedrock, will cause compartmentalization of groundwater.

Mining will continue for a period of approximately four years, with the ultimate pit floor at an elevation of approximately 33 feet (10 meters) below sea level. The pit outline and depths were input into a groundwater model to estimate the dewatering rates required to keep the pit floor dry. The expected maximum required pumping rate from the open pit perimeter interception wells is 635 gpm. Pumping will need to begin at 600 gpm early in the mine life to meet the planned pit depth. The interception wells will be connected to a header pipeline that will transfer the pumped water to the processing system or to the Class V injection system via the treatment system.

Class V Injection System

The objective is to re-inject water from the pit pumping wells that is not required in the process. The re-injection would be using Class V wells, relatively shallow and simply constructed devices which inject under the force of gravity. In wet weather, all of the water from the perimeter wells may need to be treated and injected. In dry weather and particularly in the winter, much of the water from the perimeter wells will be used in process. Several injection methods were considered at the site with injection wells and drain fields or infiltration galleries being selected as the two best alternatives. Based on site investigation work, limited injection using a drain field is possible on the Rock Creek fan. The remainder of the water will be injected into bedrock wells.

The Class V injection system infiltration gallery will be located on the Rock Creek alluvial fan. The fan toe is adjacent to side channels of the Snake River. Water injected into this fan will migrate through the fan deposits towards the toe of the fan where it would discharge into alluvium and into the side channels at the toe of the fan. During operations, water from the upper reaches of the Rock Creek basin will be diverted to Lindblom Creek, reducing the quantity of water reaching this fan. Following treatment, the water from the pit pumping wells will be re-injected into the fan to make up for this reduction. The capacity of this system is estimated at 100 gpm.

All of the perimeter well water not used in the process, except the 100 gpm injected into the fan through the infiltration gallery, will be injected into a Class V injection well system. Pumping test results and water returns during drilling indicate fracture sets are permeable enough to receive the remaining water. Each well will inject into a relatively permeable environment that is bounded by lower permeability materials. This will result in considerable dispersion of the injected water along a variety of discontinuous fractures and faults. The dispersed water will enter alluvium at depth under the local water surface, and travel downstream in the alluvium prior to discharging along a considerable length of Snake River. The injection capacity of each well is not expected to exceed 50 gpm. The injection program will include sufficient wells to allow resting of wells and dissipation of groundwater mounding.

Mill and Tailings Facility System

The losses in the mill and tailings circuit are to tailings voids, evaporation, seepage and minor losses in the process. In order to reduce the water volume loss, this project utilizes a paste tailings system rather than a conventional slurry tailings system. This results in a higher density tailings and lower void volume. The tailings assumptions are:

- Solids specific gravity of 2.75
- A dry unit weight of the paste tailings of 94.8 pounds/cubic foot (1.52 tonnes/m^3)
- A milling rate of 7,700 tons/day (7,000 tonnes/day) of ore

The resulting void ratio of the deposited tailings is 0.461 and the water lost to void space is 340 gpm (2,225 m^3/day).

Evaporation losses occur from tailings area open water and from moisture on exposed tailings deposits. Evaporation was estimated using the Thornthwaite (1948) procedure. The full PET was used for open water. Some of the tailings area will be a natural ground surface. The water balance on this natural ground was calculated with the same parameters as used for the pre-mine condition. Evaporation from the pond required an estimation of the pond area. The evaporation losses from the surface of the pond were based on PET values. Complete details are available in the Rock Creek Project Plan of Operations Volume 5 Water Management Reports.

Evaporation from the tailings deposit was a product of the tailings area and the expected evaporation rate. The tailings area was estimated by subtracting the pond area from the total expected area. The evaporation rate used was based on the PET, but only 50% of the result was taken to account for the likely dry areas on the tailings surface.

Sublimation was accounted for on natural surfaces, but was not included in the tailings pond balance.

Seepage from the tailings area will be minimized by keeping the stored volume of water low, and by appropriate design of the tailings dam. Seepage from the pond was estimated as a function of the stored water volume.

Other minor losses considered were losses in the mill area such as evaporation and losses to the foundation pore spaces as the tailings elevation increased. The assumptions were:

- Approximately 3.3 m^3/day (0.6 gpm) lost in the mill area; and
- Approximately 50 m^3/day (9 gpm) lost to pore spaces in the tailings foundation.

Makeup water for the mill will be obtained from precipitation, seepage recovery and the pit interception wells.

Diversion ditches upslope of the tailings facility will reduce the quantity of water entering the mine area from precipitation and snowmelt. The precipitation and snowmelt occurring below the Lower South Diversion Channel and within the tailings storage facility will be captured and returned to the mill for use in the process. Surface runoff within the plant site area will also be captured, at the mill recycle water pond, and reclaimed into the process. The surface water runoff into the pit will be minimized by the construction of ditches upslope of the pit to divert water to Lindblom Creek. The inflow will be further reduced by construction of temporary diversion ditches to direct most of the area below the diversion ditch into Rock Creek. Inflow to the pit from surface water will be derived primarily from direct snowmelt and precipitation.

Seepage will be recovered from the toe of the tailings dam to isolate the tailings from the downstream environment. Water collected from this system will be pumped directly to the reclaim water tank where it will feed the mill recycle water pond. The quantity of water to be collected from this system includes a groundwater component that is a function of the calculated volume of groundwater that is in storage. Seepage from the tailings area and local recharge contribute to volume of groundwater in storage. The seepage and thermal model estimates that no seepage will occur between the months of December and March, however, the system has been designed to collect and pump solution throughout the year.

Water from the open pit interception wells will be used to supplement the water demand of the process. Water in excess of the process demand will be treated and discharged to the Class V injection system.

Site-Wide Water Balance Analysis

The conceptual surface and mill water flow diagram used to perform the site-wide water balance is illustrated on Figure 7.7. The catchment areas were established to reflect natural and operational barriers to flows. The watersheds at the project site were divided into the catchments presented to facilitate suitable inflows for mine operation planning. Using these catchments, system inputs described above and the operational parameters required by the process and mine plan, a life of mine water balance analysis was performed for the average climate conditions (1978 precipitation distribution).

The following are comments regarding the Site Wide Water Balance Summary Average Conditions. Complete details are available in the Rock Creek Project Plan of Operations Volume 5 Water Management Reports.

- All of the water from the plant site will report directly to the mill recycle pond with water from the tailings thickener. In addition, all of the water from the seepage collection sump will report to the mill recycle water pond.
- Whenever possible, open pit runoff will be pumped to the mill recycle water pond. Excess water will be treated and injected to a Class V injection system.
- During dry periods, particularly during the winter, some of the pit interception well water will be pumped to the mill recycle water pond for use in the process system.

The remainder of the interception well water will be treated and injected in a Class V injection system.

- The most significant contributors of water to the tailings storage facility are the water contained in the tailings paste when deposited and precipitation within the facility catchment.

- Throughout the winter, water will accumulate in the tailing storage facility, predominantly as snow and ice. During snowmelt, and perhaps in wet summer/fall months, there will be excess water that will accumulate a pond in the facility prior to being utilized by the process.

- Significant volumes of water will be diverted to Lindblom and Rock creeks, thereby reducing the volume of water that must be managed on site.

To illustrate impacts of operating in wet or dry years, the water balance was run in a repeating mode rather than a life of mine mode. The water balance was computed for year 1 using climate data from 1907 to 2004. Ten year return period wet and dry conditions were selected by computing statistics on annual runoff rather than precipitation, as runoff is more important to mine operations. The selected climate years to represent expected operating conditions were:

- 1978 for the average year;
- 1933 for the 10 year return period dry year; and
- 1932 for the ten year return period wet year.

Table 7-23 provides a summary of average, wet and dry year site responses for the first year of operations with 1.7 times Nome precipitation and a pit interception well pumping rate of 600 to 635 gpm.

With the dry year (1933), make-up water from the interception wells is required for most of the year. The tailings pond is expected to be dry for five months. Although pit runoff would be treated if required, very little runoff is predicted from the pit in these dry conditions.

With the wet year (1932), make-up water from the interception wells is mostly treated and released through the year as is the pit runoff. The maximum tailings pond stored volume would exceed 227 acre-feet (280,000 m^3) in June of a wet year.

Under the full range of conditions examined, the annual treatment volume in year one would range from 148.5 million gallons to 228.8 million gallons (562,000 to 866,000 m^3).

Rock Creek Flow

With upper surface water volumes diverted and groundwater sources intercepted, there will be minimal inflow into Rock Creek below the proposed pit. Rock Creek flows below the pit will remain minimal until closure when the pit lake fills and discharges and until groundwater flows reestablish after interception has ceased.

7.6 CLIMATE/AIR QUALITY

7.6.1 Affected Environment

7.6.1.1 Meteorological Data Summary

Meteorological monitoring was conducted at the Rock Creek site from January 1 through December 31, 2004, with one exception. Meteorological monitoring was not conducted at Big Hurrah as there was less industrial activity proposed at that site. However, based on proximity, the meteorological data collected at the Rock Creek site are generally representative of the Big Hurrah site. Some minor differences in wind speed and direction could be expected as a result of local terrain effects.

The collection of precipitation data at Rock Creek was not initiated until August 2004. All meteorological monitoring was conducted following the EPA and Alaska Department of Environmental Conservation (ADEC) guidelines and procedures for collecting Prevention of Significant Deterioration (PSD)-quality meteorological data. The data were collected consistent with the QAPP for the Rock Creek Ambient Air Monitoring Project that was submitted to ADEC in November 2003.

The monitored parameters were:

- Wind speed (m/s);
- Wind direction (degrees [°]);
- Wind direction standard deviation (wind sigma [σ_θ]);
- Air temperature, 2 meters above ground (°C);
- Air temperature, 10 meters above ground (°C);
- Relative humidity, motor-aspirated shield (%);
- Solar radiation (watts per square meter [watts/m^2]);
- Barometric pressure (millibars [mb]); and
- Precipitation (inches).

The detailed monitoring specifications and results are provided in the 2004 Annual Data Report for the Rock Creek Meteorological Monitoring Project, included in the Climate section of the appendices.

Wind

On an annual basis, the wind in 2004 was predominantly from the north, north-northeast, and north-northwest, with minor components from the south and east. The annual average wind speed was 9.8 mph (4.4 m/s). A summary of the average wind speeds, maximum instantaneous wind speeds, and the maximum and minimum average hourly wind speeds for each quarter is provided in Table 7-20. Annual and quarterly windroses are presented in Figures 7.13 through 7.17.

Table 7-20 Average, Maximum, and Minimum Wind Speeds for 2004

Quarter	Average Hourly Wind Speeds	Maximum Instantaneous Wind Speeds	Maximum Average Hourly Wind Speed	Minimum Average Hourly Wind Speed
First	12.3 mph (5.50 m/s)	72.9 mph (32.6 m/s)	55.0 mph (24.6 m/s)	0.7 mph (0.3 m/s)
Second	11.9 mph (5.32 m/s)	47.2 mph (21.1 m/s)	33.3 mph (14.9 m/s)	0.4 mph (0.2 m/s)
Third	7.6 mph (3.4 m/s)	38.7 mph (17.3 m/s)	21.9 mph (9.79 m/s)	0.9 mph (0.4 m/s)
Fourth	13.6 mph (6.08 m/s)	64.6 mph (28.9 m/s)	43.6 mph (19.5 m/s)	1.1 mph (0.5 m/s)

Notes:

m/s = meters per second

mph = miles per hour

Figure 7.13 2004 Annual Windrose

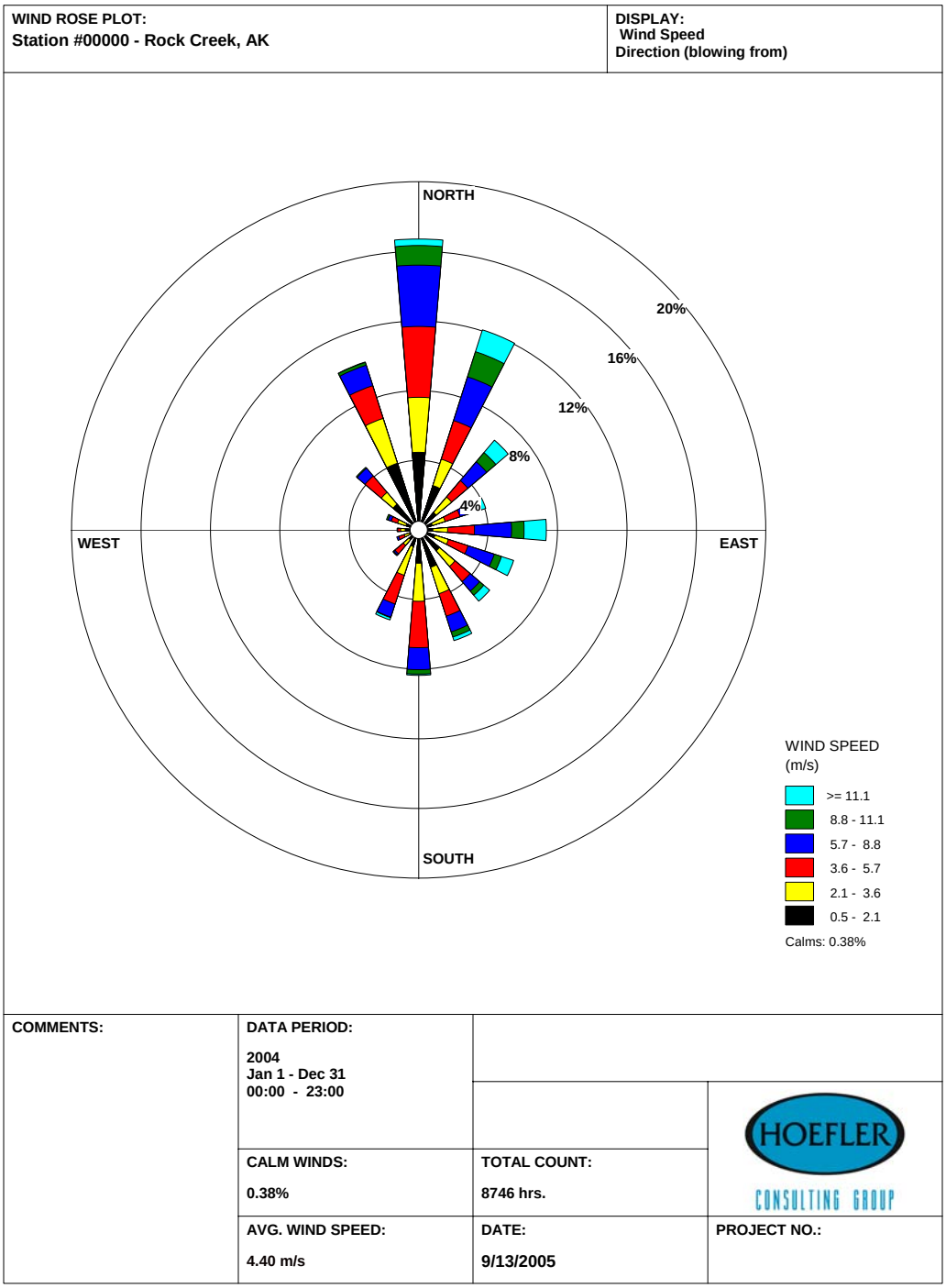


Figure 7.14 First Quarter 2004 Windrose

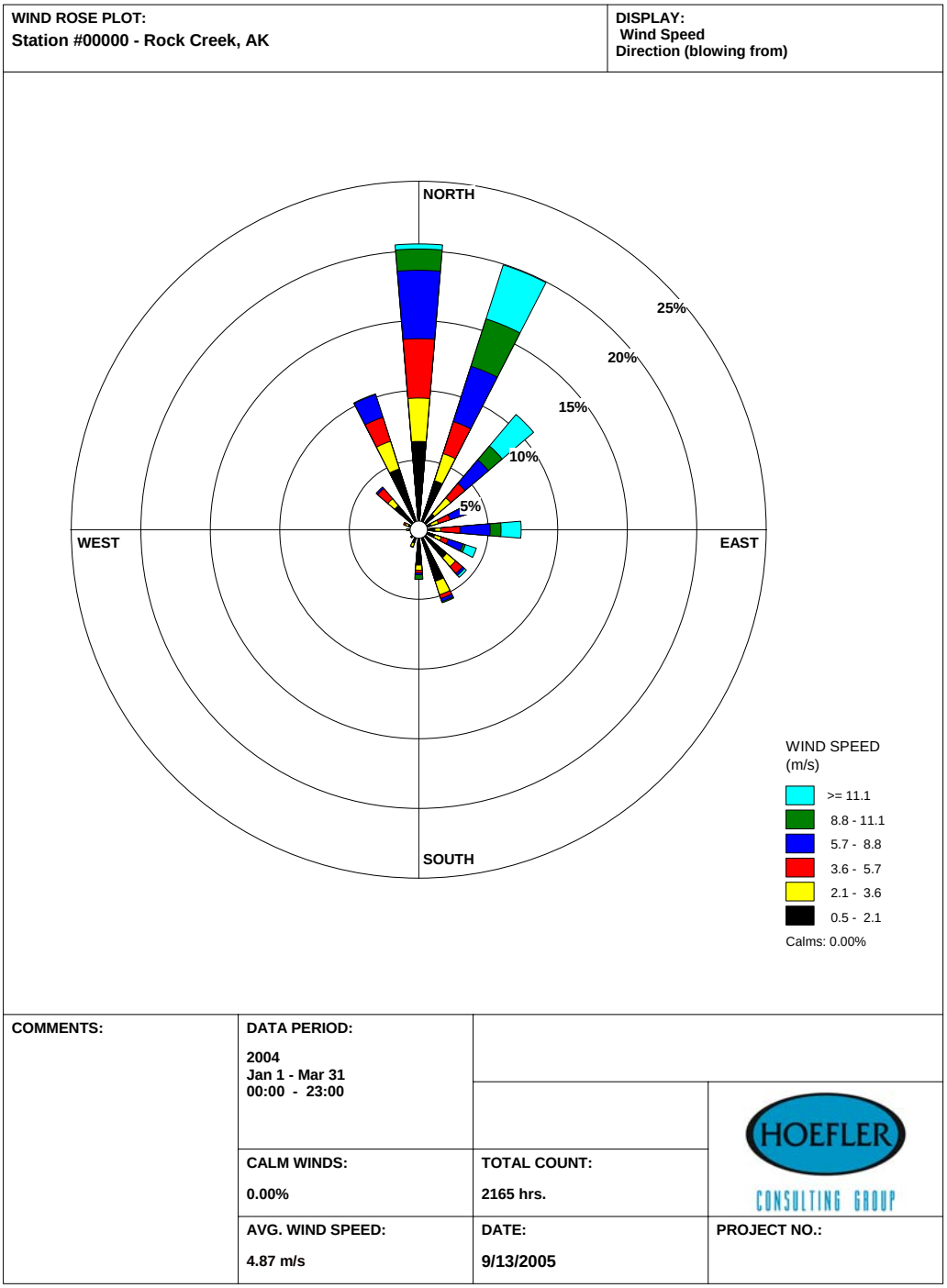


Figure 7.15 Second Quarter 2004 Windrose

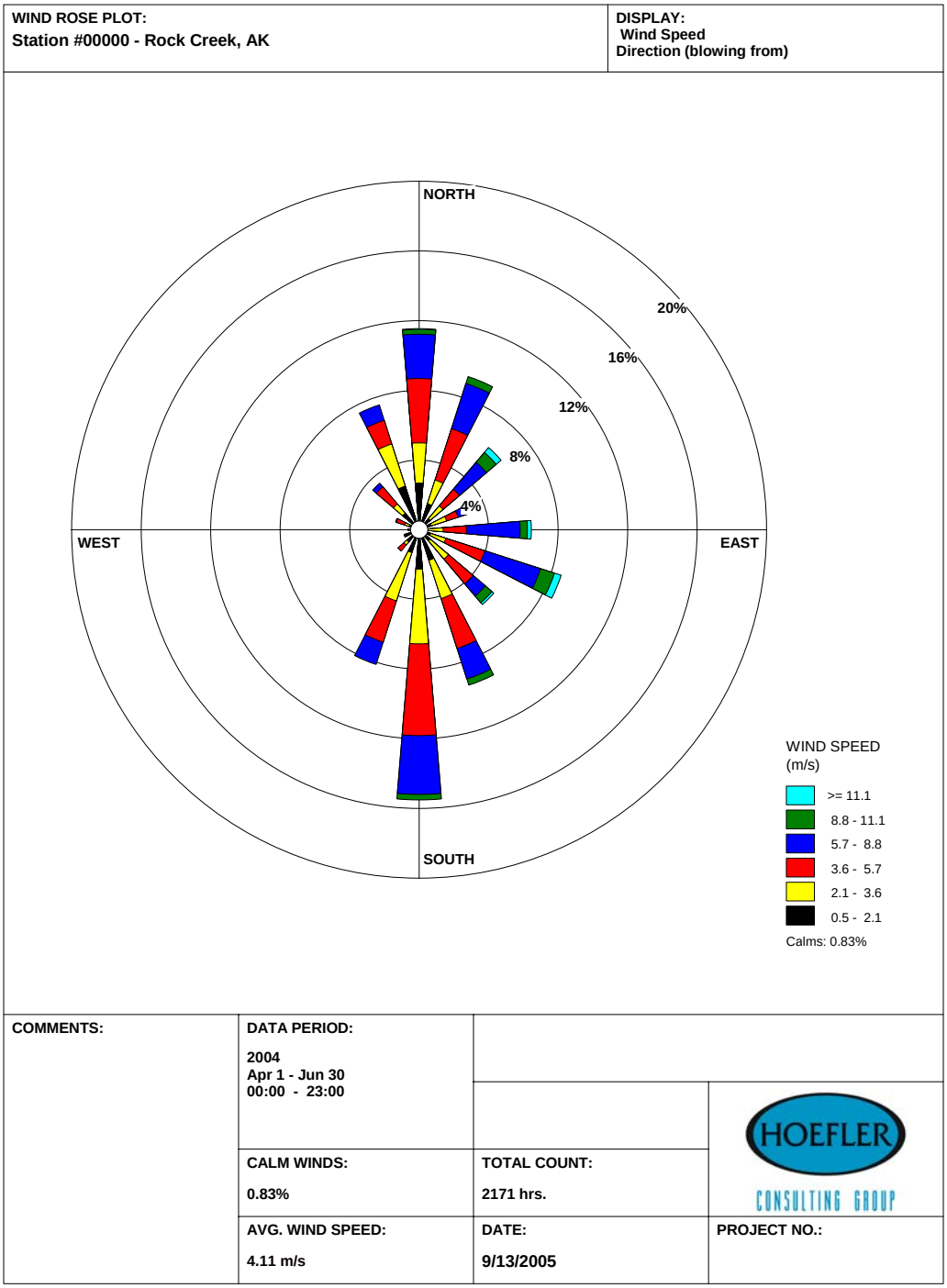


Figure 7.16 Third Quarter 2004 Windrose

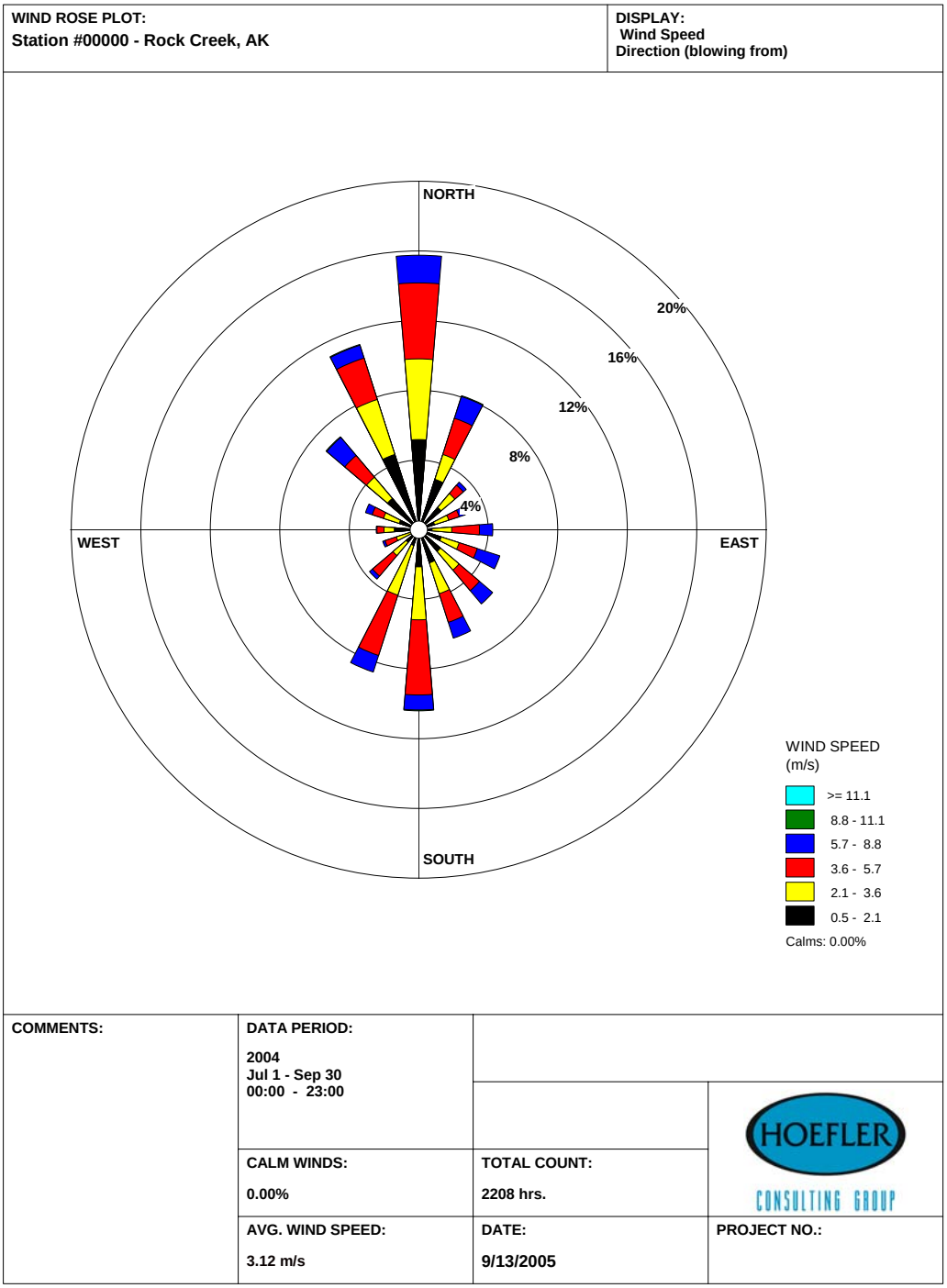
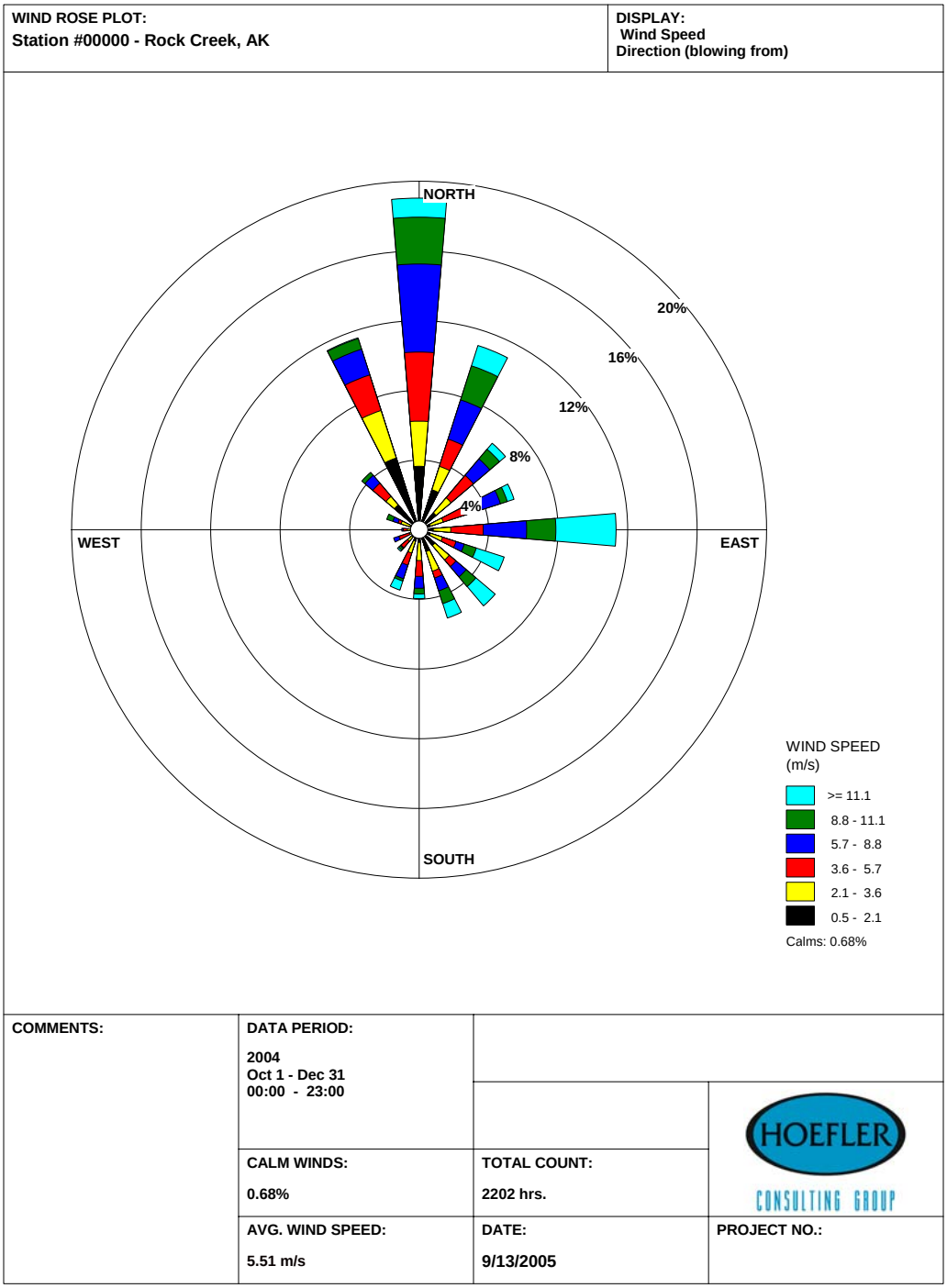


Figure 7.17 Fourth Quarter 2004 Windrose



Temperature

The annual average temperature at 6.6 feet (2 m) above grade was 31.6 °F (-0.2 °C). The maximum hourly temperature at the same height was 85.1 °F (29.5 °C). The minimum hourly temperature at the same height was -27.9 °F (-33.3 °C). A summary of monthly temperature averages and extremes is provided in Table 7-21.

Table 7-21 Summary of 2004 Monthly Temperature Averages and Extremes

Month	Minimum Hourly Average	Maximum Hourly Average	Average Temperature
January	-27.9 °F (-33.3 °C)	30 °F (-0.8 °C)	6.62 °F (-14.1 °C)
February	-19.5 °F (-28.6 °C)	37 °F (2.7 °C)	9.14 °F (-12.7 °C)
March	-21.8 °F (-29.9 °C)	32 °F (-0.3 °C)	10.6 °F (-11.9 °C)
April	-10.8 °F (-23.8 °C)	46 °F (7.5 °C)	29 °F (-1.5 °C)
May	29 °F (-1.5 °C)	62.6 °F (17.0 °C)	41 °F (5.1 °C)
June	33 °F (0.8 °C)	85.1 °F (29.5 °C)	55.8 °F (13.2 °C)
July	39 °F (4.0 °C)	75.7 °F (24.3 °C)	57.9 °F (14.4 °C)
August	32 °F (-0.3 °C)	82.2 °F (27.9 °C)	56.8 °F (13.8 °C)
September	18 °F (-7.6 °C)	64.0 °F (17.8 °C)	40 °F (4.7 °C)
October	6.80 °F (-14.0 °C)	52.9 °F (11.6 °C)	35 °F (1.7 °C)
November	3.40 °F (-15.9 °C)	38 °F (3.2 °C)	24 °F (-4.7 °C)
December	-20.7 °F (-29.3 °C)	33 °F (0.4 °C)	13.6 °F (-10.2 °C)
2004 Annual	-27.9 °F (-33.3 °C)	85.1 °F (29.5 °C)	32 °F (-0.2 °C)

Note:
°C = degrees Celsius

Relative Humidity and Barometric Pressure

The annual average relative humidity was 75.5%. The maximum and minimum hourly average relative humidity were 100% and 18.0%, respectively. The annual average barometric pressure was 1,004 mb. The maximum and minimum barometric pressures were 1,041 mb and 963 mb, respectively. Incoming solar radiation ranged from 842 w/m2 to 0 w/m2.

Hourly values for wind speed, temperature, relative humidity, barometric pressure, and solar radiation for 2004 were collected at the Rock Creek site by Hoefler Consulting Group. Hourly values were used to compute daily averages for each parameter. Monthly average values were then calculated from daily averages. Results for each parameter are shown in Table 7-22.

Table 7-22 Rock Creek Average Monthly Climate Values

Month	Wind Speed (m/sec)	Wind Speed (mph)	Temperature (°C)	Temperature (°F)	Relative Humidity (%)	Barometric Pressure (mbar)	Solar Radiation (watts/m^2)	Solar Radiation (watts/yd^2)
January	4.6	10.3	-14.1	6.62	68	1013.7	11.2	9.4
February	5.5	12.3	-12.7	9.14	69	998.5	39.9	33.4
March	4.4	9.8	-11.9	10.58	73	1007.2	111.9	93.6
April	5.3	11.9	-1.5	29.3	77	1004.4	149.7	125.2
May	3.9	8.7	5.1	41.18	80	1007.5	161.5	135.0
June	3.1	6.9	13.2	55.76	67	1009.9	236.9	198.1
July	2.8	6.3	14.6	58.28	75	1006.8	214.9	179.7
August	3.2	7.2	13.9	57.02	80	1008.4	124.8	104.3
September	3.3	7.4	5	41	72	1004.9	106	88.6
October	4.7	10.5	1.7	35.06	84	993	35.1	29.3
November	6.1	13.6	-4.7	23.54	81	991.7	11.8	9.9
December	5.7	12.8	-10.2	13.64	81	1000.9	2.4	2.0

Notes:

%	=	percent	mbar	=	millibar
°C	=	degrees Celsius	mph	=	miles per hour
°F	=	degrees Fahrenheit	watts/m^2	=	watts per square meter
m/sec	=	meters per second	watts/yd^2	=	watts per square yard

Precipitation

Precipitation data for both the Rock Creek and Big Hurrah sites were obtained from the Oregon State Spatial Climate Analysis Service (SCAS), U.S. Weather Bureau Precipitation Atlases, and the Western Regional Climate Center. Statewide average precipitation data for each month for the period between 1961 and 1990 are available through SCAS. This geographic information system (GIS)-based data set was assembled into maps of monthly average precipitation by the Institute of Arctic and Alpine Research at the University of Colorado, Boulder. These maps were used to quantify average monthly precipitation at Nome, the Rock Creek site, and the Big Hurrah site. From this analysis, annual total precipitation at Nome was determined to be 15.41 inches (391.5 mm). Annual total precipitation at the Rock Creek and Big Hurrah sites was determined to be 18.82 inches (478.0 mm) and 21.26 inches (540.0 mm), respectively. All monthly and annual values are presented in Table 7-23.

Table 7-23 Average Monthly Precipitation (SCAS 1961-1990)

Month	Nome		Rock Creek		Big Hurrah	
	mm	inches	mm	inches	mm	inches
January	24.5	0.96	27.0	1.06	37.0	1.46
February	16.0	0.63	23.0	0.91	28.0	1.10
March	18.0	0.71	20.0	0.79	26.0	1.02
April	17.0	0.67	19.0	0.75	21.0	0.83
May	16.0	0.63	18.0	0.71	21.0	0.83
June	33.0	1.30	39.5	1.56	37.0	1.46
July	54.0	2.13	74.0	2.91	80.0	3.15
August	74.0	2.91	85.5	3.37	97.0	3.82
September	57.0	2.24	74.0	2.91	91.0	3.58
October	37.0	1.46	42.0	1.65	40.0	1.57
November	25.0	0.98	31.0	1.22	32.0	1.26
December	20.0	0.79	25.0	0.98	30.0	1.18
Annual Total	**391.5**	**15.41**	**478.0**	**18.82**	**540.0**	**21.26**

Notes:

mm = millimeters

SCAS = Oregon State Spacial Cliimate Analysis Service

The Rock Creek and the Big Hurrah site annual precipitation totals are 22% and 37% greater than the totals for Nome, respectively. It should be noted that Water Management Consultants presented a comparison of the total precipitation values at the Nome Airport with those collected at the Rock Creek site for a total of four months. Results are presented in Table 2-2 of the Rock Creek Mine Project Water Management Report dated May 2005. Data presented indicate that the total precipitation at the Rock Creek site is 25% greater than at Nome for that time, consistent with results shown in Table 7-23.

In order to compare the values presented in Table 7-23 with validated results, Ecological Resource Consultants, Inc. (ERC) obtained average monthly precipitation values for the Nome Airport. These are available through the Western Regional Climate Center (WRCC). The WRCC maintains an online database that includes average monthly precipitation totals for the period between 1948 and 2004. For this data set, the normal precipitation is the arithmetic mean for each month over the period of record, adjusted as necessary, and includes the liquid water equivalent of snowfall.

The average monthly precipitation values in Nome for the period between 1961 and 1990 are presented in Table 7-24 to confirm the validity of the results presented in Table 7-23. This period of record was chosen as it is identical to the period of record used by SCAS to produce data presented in Table 7-23. It is of note that there is a 3% difference between the annual total precipitation values at Nome presented in Tables 7-23 and 7-24, which validates the approach used by ERC.

Table 7-24 Average Monthly Nome Precipitation (WRCC 1961-1990)

Month	Precipitation	
	mm	inches
January	21.3	0.84
February	15.5	0.61
March	15.0	0.59
April	16.5	0.65
May	18.0	0.71
June	27.9	1.10
July	53.8	2.12
August	70.6	2.78
September	59.7	2.35
October	36.6	1.44
November	24.9	0.98
December	21.1	0.83
Annual Total	**380.5**	**14.98**

Notes:

mm = millimeter
WRCC = Western Region Climate Center

On the basis of the validity of the Nome precipitation data presented in Table 7-23, ERC considered the precipitation values for the Rock Creek and Big Hurrah sites to be reasonable. ERC used the calculated percentages of total precipitation at the Rock Creek and Big Hurrah sites (22% and 37% greater than Nome, respectively) with the average monthly precipitation totals at Nome for the full period of record between 1948 and 2004 published by the WRCC to determine the average monthly precipitation at the Rock Creek and Big Hurrah sites for the same period. Results are shown in Table 7-25.

Table 7-25 Average Monthly Precipitation (WRCC 1948-2004)

	Nome		Calculated Rock Creek		Calculated Big Hurrah	
Month	**mm**	**inches**	**mm**	**inches**	**mm**	**inches**
January	22.2	0.87	27.1	1.07	30.5	1.20
February	17.3	0.68	21.1	0.83	23.7	0.93
March	15.2	0.60	18.6	0.73	20.9	0.82
April	17.6	0.69	21.5	0.85	24.1	0.95
May	18.0	0.71	22.0	0.87	24.7	0.97
June	26.5	1.04	32.4	1.28	36.4	1.43
July	54.2	2.13	66.1	2.60	74.2	2.92
August	83.2	3.28	101.6	4.00	114.1	4.49
September	61.2	2.41	74.7	2.94	83.9	3.30
October	37.2	1.46	45.4	1.79	51.0	2.01
November	28.3	1.11	34.5	1.36	38.8	1.53
December	22.4	0.88	27.3	1.07	30.6	1.20
Annual Total	**404.6**	**15.93**	**493.7**	**19.44**	**554.4**	**21.83**

Notes:

mm = millimeter
WRCC = Western Region Climate Center

Annual precipitation resulting from extreme wet and dry years was calculated based on the 57 years of available monthly Nome precipitation data. Annual totals were plotted using the Weibull formula. The wettest and driest years of record totaled 26.9 inches (683 mm) and 7.40 inches (188 mm) of precipitation, respectively. Based on the plot, the high value is above the trend line and may slightly overestimate a 1% wet year, and the low value is below the trend line and may slightly underestimate a 1% drought. The values of 26.9 inches (683 mm) and 7.40 inches (188 mm) were used as the design values. Factoring in the difference between predicted precipitation at the sites and Nome, the 1% wet year was estimated to be 32.8 inches (833 mm) and 36.9 inches (936 mm) at the Rock Creek and Big Hurrah sites, respectively. One percent annual drought rainfall was estimated to be 9.02 inches (229 mm) at Rock Creek and 10.2 inches (258 mm) at Big Hurrah.

Data for short-term duration storms at the Rock Creek and Big Hurrah sites were collected from the U.S. Department of Commerce Weather Bureau Technical Paper 47, Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska. This report is available through the WRCC and presents statewide rainfall isohyetal maps for storm durations up to 24 hours and return periods from 1 to 100 years. Rainfall intensity-duration-frequency (IDF) curves for both sites were created by ERC on the basis of these data. Numerical values for the IDF curves are provided in Table 7-26. Note that rainfall intensity values for both sites are the same, with the exception of storms with a 50- and 100-year return period.

Table 7-26 Rainfall Intensity Duration Frequency Values

		Rainfall Intensity (mm/hr)		Rainfall Intensity (in/hr)	
Return Period (years)	Storm Duration (hours)	Rock Creek	Big Hurrah	Rock Creek	Big Hurrah
1	0.5	7.6	7.6	0.30	0.30
1	1	5.1	5.1	0.20	0.20
1	2	3.8	3.8	0.15	0.15
1	3	3.4	3.4	0.13	0.13
1	6	2.1	2.1	0.08	0.08
1	12	1.6	1.6	0.06	0.06
1	24	1.1	1.1	0.04	0.04
2	0.5	12.7	12.7	0.500	0.500
2	1	7.6	7.6	0.30	0.30
2	2	5.1	5.1	0.20	0.20
2	3	4.2	4.2	0.17	0.17
2	6	3.2	3.2	0.13	0.13
2	12	2.1	2.1	0.08	0.08
2	24	1.6	1.6	0.06	0.06
5	0.5	15.2	15.2	0.598	0.598
5	1	10.2	10.2	0.402	0.402
5	2	7.6	7.6	0.30	0.30
5	3	6.4	6.4	0.25	0.25
5	6	4.2	4.2	0.17	0.17
5	12	3.2	3.2	0.13	0.13
5	24	2.1	2.1	0.08	0.08
10	0.5	20.3	20.3	0.799	0.799
10	1	12.7	12.7	0.500	0.500
10	2	8.9	8.9	0.35	0.35
10	3	7.2	7.2	0.28	0.28
10	6	5.3	5.3	0.21	0.21
10	12	3.7	3.7	0.15	0.15
10	24	2.4	2.4	0.09	0.09

Table 7-26 Rainfall Intensity Duration Frequency Values (continued)

		Rainfall Intensity (mm/hr)		Rainfall Intensity (in/hr)	
Return Period (years)	**Storm Duration (hours)**	**Rock Creek**	**Big Hurrah**	**Rock Creek**	**Big Hurrah**
25	0.5	25.4	25.4	1.00	1.00
25	1	15.2	15.2	0.598	0.598
25	2	10.8	10.8	0.425	0.425
25	3	8.5	8.5	0.33	0.33
25	6	6.4	6.4	0.25	0.25
25	12	4.2	4.2	0.17	0.17
25	24	2.6	2.6	0.10	0.10
50	0.5	27.9	30.5	1.10	1.20
50	1	17.8	17.8	0.701	0.701
50	2	12.1	12.7	0.476	0.500
50	3	10.2	10.6	0.402	0.417
50	6	7.4	7.4	0.29	0.29
50	12	4.8	5.3	0.19	0.21
50	24	2.9	3.2	0.11	0.13
100	0.5	30.5	35.6	1.20	1.40
100	1	19.1	20.3	0.752	0.799
100	2	14.0	15.9	0.551	0.626
100	3	11.0	12.7	0.433	0.500
100	6	8.5	8.5	0.33	0.33
100	12	5.3	6.4	0.21	0.25
100	24	3.2	3.7	0.13	0.15

Notes:

in/hr = inches per hour

mm/hr = millimeters per hour

From the IDF data presented in Table 7-27, total precipitation values for the 100-year storms with 24-hour duration periods at the Rock Creek and Big Hurrah sites were determined to be 3.00 inches (76.2 mm) and 3.50 inches (88.9 mm), respectively.

The probable maximum precipitation (PMP) is defined as a quantity of precipitation that is close to the physical upper limit for a given duration over a particular basin (Chow, et al., 1988). The PMP for Nome was calculated using the Hershfield Method and annual maximum precipitation values at Nome obtained from the WRCC. ERC used the calculated percentages of total precipitation at the Rock Creek and Big Hurrah sites (22% and 37% greater than Nome, respectively) with the PMP value at Nome determine the PMP values at the Rock Creek and Big Hurrah sites. Results are presented in Table 7-27

Table 7-27 Probable Maximum Precipitation

Nome		Rock Creek		Big Hurrah	
(mm)	(inches)	(mm)	(inches)	(mm)	(inches)
216.1	8.508	263.7	10.38	293.1	11.54

Note:

mm = millimeters

Evaporation

Evaporation from open water surfaces is calculated with the Penman-Thornthwaite method in this analysis. The Penman-Thornthwaite evaporation method requires data on air temperature, atmospheric pressure, relative humidity, and solar radiation. Hourly values of these parameters were collected at the Rock Creek site by Hoefler Consulting Group. Hourly values were used to compute a daily average for each parameter, which was used to calculate daily evaporation. Daily evaporation was then summed to a monthly total. It was assumed that no evaporation occurred on days where the average temperature was below freezing.

Comparable data necessary for evaporation calculations have not been collected at the Big Hurrah site. Therefore, evaporation was quantified at the Rock Creek site only and will be used for both locations. Total monthly evaporation at the Rock Creek site is shown in Table 7-28.

Table 7-28 Rock Creek Evaporation

Month	Total Evaporation (mm)	Total Evaporation (inches)
January	0.0	0.0
February	3.1	0.12
March	0.0	0.0
April	52.1	2.05
May	98.0	3.86
June	170.2	6.701
July	157.9	6.217
August	93.2	3.67
September	58.4	2.30
October	21.1	0.831
November	0.3	0.012
December	0.0	0.0

Note:

mm = millimeters

It should be noted that February and November each had only one day with average temperatures above freezing. As it was assumed that no evaporation occurred on days where the average temperature was below freezing, water loss for these months is likely to be more accurately represented by snow sublimation. It will be possible to quantify evaporation during the months of February and November with greater accuracy as more data become available.

Evapotranspiration

Evapotranspiration is the combination of evaporation from the soil surface and transpiration from vegetation (Chow, et al., 1988). Calculations of evapotranspiration are made using evaporation calculation methods with adjustments to account for the conditions of the vegetation and soil.

In this analysis, the combination Penman-Thornthwaite method for evaporation over open water was applied, with an adjustment to account for land condition based on wind speed (Chow, et al., 1988). Hourly data collected by Hoefler Consulting Group were used to calculate daily evapotranspiration values. Daily evapotranspiration was summed to a monthly total. It was assumed that no evapotranspiration occurred on days where the average temperature was below freezing.

Comparable data necessary for evapotranspiration calculations have not been collected at the Big Hurrah site. Therefore, evapotranspiration was quantified at the Rock Creek site only and

will be used for both locations. Total monthly evapotranspiration at the Rock Creek site is shown in Table 7-29.

Table 7-29 Rock Creek Evapotranspiration

Month	Total Evapotranspiration (mm)	Total Evapotranspiration (inches)
January	0.0	0.0
February	7.2	0.28
March	0.0	0.0
April	70.0	2.76
May	121.7	4.791
June	215.3	8.476
July	191.3	7.531
August	118.4	4.661
September	83.5	3.29
October	34.6	1.36
November	0.8	0.03
December	0.0	0.0

Note:

mm = millimeters

It should be noted that February and November each had only one day with average temperatures above freezing. As it was assumed that no evapotranspiration occurred on days where the average temperature was below freezing, water loss for these months is likely to be more accurately represented by snow sublimation. It will be possible to quantify evapotranspiration during the months of February and November with greater accuracy as more data become available.

Snow Sublimation

Sublimation is the direct conversion of solid snow or ice to water vapor. Calculations of daily surface (not intercepted or blowing) snow sublimation are based on wind speed, air vapor pressure, and saturated vapor pressure over ice (Gelfan, et al., 2004). In this analysis, total monthly sublimation was calculated using hourly data collected at the Rock Creek site by Hoefler Consulting Group. Hourly values were used to compute a daily average for each required parameter, which were then used to calculate daily sublimation. Daily sublimation was summed to a monthly total. Sublimation at the Rock Creek site was calculated for the months of November, December, January, February, and March, where below-freezing temperatures were recorded for more than half of all days. Sublimation was not calculated at the Big Hurrah site, as necessary climatological data have not been collected.

Total sublimation values at the Rock Creek site represent a depth of snow converted to water vapor. In order to convert snow depth to the corresponding depth of water, the snow-water equivalent is necessary. Average monthly snow-water equivalent values were determined for the months of November, December, January, February, and March at the Nome Airport. Snow-water equivalents were calculated from average total precipitation, which includes the liquid water equivalent of snowfall and average total snow fall data. These data are available through WRCC for the period between 1949 and 2005, and were assumed applicable to the Rock Creek site snowpack, as no snowfall data are available at that site.

Total monthly sublimation and water-equivalent results are shown in Table 7-30. It should be noted that equivalent sublimated water results based on calculated snow-water equivalent values represent minimum water loss, as they do not take snow compaction and settling in to account. Calculated snow-water equivalent values range between 9 and 10 percent water content. However, as snow settles, it may reach up to a 30-35% water content before melting (Rick McClure, Anchorage Natural Resources Conservation Service, personal communication September 1, 2005). Therefore, equivalent water results determined from calculated snow-water equivalent values are listed as "minimum" in Table 9.

Table 7-30 Rock Creek Evapotranspiration

Rock Creek Evapotranspiration

Month	Total Evapotranspiration (mm)
January	0.0
February	7.2
March	0.0
April	70.0
May	121.7
June	215.3
July	191.3
August	118.4
September	83.5
October	34.6
November	0.8
December	0.0

Note:
mm = millimeters

Although no snow sublimation data are available at the Nome Airport for comparison, these results were compared to published snow sublimation research in the Imnavait Creek watershed. This watershed is located on the northern slope of Alaska at the foothills of the Brooks Range.

Snow Melt

The WRCC maintains a record of average daily snow depth at the Nome Airport for the period between 1949 and March 31, 2005. Recorded results suggest that nearly all snow melts during the months of April and May. For the purpose of water balance analysis, ERC recommends assuming that half of the snow melts in April, and the remainder in May.

Analysis of the snow melt rate suggests that rainfall runoff associated with the 100-year 24-hour storm acts as the controlling criterion for facilities design at the proposed Rock Creek and Big Hurrah sites, rather than snow melt. The water produced by snow melt, using a maximum water equivalent of settled snow, is delivered with an intensity two orders of magnitude less than the precipitation intensity of a 100-year 24-hour storm. Further, April and May receive approximately one quarter to one third of the precipitation that falls during the wettest months of July, August, and September. Rainfall would therefore not significantly contribute to the intensity of the total water delivered by snow melt.

7.6.1.2 Air Quality Data Summary

The area surrounding the Rock Creek site has been classified as attainment or unclassifiable for all pollutants. The closest nonattainment area to the facility is the Anchorage urban particulate matter (PM) nonattainment area, which is located approximately 560 miles (900 km) southeast of the Rock Creek site.

The region surrounding the Rock Creek site is a PSD Class II area. The nearest PSD Class I area is the Bering Sea National Wildlife Refuge designated as a National Wilderness Area on St. Mathew Island. This PSD Class I area is located approximately 370 miles (600 km) southwest of the Rock Creek site.

Monitoring of ambient levels of particulate matter with an aerodynamic diameter of less than or equal to a nominal 10 micrometers (PM_{10}) was conducted at the Rock Creek site from April 1, 2004, through March 31, 2005. All PM_{10} monitoring was conducted following the EPA and ADEC guidelines and procedures for collecting PSD-quality ambient air pollutant data. The data were collected consistent with the QAPP for the Rock Creek Ambient Air Monitoring Project that was submitted to ADEC in November 2003. Ambient air quality monitoring for PM_{10} was not conducted at the Big Hurrah mine site. However, based on proximity, vegetative cover, and lack of nearby anthropogenic emission sources , the ambient PM_{10} data collected at the Rock Creek site are generally representative of the Big Hurrah site.

The highest and second highest 24-hour ambient PM_{10} concentration measured at the Rock Creek site was 75 micrograms per cubic meter ($\mu g/m^3$) and 18 $\mu g/m^3$, respectively. This second highest measured concentration is 12% of the 24-hour ambient air quality standard for PM_{10} of 150 $\mu g/m^3$.

The annual average ambient PM_{10} concentration measured at the Rock Creek site was 5.1 $\mu g/m^3$. This annual average concentration is 10% of the annual ambient air quality standard for PM_{10} of 50 $\mu g/m^3$.

The detailed monitoring specifications and results are provided in One Year PM_{10} Data Report, April 1, 2004, through March 31, 2005, for the Rock Creek Ambient Air Monitoring Project, included in the Climate section of the appendices.

7.6.1.3 Climate-related Hazards

The major climate-related risk, for the City of Nome and arguably the beaches along the coast down to Safety, is from coastal storm surges. The Nome coastline is subject to positive storm surge due to its exposure to a long southwest fetch. Contributing to the surge are the effects of the Bering Sea, Norton Sound, and mildly sloping shallow depths, which amplify surges. Positive surges are distinguished from negative surges as an increase in water level from the normal tidal elevation as compared to a decrease. A storm surge consists of the water surface response to wind-induced surface shear stress and pressure fields. Storm-induced surges can produce short-term increases in water levels to an elevation considerably above mean levels. The average mean high water (MHW) and the mean low water (MLW) is 0.9 foot (0.3 m). The mean range is the difference between MHW and MLW in the Nome area is 1.0 foot (0.3 m). This very small range of tidal fluctuation at Nome means that it makes little difference whether a storm arrives at high or low tide. In addition, the Bering Sea at Nome is frozen in winter, so the frequent winter storms do not create storm surge or storm wave problems.

At the time the Flood Insurance Study and Flood Insurance Rate Maps were prepared in 1983 by the U.S. Army Corps of Engineers for the Federal Emergency Management Administration (FEMA), there was no documentation of river flooding along the Snake River. While there was no official documentation, people who lived in the area have noted that during the flood of 1974, the airport road and the airport were under water. The National Weather Service's Alaska River Forecast Center found records of one flood event caused by heavy rainfall in May 1996. Seven homes near the Nome-Teller Road Bridge on the Snake River had water in their yards but were not damaged. It appears that river flooding within the City of Nome is a low to moderate risk.

The Alaska Tsunami Warning Center is quoted in the City of Nome Hazard Mitigation Plan as relating that there is zero risk from tsunamis in the Nome area. The Alaska Division of Emergency Services designates Nome as having a low probability of occurrence of a tsunami.

7.6.2 Consequences

7.6.2.1 Rock Creek Mine/Mill Complex

The operation of the Rock Creek Mine and Mill Complex will result in the release of nitrogen oxides (NO_X), carbon monoxide (CO), PM, and sulfur dioxide (SO_2) to the atmosphere. Combustion emission units, such as heaters, mobile equipment, and non-road engines, will be the primary source of NO_X, CO, and SO_2 emissions. However, because the facility will be connected to the Nome electrical grid, on-site power generation will be limited to only emergency situations. As a result, potential NO_X, CO, and SO_2 emissions will be less than the thresholds that could cause a significant ambient impact. These thresholds have been established by ADEC on the basis of conservative dispersion modeling. Given that the expected ambient NO_X, CO, and SO_2 impacts will be less than the significant levels, compliance with the ambient air quality standards (AAQS) and PSD Class II increments will be maintained and no adverse environmental impacts will occur.

The primary cause of PM emissions will be overburden removal, ore mining and milling, and fugitive emissions from the movement of vehicles on unpaved roads. Potential PM emissions are expected to be greater than the ADEC threshold for potential significant ambient impact. Ambient air quality analysis using dispersion modeling will be required for the site and has been conducted for those portions where adequate engineering design data were available. The predicted maximum 24-hour ambient PM_{10} impact is anticipated to be well below the AAQS of 150 $\mu g/m^3$ and the PSD Class II increment of 30 $\mu g/m^3$ based on results seen at similar sized facilities. The predicted maximum annual ambient PM_{10} impact was calculated and is well below the AAQS of 50 $\mu g/m^3$ and the PSD Class II increment of 17 $\mu g/m^3$. Based on these predicted ambient PM_{10} impacts, no adverse environmental impacts will occur.

7.6.2.2 Big Hurrah Mine

The Big Hurrah mining operation will be much smaller than the Rock Creek operation and will have much lower potential emissions. Based on the Rock Creek ambient analysis and conclusions, the smaller Big Hurrah Mine is expected to be in compliance with all applicable AAQS and PSD Class II increments and is not expected to cause an adverse environmental impact.

There is some risk that storm-induced waves will cause destruction of the coastal areas, potentially interrupting ore transport until road maintenance is completed. However, it is likely that ore transport will be a seasonal activity with flexibility to adjust to interruptions in road access for a reasonable amount of time. Transportation of ore will be along the established public road and will not affect the potential for erosion.

7.7 BIOLOGICAL RESOURCES

7.7.1 Habitat Types

7.7.1.1 Affected Environment

Rock Creek Mine/Mill Complex

A total of 23 wildlife habitat types were identified and mapped in the 3092-acre (1251-ha) Rock Creek study area (ABR, Inc., Environmental Research & Services, 2004). Preliminary mapping was conducted using August 1993 true-color, digital aerial photography for the Rock Creek area. Different photo signatures in the aerial photography were assigned land cover types based on vegetation, surface form, and landscape physiographic characteristics. Field verification of the wildlife habitat map for the Rock Creek Mine study area was conducted on 10 and 11 August 2004. A total of 27 plots were sampled, chosen to sample each habitat type in order to (1) evaluate the mapped polygons for accuracy, (2) determine the landscape physiography and surface form, and local vegetation type within a 33-foot (10-m) radius surrounding the selected point. The sampling results were used to edit the wildlife map to better define boundary delineations and determination of land cover types.

During the mapping of wildlife habitats 39 land cover classes within the 3092-acre (1251-ha) study area were identified. These land cover classes were then collapsed into 24 wildlife habitat types. The primary aggregations involved combining open and closed scrub habitats

and combining gravel land cover categories (both artificial and excavated). Open and closed scrub habitats were combined because both types occurred in patches across the study area and contained similar "edge" habitats, and both appeared to be used similarly by breeding birds. The gravel land cover categories were combined because these land cover types had similarly characteristics and were rarely used by breeding birds. The differences were maintained among land cover classes in landscape physiography, because the different physiographic classes within a given vegetation structure type (e.g. upland, lowland, and riverine tall willow scrub) can be used differently by breeding birds. Habitat types are further defined in the Biological Resources section of the appendices under the titles Rock Creek Description of Habitat Types and RC Tbl01 Collapsed Land Cover.

The study area (Figure 7.18) consists of 2141 acres (866.4 ha) (63%) of uplands, 677 acres (274 ha) of lowlands (22%), and 189 acres (76.5 ha) of riverine habitat (6%). Lacustrine waterbodies were rare in the study area, comprising only 6 acres (2 ha) (0.21%) of the study area. On the 1993 aerial photography, approximately 79 acres (32 ha) (<3%) of the study area showed evidence of previous mining excavation and gravel road surfaces.

Dwarf ericaceous scrub types dominated the area, covering 1377 acres (557.3 ha) or 45 % of the study area. Tall willow scrub habitats of various types (upland, lowland, riverine) are the next most common habitats, covering 780 acres (320 ha) (25% of the study area). Low Shrub birch and low birch-willow habitats (both upland and lowland) comprise 616 acres (249 ha) (20% of the study area). Poorly drained wet and marsh habitats, lacustrine water, and riverine types as well as artificial habitats, comprise only about 80 acres (30 ha), or <3% of the study area, each.. Habitat mapping is shown in Figure 7.19. Additional information can be found in the Biologic Resources section of the appendices under the titles Rock Creek and Big Hurrah Avian Surveys and Habitat Mapping and Rock Creek Description of Habitat Types.

Figure 7.18 Mapped Area and Development Footprint in the Rock Creek Mine Study Area, Alaska

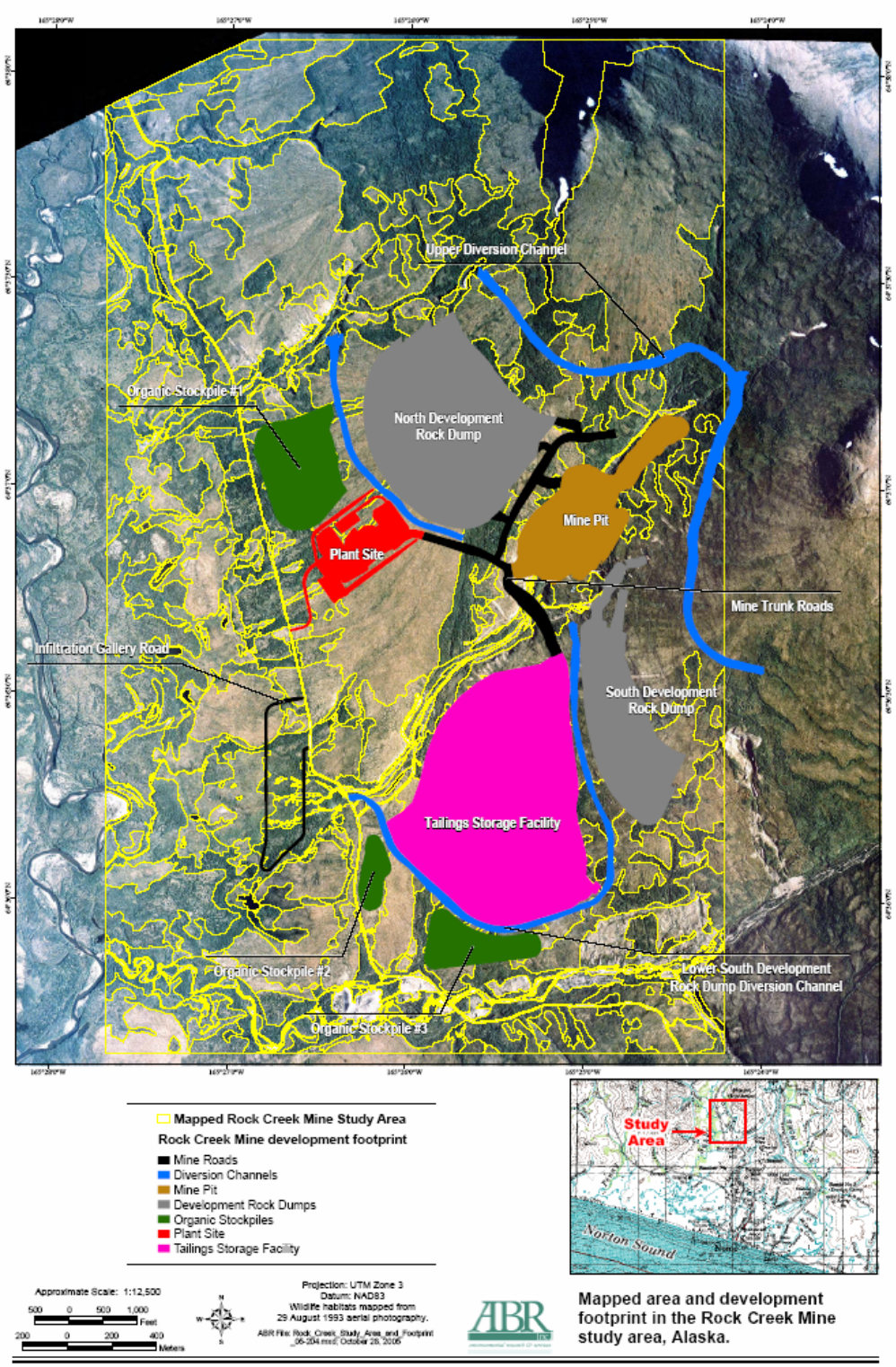
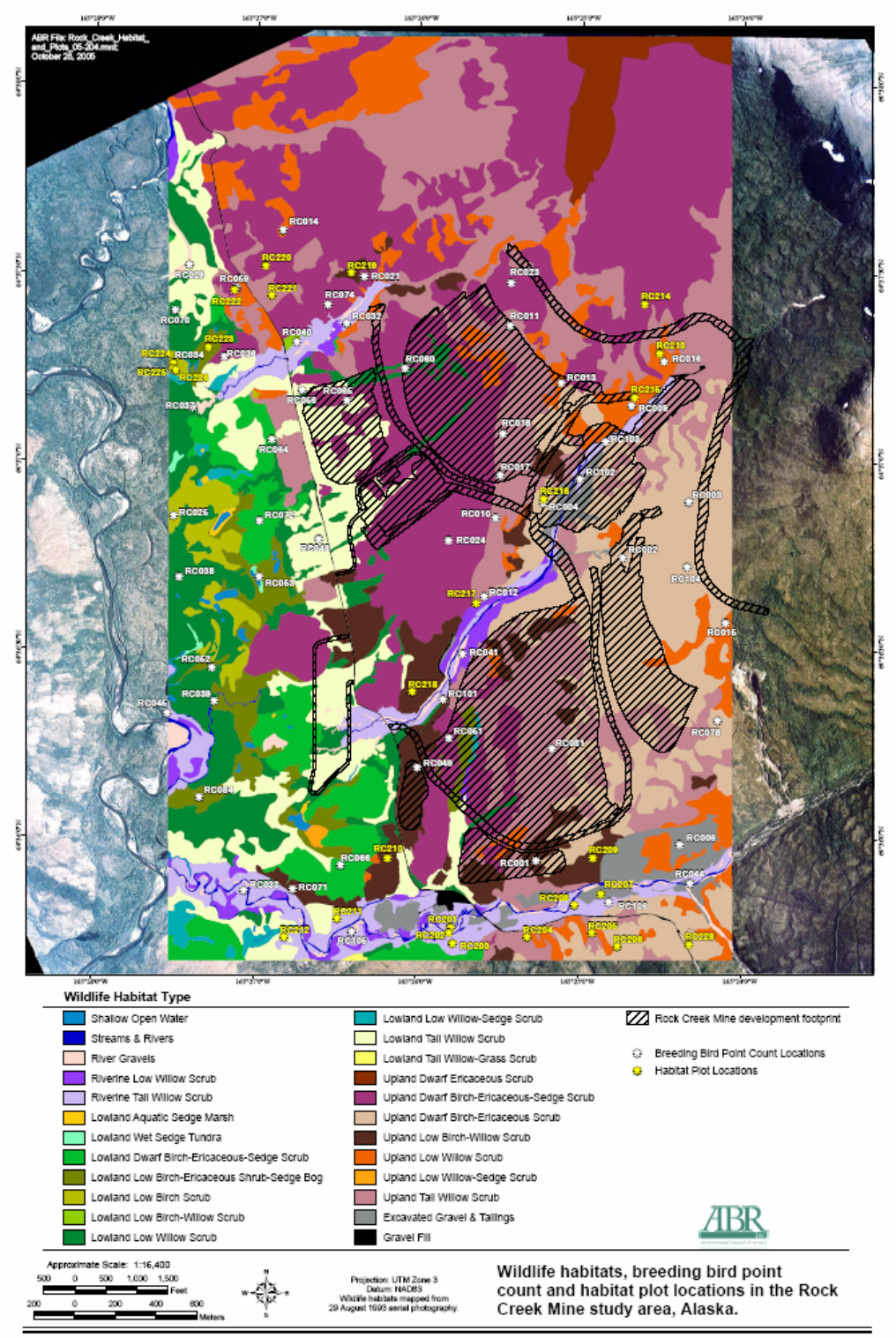


Figure 7.19 Wildlife Habitats, Breeding Bird Point Count and Habitat Plot Locations in the Rock Creek Mine Study Area, Alaska



Big Hurrah Mine

A total of 17 wildlife habitat types covering 1,918.7 acres (776.47 ha)of the Big Hurrah Creek watershed were identified and mapped by ABR, Inc., Environmental Research & Services, 2005. The study area (Figure 7.20) was centered roughly on the proposed location of the mine site facilities. A large area was studied to evaluate the distribution of wildlife habitats and breeding bird use of those habitats both in the proposed mine area as well as in the region surrounding the proposed mine. Aerial photography taken October 2004 was used to determine distinct photosignatures within the study area. Using a field copy of the aerial photography as a guide, the study team navigated by foot to locations that were representative of each different photosignature. In total, 45 plots were sampled for wildlife habitat data. At each sample plot, records were taken of physiography, local surface form and local vegetation type in a 10-m radius surrounding the selected sample point. Field plot data for specific photosignatures were used to extrapolate and map those data and similar photosignatures observed across the study area. Land cover types were identified based on vegetation, surface form, and landscape physiographic characteristics. Selected land cover types were aggregated into broader habitat types that represent combinations of vegetation structure, surface form, and physiography relevant to wildlife use, particularly by avian species. These wildlife habitat types were then use din the analyses of habitat use by breeding birds.

The study area is typified by rolling foothills terrain with mostly gradual slopes that are steeper near small drainages and especially near Little Hurrah and Big Hurrah Creeks. Vegetation in the area is dominated by dwarf shrub tundra (≤0.7 feet [0.2 m] tall) with rocky fell-field areas on some of the higher ridge tops and hillcrests. Patches of low willow thickets and low willow-sedge openings often occur on drainage swales and terraced hillslopes. Tall willow thickets also occur in patches on slopes, but are most common in the riparian areas where the plants range from 7 – 10 feet (2 – 3 m) in height.

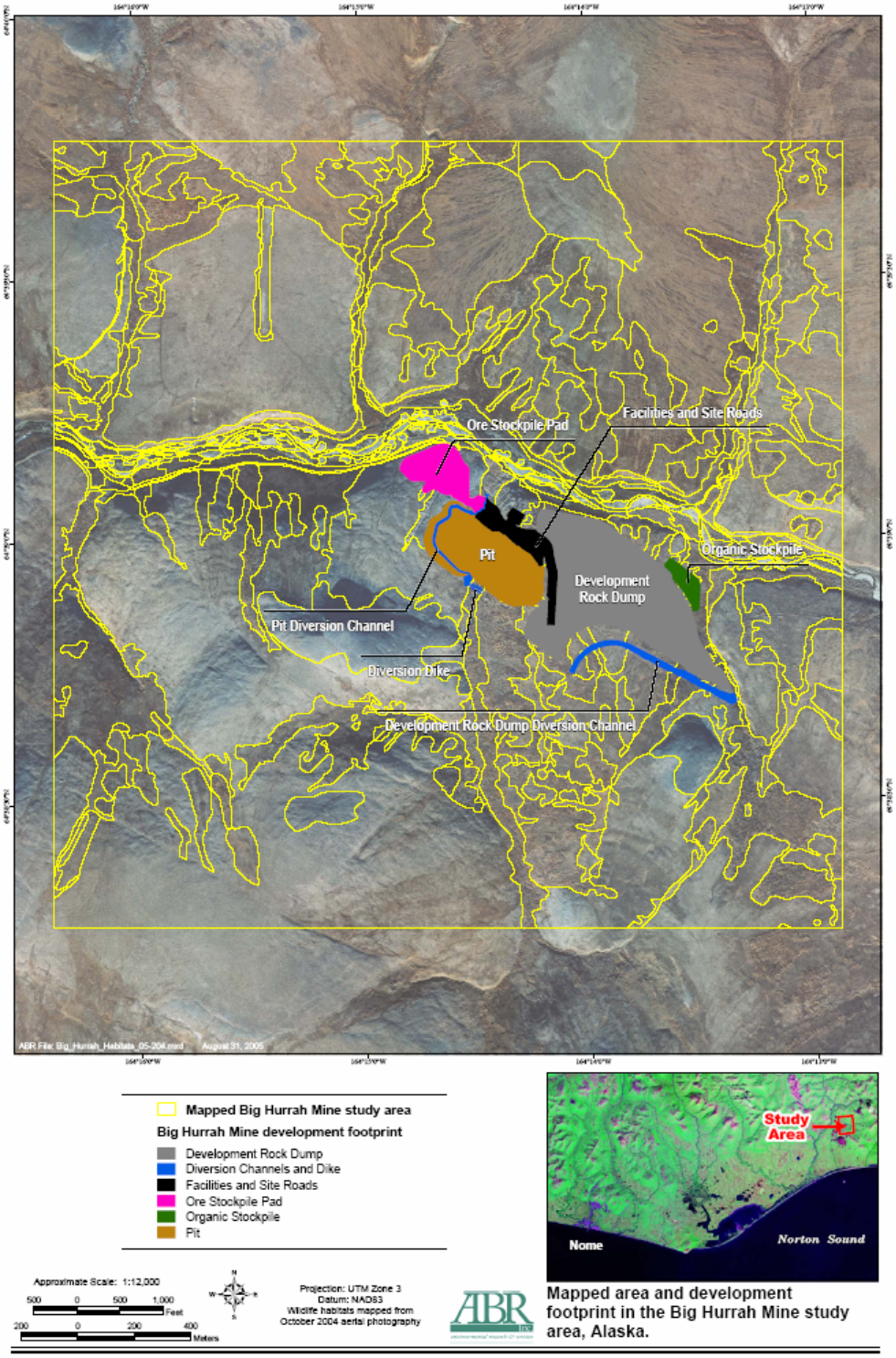
The study area consists of 1,919 acres (776.6 ha), with 26 land cover classes. These 26 land cover classes were then collapsed into 18 wildlife habitats. The primary aggregations involved combining open and closed scrub habitats and combining gravel land cover categories (both artificial and excavated). Open and closed scrub habitats were combined because both types occurred in patches across the study area and contained similar “edge” habitats, and in addition, the two types appeared to be used similarly by breeding birds. The gravel land cover categories were combined because these land cover types had similar characteristics and were rarely used by breeding birds. Differences among land cover classes in landscape physiography were maintained because the different physiographic classes within a given vegetation structure type (e.g., upland and riverine tall willow scrub) can be used differently by breeding birds. Additional information on the habitat types can be found in the Biological Resources section of the appendices under the titles Big Hurrah Description of Habitat Types and BHTbl01 Collapsed Land Cover.

The Big Hurrah Mine study area occurs primarily in upland habitats, which comprise 1761 acres (712.7 ha) (92% of the acreage). Riverine types were the second most common habitats, comprising 112 acres (45.3 ha) (6% of the acreage). Lacustrine water, lowland, and artificial habitats (mining excavations and gravel fill) were uncommon, and cumulatively, comprise <5% of the overall mapped area. Although it should be noted that the majority of

previous mining disturbance occurs in the immediate area of the proposed project site on Little Hurrah Creek, and in dredge disturbance within Big Hurrah creek itself.

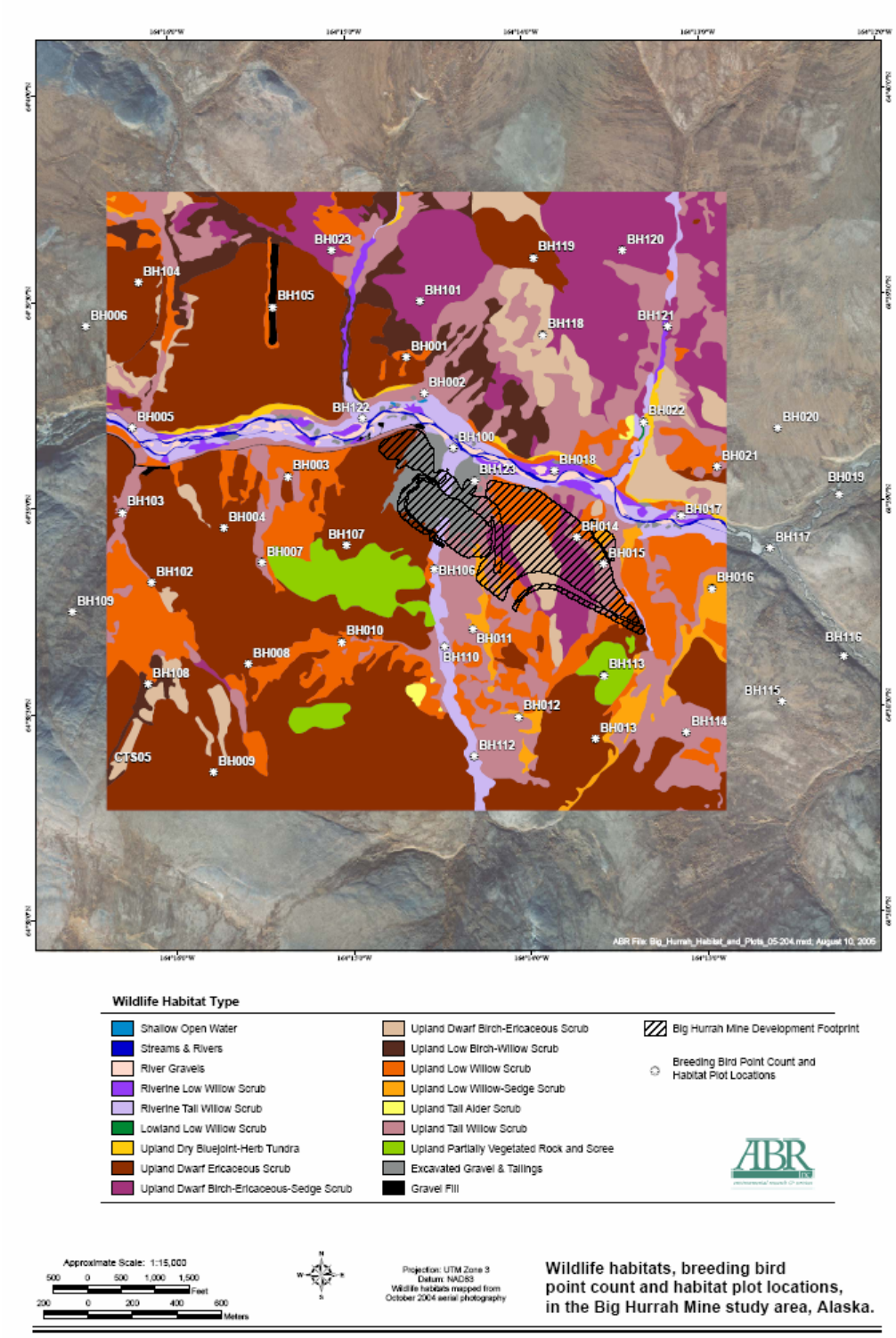
Dwarf scrub habitats which cover 1055 acres (426.9 ha) (55%) of the study area were the most common habitat types. Tall scrub habitats (riverine and upland) and low scrub habitats (riverine, lowland, and upland) cover 361 acres (146 ha) and 366 acres (148 ha), respectively, and each type comprises 19% of the study area. No other vegetative structure categories covered more than 3% of the study area. Habitat mapping for Big Hurrah is shown in Figure 7.21. A more complete description of the habitat types can be found in the Biological Resources section of the appendices under the titles Rock Creek and Big Hurrah Avian Surveys and Habitat Mapping and Big Hurrah Description of Habitat Types.

Figure 7.20 Mapped Area and Development Footprint in the Big Hurrah Mine Study Area, Alaska



Mapped area and development footprint in the Big Hurrah Mine study area, Alaska.

Figure 7.21 Wildlife Habitats, Breeding Bird Point Count and Habitat Plot Locations, in the Big Hurrah Mine Study Area, Alaska



7.7.1.2 Consequences

The Rock Creek Mine / Mill complex and operation footprint, as well as the Big Hurrah Mine, have been designed to be as compact as practicable, minimizing impacts on wildlife habitat. Within the project area approximately 612 acres (248 ha) of land will be disturbed at the Rock Creek site. The proposed footprint of the Rock Creek Mine occurs largely in upland areas and would primarily impact these types, removing 537 acres (217 ha) or 25% of the total upland habitat within the study area (Figure 7.19 in section 7.7.1.1, Table – 31 below). Few other natural landscape types would be as strongly affected by the mine development, as the footprint would impact <13% of the riverine and lowland habitats in the study area (8 acres [3 ha] and 55 acres [22 ha], respectively; Table 1-2). The primary wildlife habitat types that would be removed by the mine development include Upland Dwarf Birch-Ericaceous-Sedge Scrub, Upland Dwarf Birch-Ericaceous Scrub, and Upland Tall Willow Scrub (154 acres [62.3 ha], 136 acres [55.0 ha], and 186 acres [75.3 ha] of each, respectively). The mine would remove 18%, 37%, and 33%, respectively, of these types within study area. For a more specific breakdown of habitat areas and impacts see Table 7-31 below.

Table 7-31 Mapped Wildlife Habitat Types at the Rock Creek Mine Study Area, Alaska, 2004: number of point count surveys conducted, acreage mapped, percent of total study area mapped, acreage expected to be removed by mine development footprint, and percent of habitats in total study area expected to be removed by mine development footprint.

Class	Wildlife Habitat Type	No. Point Counts	Acres Mapped	% of Study Area	Acres in Mine Footprint	% of Habitat in Footprint
Lacustrine	Shallow Open Water	0	6.44	0.21	0.00	0.00
	Lacustrine subtotal	**0**	**6.44**	**0.21**	**0.00**	**0.00**
Riverine	Stream or River	0	16.43	0.53	0.67	4.08
	River Gravel	0	23.37	0.76	0.23	0.98
	Riverine Low Willow Scrub	0	30.93	1.00	1.08	3.49
	Riverine Tall Willow Scrub	9	118.40	3.83	6.38	5.39
	Riverine subtotal	**9**	**189.13**	**6.12**	**8.36**	**4.42**
Lowland	Lowland Aquatic Sedge Marsh	0	1.97	0.06	0.00	0.00
	Lowland Wet Sedge Tundra	1	2.23	0.07	0.00	0.00
	Lowland Dwarf Birch-Ericaceous-Sedge Scrub	3	125.12	4.05	0.52	0.42
	Lowland Low Birch-Ericaceous-Sedge Bog	2	71.24	2.30	7.26	10.19
	Lowland Low Birch Scrub	2	38.97	1.26	0.00	0.00
	Lowland Low Birch-Willow Scrub	1	1.29	0.04	0.00	0.00
	Lowland Low Willow Scrub	4	206.81	6.69	14.27	6.90
	Lowland Low Willow-Sedge Scrub	0	15.32	0.50	1.24	8.09
	Lowland Tall Willow Scrub	3	212.77	6.88	31.48	14.80
	Lowland Tall Willow-Grass Scrub	0	0.77	0.02	0.00	0.00
	Lowland subtotal	**16**	**676.50**	**21.88**	**54.77**	**8.10**
Upland	Upland Dwarf Ericaceous Scrub	0	50.29	1.63	0.00	0.00
	Upland Dwarf Birch-Ericaceous Scrub	5	366.00	11.84	136.36	37.26
	Upland Dwarf Birch-Ericaceous-Sedge Scrub	9	835.96	27.03	153.65	18.38
	Upland Low Birch-Willow Scrub	3	131.91	4.27	38.30	29.03
	Upland Low Willow Scrub	5	188.27	6.09	22.39	11.89
	Upland Low Willow-Sedge Scrub	0	2.17	0.07	0.00	0.00
	Upland Tall Willow Scrub	6	566.06	18.31	185.82	32.83
	Upland subtotal	**28**	**2140.66**	**69.23**	**536.52**	**25.06**
Artificial	Excavated Gravel & Tailings	2	60.88	1.97	11.45	18.81
	Gravel Fill	0	18.54	0.60	0.77	4.15
	Artificial subtotal	**2**	**79.43**	**2.57**	**12.22**	**15.38**

Within the project area at the Big Hurrah site, approximately 95 acres (38 ha) will be disturbed. The proposed footprint of the Big Hurrah Mine occurs largely in upland areas, and would remove 69 acres (28 ha) of habitat in the uplands. This acreage represents 4% of the upland habitat available within the study area. The artificial landscape class, disturbed areas from earlier mining operations at Big Hurrah, such as Excavated Gravel & Tailings and Gravel Fill, would be the second most common landscape class removed by development (23 acres or 51% of these types mapped in the study area would be affected). Few other landscape classes would be affected by the mine development. The primary wildlife habitat types that would be directly affected by mine development include Upland Tall Willow Scrub and Upland Low Willow Scrub (16 acres [6.5 ha] and 18 acres [7.3 ha], respectively; 13% of these

types combined within study area), and 3 forms of upland dwarf scrub (Upland Dwarf Ericaceous Scrub, 6 acres [2 ha]; Upland Dwarf Birch–Ericaceous Scrub, 10 acres [4.0 ha]; and Upland Dwarf Birch–Ericaceous–Sedge Scrub, 16 acres [6.5 ha]; 17% of these types combined within study area). For a more specific breakdown of habitat areas and impacts see Table 7-32 below.

Table 7-32 Mapped Wildlife Habitat Types at the Big Hurrah Mine Study Area, Alaska, 2005: number of point count surveys conducted, acreage mapped, percent of total study area mapped, acreage expected to be removed by mine development footprint, and percent of habitats in total study area expected to be removed by mine development footprint.

Class	Wildlife Habitat Type	No. Point Counts	Acres Mapped	% of Study Area	Acres in Mine Footprint	% of Habitat in Footprint
Lacustrine	Shallow Open Water	0	0.18	0.01	0.00	0.00
	Lacustrine subtotal	**0**	**0.18**	**0.01**	**0.00**	**0.00**
Riverine	Stream or River	0	10.85	0.57	0.00	0.00
	River Gravels	0	13.54	0.71	0.00	0.00
	Riverine Low Willow Scrub	4	19.55	1.02	0.00	0.00
	Riverine Tall Willow Scrub	6	68.39	3.56	2.42	3.54
	Riverine subtotal	**10**	**112.33**	**5.85**	**2.42**	**2.15**
Lowland	Lowland Low Willow Scrub	1	0.44	0.02	0.00	0.00
	Lowland subtotal	**1**	**0.44**	**0.02**	**0.00**	**0.00**
Upland	Upland Dry Bluejoint-Herb Tundra	0	11.72	0.61	0.00	0.00
	Upland Dwarf Ericaceous Scrub	9	718.64	37.45	6.10	0.85
	Upland Dwarf Birch-Ericaceous Scrub	3	108.14	5.64	10.09	9.33
	Upland Dwarf Birch-Ericaceous-Sedge Scrub	3	228.19	11.89	15.56	6.82
	Upland Low Birch-Willow Scrub	1	77.34	4.03	0.00	0.00
	Upland Low Willow Scrub	5	234.50	12.22	17.97	7.66
	Upland Low Willow-Sedge Scrub	2	33.95	1.77	3.76	11.08
	Upland Tall Alder Scrub	1	2.74	0.14	0.00	0.00
	Upland Tall Willow Scrub	9	290.06	15.12	15.89	5.48
	Upland Partially Vegetated Rock and Scree	0	55.74	2.91	0.00	0.00
	Upland subtotal	**33**	**1761.03**	**91.78**	**69.37**	**3.94**
Artificial	Excavated Gravel & Tailings	1	36.47	1.90	22.83	62.60
	Gravel Fill	0	8.25	0.43	0.00	0.00
	Artificial subtotal	**1**	**44.72**	**2.33**	**22.83**	**51.05**

The project was designed to avoid wetlands to the extent practicable, which is reflected in the greater loss of upland habitat. The expected impacts and habitat loss percentages discussed here have so far been considered only on a local scale (within the project study area). The percentages of important breeding habitats expected to be removed by development are based on the relative abundance of habitats within the mine footprint as compared to the surrounding study area. The local study area used at the Big Hurrah site was about 20-times the area of the proposed mine development, which compares to the much smaller local study area for the Rock Creek Mine (see Section 1) which was only about 4-fold larger than the proposed mine footprint. Local-scale impacts are expected to be far less at the Big Hurrah

Mine than at Rock Creek (see Section 1), which indicates that the assessment of local scale impacts is highly dependent on the size of the local study area.

From a broader, regional perspective, the important habitat types, are not unique to the project areas, but are widespread across low mountainous areas of the Seward Peninsula (Kessel 1989). The Seward Peninsula, outside of the Nome area and the scattered small villages, is relatively undeveloped, which means that largely undisturbed habitats will be available for use throughout the peninsula. Considering this widespread availability of common habitats at the regional scale of the Seward Peninsula, the direct impacts from development of the two mine sites would be expected to be of much less magnitude than the impacts expected at the local scale of the mine study areas. In the language of the National Environmental Policy Act (NEPA), the impacts at the regional scale would be nearly negligible. The prevalence of similar habitat types in surrounding areas will absorb the impacts of habitat loss.

7.7.2 Wetlands

7.7.2.1 Affected Environment

Rock Creek Mine / Mill Complex

There are 681 acres (276 ha) of wetlands within the 1,298-acre (525.3-ha) project area. The type and distribution of wetlands within the project area appear to be similar to surrounding areas, most of which is undisturbed and in a natural state. The dominant wetland community in the project area is open sedge/shrub tundra wetland which covers approximately 40% of the project area and comprises approximately 70% of all wetlands at the site. Other wetland communities, in descending order of abundance, include closed willow thicket wetlands, shrub/sedge tundra communities, and close-flooded willow thicket wetlands which lie along the perimeter of Rock Creek and its riverine habitat. There are 617 acres (250 ha) of upland area composed of willow/grass communities.

Big Hurrah Mine

There are no wetlands within the Big Hurrah project area. The Little Hurrah Creek bisects the project area. Wetlands occur in some sections along Big Hurrah Creek, which comprises the transportation corridor, and are discussed within the Transportation Corridor section of this document.

7.7.2.2 Consequences

Four-hundred one acres (162 ha) of these wetlands will be disturbed by the mine and its related facilities. The higher-value willow wetlands disturbance is minimized to the extent practicable within the project design. Approximately 50% of the willow communities are left undisturbed. Upland areas are used to the extent practicable, but by nature are steeper, less geotechnically stable areas for stockpiling materials or locating facilities. The apparent abundance of similar wetland habitat in surrounding areas provides substantial opportunity for wildlife to relocate within the vicinity.

There are no wetlands impacts at the Big Hurrah project site. Little Hurrah Creek is disturbed in the area of the mine pit. The creek is routed around the side of the pit and then returned to the original stream channel.

7.7.3 Mammals

7.7.3.1 Affected Environment

Rock Creek Mine / Mill Complex

Mammals

Brown bear (Ursus arctos) are known to be generally distributed in the general project area. Known concentrations of brown bear are found along the Niukluk River, feeding on salmon near Council (Alaska Habitat Management Guide, 1985).

Since 1991, brown bear populations in the Nome and Solomon River areas have increased, while moose populations and recruitment rates have declined in most parts of Unit 22. In Unit 22, which includes the project area, brown bears are heavily harvested and the moose population is above Alaska Department of Fish & Game's (ADFG's) management goal (Persons, 2003).

Moose (Alces alces) are generally distributed throughout the Solomon River area. Unit 22C, the subsection in which both project sites are located, is the only portion where consistently high recruitment rates have exceeded ADFG's management goal. The high recruitment rate may be attributed to a reduction of predation on calves by brown bears because of brown bear hunting in 22C. An antlerless moose hunt in Unit 22 was started in 2000 to help stabilize the population and prevent the overuse of limited winter moose habitat.

Musk oxen (Ovibos moschatus) were reintroduced to Units 22C (which includes the project area) and 22D (an area to the northwest) in 1970. Since that time, the musk oxen population has continued to increase and extend its range throughout Units 22C, 22D, 22E (further northwest of 22D), and western Units 22B and 23SW, both to the southwest of the project area. In Unit 22C, which includes the project area, the number of musk oxen increased 74% from 148 musk oxen in 2000 to 257 musk oxen in 22 groups in 2002 (Persons, 2003). ADFG noted a large increase in musk oxen numbers in the Moon Mountains in western Unit 22C, west of the project site.

Reindeer (Rangifer tarandus) are a commercial enterprise and are discussed under section 7.23 of this report.

Furbearers

Detailed information about the distribution and abundance of beaver, red fox, Arctic fox, lynx (Lynx canadensis), marten (Martes americana), mink (Mustela vison), muskrat (Ondatra zibethicus), river otter (Lutra canadensis), wolverines (Gulo gulo), and wolves (Canis lupis) within the project area is unknown. The project site is located within Game Unit 22C.

Furbearers are found throughout Units 22B, 22C, 22D, and 22E on the Seward Peninsula and are most abundant in the eastern half of Unit 22B (to the southeast of the project) in extensive spruce tree forests and riparian willow habitat (Persons, 2001). The density of furbearers has fluctuated widely over the years on the Seward Peninsula in response to natural factors, hunting, and trapping. Beaver, lynx, and wolverine populations appear to be stable or increasing, whereas red fox populations started declining in 1997 and 1998 but are still fairly stable. Very little is known about the status of mink and marten populations in Unit 22C near Nome. Marten are most abundant east of Shaktoolik in Unit 22A. Most of the suitable marten and mink habitat is located in Units 22A and 22B (Fish River and Koyuk River watersheds).

Surveys of wolf population status, composition, and trends in Unit 22 and the project area have not been conducted by ADFG (Gorn, 2003). Research to assess wolf distribution and abundance has never been conducted in Unit 22. Estimates of wolf distribution, population trend, harvest, and human use data are annually obtained from sealing certificates and observations by ADFG, reindeer herders, and local residents.

Historically wolves have been scarce throughout Unit 22 for much of the 20th century. In 1960, government-sponsored predator control programs ended. By 1980, wolves were reported in all major drainages in Unit 22.

Big Hurrah Mine

The distribution and abundance of brown bear, moose, musk ox, and furbearers for the Big Hurrah area is similar to and fully described in wildlife discussion for Rock Creek above.

7.7.3.2 Consequences

The Rock Creek Mine / Mill complex and operation footprint, as well as the Big Hurrah Mine, have been designed to be as compact as practicable, minimizing impacts on wildlife habitat. Approximately 612 acres (248 ha) of land will be disturbed at the Rock Creek site and 95 acres (38 ha) at the Big Hurrah site. There is open habitat that provides for free range and passage of mammals in all directions around both sites. The Snake River floodplain and the Solomon River/Big Hurrah River floodplains, in particular, provide a generally flat willow habitat that is highly suitable for moose and bear and other mammals. This area is downslope of the active operations and provides a significant transportation corridor around the mines to the rest of the watershed.

The Snake River and Anvil Creek watersheds and the Solomon River watershed have experienced continued intermittent mining activity for the last 100 years. The project areas have been under continued mineral exploration activity over the last several decades. Current wildlife populations are likely acclimated to this type of activity. Most mammals found within this area can be seen in close proximity to current mining operations and/or residential areas. Small-scale industrial development and human occupants do not seem to cause significant disruption to mammalian wildlife in the region. Extensive wildlife habitat of a similar nature exists around the project area, providing significant opportunity for wildlife to re-establish if the project should disrupt their usual domain.

7.7.4 Avian Resources

7.7.4.1 Affected Environment

Study Methods

To determine baseline conditions for breeding birds for the Project, ABR, Inc., conducted pre-development field surveys in the region of the proposed mine and adjacent lands. Field surveys for breeding birds were designed to determine abundance and habitat use.

The area around the Rock Creek Mine/Mill Complex was surveyed in 2004. The breeding bird survey was conducted in early June to coincide with the peak of passerine breeding season on the Seward Peninsula. Fifty-five point counts were conducted at multiple locations representing 14 habitat types in a rectangular area of 3092 acres (1251 ha) surrounding the proposed mine site (approximately 4 times larger than the proposed 618 acre (250 ha) development site). Vegetation in the area is a mixture of dwarf shrub and graminoid-dominated tundra (≤m tall) and patches of low willow and low shrub birch thickets. Tall willow thickets occur in patches on slopes., but are most common in the lower riparian areas where the plants range from 7 – 10 feet (2 – 3 m) in height. The breeding bird community in the area, like most montane areas in arctic and subarctic Alaska, is dominated by landbirds and shorebirds.

Around the Big Hurrah Mine, breeding bird surveys were conducted June 3 through 7, 2005, over a 1,919-acre (776.6-ha) study area (approximately 20 times the size of the proposed 95-acre [38-ha] development site). Survey timing was selected to coincide with the peak of the passerine breeding season on the Seward Peninsula (Kessel, 1989). In total, 46 point counts were conducted in the field.

Preferred habitats were determined for each bird species surveyed, the total acreage of preferred breeding habitats for each species in the study area was calculated by referencing an aerial wildlife habitat map (see section 7.7.1 of this document). Preferred breeding habitat in the surrounding areas that would not be directly affected by the mine was also calculated to provide perspective on opportunities for relocation. In these analyses no corrections were made for patchiness in bird occurrence on the landscape. That is, for each map polygon representing a preferred habitat type, it was assumed that the area did in fact serve as preferred habitat for the species in question. In actuality, and this is especially true for the less common species, some patches of preferred habitat may never be occupied for a variety of reasons related to subtle differences in habitat quality that are not reflected in aerial photography.

Each bird species observed was categorized as either a habitat specialist or generalist and the level of use of each habitat type was determined. Habitat specialists usually indicated a preference for one or two habitats and were found to use single habitat types greater than 50% of the time. For habitat specialist only, high-use habitats are defined as those where >50% of the observations occurred. For both habitat specialists and generalists, moderate-use habitats are defined as those habitats where 25 to 50% of the observations occurred and low-use where 1 to 24% of the observations were noted.

Uncommon bird species encountered when in transit between sample points, and/or those species that are more difficult to detect with point counts, along with the habitat(s) the birds were using, were also recorded. Water-oriented habitats were scanned for birds, both to address the difficulty of conducting point counts in these areas and to survey for waterfowl and feeding shorebirds, This was done to enhance bird/habitat association information beyond what was collected with the point count sampling.

During field surveys at Rock Creek and Big Hurrah, several species that are of increasing conservation concern were recorded. The production of lists of North American birds of conservation concern is an ongoing process and was given greater attention over the last decade with the implementation of the vulnerability ranking system developed by the Partners in Flight program. There are now numerous agency and working group lists in use in the United States, all of which are independent of the U.S. Fish and Wildlife Service's list of federally threatened or endangered under the Endangered Species Act. The concept behind the Partners in Flight program, and the other listing programs that followed, is to identify species that are still common but may be undergoing population declines and/or facing population threats. The goal is to stimulate proactive conservation actions now to avoid sharp declines in populations of these species in the future and avoid the need for listing under the Endangered Species Act. There also is an explicit recognition, for the Neotropical migrant species, that conservation efforts must be international in scope and focused on habitats used during breeding, migration and wintering. For this study, several lists to identify species of conservation concern were used.

Rock Creek Survey Results

Biologists from ABR, Inc., recorded 704 observations of 41 bird species in the Rock Creek study area during the June 2004 bird survey (Table 7-33 and 7-34) Most species were observed at the 55 point count sampling sites, but additional species were observed in transit between sampling points Ten of the 41 bird species are considered species of conservation concern for Western Alaska (Red-throated Loon, American Golden-Plover, Whimbrel, Arctic Tern, Artic Warbler, Gray-cheeked Thrush, Blackpoll Warbler, Golden-crowned Sparrow, and Hoary Redpoll). The most frequently observed species during the survey were common redpoll (Carduelis flammea), hoary redpoll (Carduelis hornemanni), American tree sparrow (Spizella arborea), gray-cheeked Thrush (Turdus sp.), Wilson's snipe (Gallinago delicate), golden-crowned sparrow (Zonofrichia africapilla**), f**ox asparrow (Passerella iliaca), orange-crowned warbler (Vermivora celata), yellow warbler (Dendroica petechia), and Savannah sparrow (Passerculus sandwichensis). Over 40 observations for each of these species were recorded and the species were all considered to be abundant in the study area. Nine additional species were observed 8-28 times each in the study area and were also considered to be abundant. The remaining 23 species were considered uncommon.

Table 7-33 Avian Species Observed at the Rock Creek Mine Study Area, Alaska, 7–11 June 2004.

Avian Group	Common name	Scientific name
Geese	Canada Goose	*Branta canadensis*
Ducks	American Wigeon	*Anas americana*
	Northern Shoveler	*Anas clypeata*
	Northern Pintail	*Anas acuta*
Grouse	Willow Ptarmigan	*Lagopus lagopus*
	Rock Ptarmigan	*Lagopus muta*
Loons	Red-throated Loon	*Gavia stellata*
Raptors	Northern Harrier	*Circus cyaneus*
Shorebirds	American Golden-Plover	*Pluvialis dominica*
	Pacific Golden-Plover	*Pluvialis fulva*
	Semipalmated Plover	*Charadrius semipalmatus*
	Spotted Sandpiper	*Actitis macularius*
	Whimbrel	*Numenius phaeopus*
	Western Sandpiper	*Calidris mauri*
	Pectoral Sandpiper	*Calidris melanotos*
	Wilson's Snipe	*Gallinago delicata*
	Red-necked Phalarope	*Phalaropus lobatus*
Jaegars, Gulls & Terns	Parasitic Jaeger	*Stercorarius parasiticus*
	Long-tailed Jaeger	*Stercorarius longicaudus*
	Mew Gull	*Larus canus*
	Glaucous Gull	*Larus hyperboreus*
	Arctic Tern	*Sterna paradisaea*
Corvids	Common Raven	*Corvus corax*
Passerines	Arctic Warbler	*Phylloscopus borealis*
	Bluethroat	*Luscinia svecica*
	Gray-cheeked Thrush	*Catharus minimus*
	American Robin	*Turdus migratorius*
	Eastern Yellow Wagtail	*Motacilla tschutschensis*
	Orange-crowned Warbler	*Vermivora celata*
	Yellow Warbler	*Dendroica petechia*
	Blackpoll Warbler	*Dendroica striata*
	Northern Waterthrush	*Seiurus noveboracensis*
	Wilson's Warbler	*Wilsonia pusilla*
	American Tree Sparrow	*Spizella arborea*
	Savannah Sparrow	*Passerculus sandwichensis*
	Fox Sparrow	*Passerella iliaca*
	White-crowned Sparrow	*Zonotrichia leucophrys*
	Golden-crowned Sparrow	*Zonotrichia atricapilla*
	Lapland Longspur	*Calcarius lapponicus*
	Common Redpoll	*Carduelis flammea*
	Hoary Redpoll	*Carduelis hornemanni*

Table 7-34 Number Observed, Percent of Total Observations, and Abundance Category for Birds Recorded at the Rock Creek Mine Study Area, Alaska, 7–11 June 2004. Observations from point count data and incidental sightings. Species in bold are of conservation concern.

Species	No. Observed	% of Total Observations	Abundance Category [a]
Common and **Hoary Redpoll** [b]	102	14.49	A
American Tree Sparrow	69	9.80	A
Gray-cheeked Thrush	59	8.38	A
Wilson's Snipe	57	8.10	A
Golden-crowned Sparrow	48	6.82	A
Fox Sparrow	47	6.68	A
Orange-crowned Warbler	46	6.53	A
Yellow Warbler	46	6.53	A
Savannah Sparrow	41	5.82	A
Wilson's Warbler	28	3.98	C
Northern Waterthrush	27	3.84	C
Lapland Longspur	22	3.13	C
White-crowned Sparrow	16	2.27	C
Willow Ptarmigan	13	1.85	C
American Robin	10	1.42	C
Long-tailed Jaeger	9	1.28	C
Arctic Warbler	8	1.14	C
Canada Goose	8	1.14	C
Bluethroat	6	0.85	U
Blackpoll Warbler	5	0.71	U
American Golden-Plover	4	0.57	U
Red-throated Loon	4	0.57	U
Unidentified Golden-Plover	4	0.57	U
Common Raven	3	0.43	U
Arctic Tern	2	0.28	U
Mew Gull	2	0.28	U
Northern Pintail	2	0.28	U
Parasitic Jaeger	2	0.28	U
Whimbrel	2	0.28	U
American Wigeon	1	0.14	U
Eastern Yellow Wagtail	1	0.14	U
Glaucous Gull	1	0.14	U
Northern Harrier	1	0.14	U
Northern Shoveler	1	0.14	U
Pacific Golden-Plover	1	0.14	U
Pectoral Sandpiper	1	0.14	U
Red-necked Phalarope	1	0.14	U
Rock Ptarmigan	1	0.14	U
Semipalmated Plover	1	0.14	U
Spotted Sandpiper	1	0.14	U
Western Sandpiper	1	0.14	U

[a]Specie

The use of habitats by breeding birds at the Rock Creek Mine was quite variable. Eleven of the less common species that were observed more than once used only 3 or fewer habitat types, whereas 11 of the more common and abundant passerine species, and Wilson's Snipe, used 5–12 different habitat types for breeding activities. Of the species documented, the Arctic Warbler and Northern Waterthrush were the most specialized in their habitat use; both with ≥65% of their breeding use in Riverine Tall Willow Scrub. The Savannah Sparrow displayed the greatest diversity in habitat use (i.e., a habitat generalist species) with 41 individuals documented using 12 different habitat types during the breeding season.

Willow scrub habitats and dwarf and low birch scrub habitats were the most commonly used wildlife habitats in the study area. Riverine Tall Willow Scrub and Upland Tall Willow Scrub were each used by 15 different avian species (43% of species with habitat associations), and most of those species used these habitats ≥25% of the time. These habitats also were used by 4 of the 9 avian species of conservation concern with habitat associations. Lowland Tall Willow Scrub and the Lowland and Upland Low Willow Scrub types also were preferred breeding habitats, each observed being used by 12–13 different avian species. Additionally, Upland Dwarf Birch–Ericaceous–Sedge Scrub was an important habitat in the Rock Creek Mine area that was used by 12 different species, 7 of which used it ≥33% of the time, and 5 of which were species of conservation concern.

Thirty four of the recorded species were observed using habitats in the area, eight species (waterfowl, loons and some shorebirds) were observed only in transit over the site. Distribution of bird species by habitat type is presented in Table 7-35.and Table 7-36.

Table 7-35 Numbers of Bird Species Observed in Mapped Wildlife Habitats at the Rock Creek Mine Study Area, Alaska, 7–11 June 2004. Species of conservation concern are in bold.

	Wildlife Habitat															
Avian Species	Shallow Open Water	River Gravel	Riverine Tall Willow Scrub	Lowland Wet Sedge Tundra	Lowland Low Birch-Ericaceous-Sedge Bog	Lowland Dwarf Birch-Ericaceous-Sedge Scrub	Lowland Low Birch Scrub	Lowland Low Birch-Willow Scrub	Lowland Low Willow Scrub	Lowland Tall Willow Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings
American Golden-Plover						1						2	1			
American Robin			5											2	2	
American Tree Sparrow			8				4		17	5		2	5	6	17	
American Wigeon	1															
Arctic Tern	1															
Arctic Warbler			5								1				1	
Blackpoll Warbler			2						2							
Bluethroat							4		1				1			
Canada Goose	2			1												
Fox Sparrow			11						5	8				5	13	
Golden-crowned Sparrow			4						2	2	2	1	2	9	11	1
Gray-cheeked Thrush			21						4	8			1	7	14	1
Lapland Longspur					1	3					6	10	2			
Long-tailed Jaeger						2						1				
Northern Pintail	2															
Northern Shoveler	1															
Northern Waterthrush			13							2					5	
Orange-crowned Warbler			6						6	8			1	7	12	
Pacific Golden-Plover												1				
Parasitic Jaeger						1										
Pectoral Sandpiper				1												
Red-necked Phalarope	1															
Common and **Hoary Redpoll**							3	2	4	2		1	3	3	2	1
Red-throated Loon	1															
Rock Ptarmigan			1													
Savannah Sparrow			1		3	4	1	1	9	1	3	6	4	4	4	
Spotted Sandpiper		1														
Unknown Golden-Plover												2				
Western Sandpiper				1												
Whimbrel											1	1				
White-crowned Sparrow			2						1	2			1	1	1	
Willow Ptarmigan												3		2	1	

Table 7-36 Percentage of Total Observations for Each Bird Species in Mapped Wildlife Habitats at the Rock Creek Mine Study Area, Alaska, 7–11 June 2004. Species in bold are of conservation concern.

	Wildlife Habitat															
Avian Species	Shallow Open Water	River Gravels	Riverine Tall Willow Scrub	Lowland Wet Sedge Tundra	Lowland Low Birch-Ericaceous-Sedge Bog	Lowland Dwarf Birch-Ericaceous-Sedge Scrub	Lowland Low Birch Scrub	Lowland Low Birch-Willow Scrub	Lowland Low Willow Scrub	Lowland Tall Willow Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings
Wilson's Snipe			1		1				8	4		3		1	6	1
Wilson's Warbler			9						3	4			1	3	7	
Yellow Warbler			16						3	4				5	17	1
American Golden-Plover						25						50	25			
American Robin			56											22	22	
American Tree Sparrow			13				6		27	8		3	8	9	27	
American Wigeon	100															
Arctic Tern	100															
Arctic Warbler			71								14				14	
Blackpoll Warbler			50						50							
Bluethroat							67		17				17			
Canada Goose	67			33												
Fox Sparrow			26						12	19				12	31	
Golden-crowned Sparrow			12						6	6	6	3	6	26	32	3
Gray-cheeked Thrush			38						7	14			2	13	25	2
Lapland Longspur					5	14					27	45	9			
Long-tailed Jaeger						67						33				
Northern Pintail	100															
Northern Shoveler	100															
Northern Waterthrush			65							10					25	
Orange-crowned Warbler			15						15	20			3	18	30	
Pacific Golden-Plover												100				
Parasitic Jaeger						100										
Pectoral Sandpiper				100												
Red-necked Phalarope	100															
Common and **Hoary Redpoll**							14	10	19	10		5	14	14	10	5
Red-throated Loon	100															
Rock Ptarmigan			100													
Savannah Sparrow			2		7	10	2	2	22	2	7	15	10	10	10	
Spotted Sandpiper		100														
Unknown Golden-Plover												100				
Western Sandpiper				100												

Table 7-36 Percentage of Total Observations for Each Bird Species in Mapped Wildlife Habitats at the Rock Creek Mine Study Area, Alaska, 7–11 June 2004. Species in bold are of conservation concern. (continued)

	Wildlife Habitat															
Avian Species	Shallow Open Water	River Gravels	Riverine Tall Willow Scrub	Lowland Wet Sedge Tundra	Lowland Low Birch-Ericaceous-Sedge Bog	Lowland Dwarf Birch-Ericaceous-Sedge Scrub	Lowland Low Birch Scrub	Lowland Low Birch-Willow Scrub	Lowland Low Willow Scrub	Lowland Tall Willow Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings
Whimbrel											50	50				
White-crowned Sparrow			25						13	25			13	13	13	
Willow Ptarmigan												50		33	17	
Wilson's Snipe			4		4				32	16		12		4	24	4
Wilson's Warbler			33						11	15			4	11	26	
Yellow Warbler			35						7	9				11	37	2

Big Hurrah Survey Results

Five-hundred eleven sightings of 42 bird species were recorded in the Big Hurrah Mine study area during the June 2005 study. Most species were observed during point count sampling but additional species were observed as we traveled between sampling points in the field. Ten of these 42 bird species are considered species of conservation concern for western Alaska (Yellow-billed Loon, American Golden-Plover, Pacific Golden-Plover, Wandering Tattler, Whimbrel, Arctic Warbler, Gray-cheeked Thrush, Varied Thrush, Golden-crowned Sparrow, and Hoary Redpoll). More details on these species and the reasons for conservation concern are presented in Table 7-37 and 7-38.

The most frequently recorded species in the study area were Common/Hoary Redpoll (species identification was often impossible with flying birds so all redpoll observations were combined), Golden-crowned Sparrow, Gray-cheeked Thrush, Fox Sparrow, Wilson's Warbler, Lapland Longspur, and Yellow Warbler. We recorded over 25 observations for each of these species (>5% of all observations) and considered these species to be abundant in the study area. Ten other species were less frequently observed, recorded 6–24 times each (1–4% of all observations), and these were considered common in the study area. An additional 25 species were recorded 1–5 times each (<1% of all observations) and were considered uncommon. Two other species (Tundra Swan and Tree Swallow) were observed in flight while we were in transit between point count locations, but the number of individuals was not documented and abundance in the area was not determined.

Table 7-37 Avian Species Observed at the Big Hurrah Mine Study Area, Alaska, 3–7 June 2005.

Avian Group	Common name	Scientific name
Waterfowl	Tundra Swan	Cygnus columbianus
	Harlequin Duck	Histrionicus histrionicus
	Red-breasted Merganser	Mergus serrator
Grouse	Willow Ptarmigan	Lagopus lagopus
Loons	Yellow-billed Loon	Gavia adamsii
Raptors	Northern Harrier	Circus cyaneus
	Rough-legged Hawk	Buteo lagopus
	Merlin	Falco columbarius
Shorebirds	American Golden-Plover	Pluvialis dominica
	Pacific Golden-Plover	Pluvialis fulva
	Semipalmated Plover	Charadrius semipalmatus
	Wandering Tattler	Heteroscelus incanus
	Spotted Sandpiper	Actitis macularius
	Whimbrel	Numenius phaeopus
	Western Sandpiper	Calidris mauri
	Wilson's Snipe	Gallinago delicata
Jaegars & Gulls	Long-tailed Jaeger	Stercorarius longicaudus
	Mew Gull	Larus canus
	Say's Phoebe	Sayornis saya
Corvids	Common Raven	Corvus corax
Passerines	Tree Swallow	Tachycineta bicolor
	Bank Swallow	Riparia riparia
	Arctic Warbler	Phylloscopus borealis
	Bluethroat	Luscinia svecica
	Northern Wheatear	Oenanthe oenanthe
	Gray-cheeked Thrush	Catharus minimus
	American Robin	Turdus migratorius
	Varied Thrush	Ixoreus naevius
	Eastern Yellow Wagtail	Motacilla tschutschensis
	American Pipit	Anthus rubescens
	Orange-crowned Warbler	Vermivora celata
	Yellow Warbler	Dendroica petechia
	Northern Waterthrush	Seiurus noveboracensis
	Wilson's Warbler	Wilsonia pusilla
	American Tree Sparrow	Spizella arborea
	Savannah Sparrow	Passerculus sandwichensis
	Fox Sparrow	Passerella iliaca
	White-crowned Sparrow	Zonotrichia leucophrys
	Golden-crowned Sparrow	Zonotrichia atricapilla
	Lapland Longspur	Calcarius lapponicus
	Common Redpoll	Carduelis flammea
	Hoary Redpoll	Carduelis hornemanni

Table 7-38 Number Observed, Percent of Total Observations, And Abundance Category For Birds Recorded At The Big Hurrah Mine Study Area, Alaska, 3–7 June 2005. Observations from point count data and incidental sightings. Species in bold are of conservation concern.

Species	No. Observed	% of Total Observations	Abundance Category [a]
Common & **Hoary Redpoll** [b]	76	14.87	A
Golden-crowned Sparrow	53	10.37	A
Gray-cheeked Thrush	49	9.59	A
Fox Sparrow	40	7.83	A
Wilson's Warbler	36	7.05	A
Lapland Longspur	36	7.05	A
Yellow Warbler	27	5.28	A
Savannah Sparrow	24	4.70	C
Wilson's Snipe	20	3.91	C
Northern Waterthrush	20	3.91	C
American Tree Sparrow	19	3.72	C
Orange-crowned Warbler	16	3.13	C
American Robin	13	2.54	C
Long-tailed Jaeger	10	1.96	C
American Pipit	8	1.57	C
Arctic Warbler	6	1.17	C
Bluethroat	6	1.17	C
Willow Ptarmigan	5	0.98	U
Bank Swallow	4	0.78	U
Eastern Yellow Wagtail	4	0.78	U
White-crowned Sparrow	4	0.78	U
Red-breasted Merganser	3	0.59	U
American Golden-Plover	3	0.59	U
Unidentified golden-plover	3	0.59	U
Wandering Tattler	3	0.59	U
Common Raven	3	0.59	U
Unidentified swallow	3	0.59	U
Unidentified sparrow	3	0.59	U
Yellow-billed Loon	2	0.39	U
Harlequin Duck	2	0.39	U
Pacific Golden-Plover	2	0.39	U
Whimbrel	2	0.39	U
Mew Gull	2	0.39	U
Northern Harrier	1	0.20	U
Rough-legged Hawk	1	0.20	U
Merlin	1	0.20	U
Semipalmated Plover	1	0.20	U
Spotted Sandpiper	1	0.20	U
Western Sandpiper	1	0.20	U
Say's Phoebe	1	0.20	U
Northern Wheatear	1	0.20	U
Varied Thrush	1	0.20	U
Tundra Swan	x	x	x
Tree Swallow	x	x	x

[a]Species were considered Abundant (A) if they comprised >5% of the total observations, Common (C) if they were 1-5% of the observations, or Uncommon (U) if they were <1% of the observations; “x” used for species observed at least once in flight during incidental sightings but numbers of individuals are unknown.

[b]Both species were observed in the study area but because many redpolls were observed in flight and could not be identified to species, the records for both species were combined.

The use of habitats used by breeding birds at the Big Hurrah Mine was quite variable. Five of the less common species that were observed more than once (American Pipit, Northern Waterthrush, and 3 shorebird species) used only a single habitat type, whereas 9 of the more common and abundant passerine species used 5–8 different habitat types for breeding activities. Of the species documented, Northern Waterthrush was the most specialized in habitat use, with 14 individuals using only Riverine Tall Willow Scrub. Savannah Sparrow was the most generalist species with 21 individuals using 8 different habitat types.

Willow scrub types were the most commonly used wildlife habitats in the study area. Upland Tall Willow Scrub was used by 16 avian species (50% of species with habitat associations), and 10 of those species used this habitat ≥30% of the time. Riverine Tall Willow Scrub was used by 15 species (47% of species with habitat associations), 10 of which used this habitat ≥30% of the time. Upland Low Willow Scrub was used ≥30% of the time by 12 different species. Another important habitat was Upland Dwarf Ericaceous Scrub, which was used by 10 species, 3 of which used it exclusively. Riverine Tall Willow Scrub, Upland Low Willow Scrub, and Upland Tall Willow Scrub were used by 4 of the 9 species of conservation concern with habitat associations. Bird distribution by habitat is presented in Tables 7-39 and 7-40.

Generally, wetlands and riparian corridors associated with streams and rivers in the Nome area support an abundance of migratory waterfowl and shorebirds. However, waterfowl and shorebird use within the project area has not been documented (Alaska Habitat Management Guide, 1985; Letter from USFWS, 2003).

Tundra swans in flight, two harlequin ducks, and three red-breasted mergansers were sighted at the Big Hurrah site. All of these birds were listed as uncommon or incidental for the area and made up less than 1% of the total avian sightings.

Table 7-39 Numbers of Bird Species Observed in Mapped Wildlife Habitats at the Big Hurrah Mine Study Area, Alaska, 3–7 June 2005. Species of conservation concern are in bold (see Table 2.4).

	Wildlife Habitat														
Avian Species	Stream or River	River Gravels	Riverine Low Willow Scrub	Riverine Tall Willow Scrub	Lowland Low Willow Scrub	Upland Dwarf Ericaceous Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Low Willow-Sedge Scrub	Upland Tall Alder Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings	Gravel Fill
American Golden-Plover						1			2						
American Pipit						3									
American Robin				1		1							1		
American Tree Sparrow			1	4	1			1		1	1		7		
Arctic Warbler			1		1				1	2					
Bank Swallow		1		2										1	
Bluethroat									1	3	1		1		
Common & **Hoary Redpoll**			2	5		1				5	2	5	2		
Eastern Yellow Wagtail			1	1						1					
Fox Sparrow				7					1	5		1	9		
Golden-crowned Sparrow				1		1	1		1	10		1	9		
Gray-cheeked Thrush				11						3			11		
Harlequin Duck	2														
Lapland Longspur						13	7	1							2
Long-tailed Jaeger							1	2							1
Mew Gull				1											
Northern Harrier								1					1		
Northern Waterthrush				14											
Northern Wheatear						1									
Orange-crowned Warbler				1	1					1		1	10		
Pacific Golden-Plover						2									
Red-breasted Merganser	3														
Savannah Sparrow			1			2	1	3	2	5	3		4		

Table 7-39 (Continued)

Avian Species	Wildlife Habitat														
	Stream or River	River Gravels	Riverine Low Willow Scrub	Riverine Tall Willow Scrub	Lowland Low Willow Scrub	Upland Dwarf Ericaceous Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Low Willow-Sedge Scrub	Upland Tall Alder Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings	Gravel Fill
Say's Phoebe														1	
Semipalmated Plover [a]				1											
Spotted Sandpiper		1													
Varied Thrush													1		
Wandering Tattler		2													
Western Sandpiper		1													
Whimbrel								2							
White-crowned Sparrow				1											
Willow Ptarmigan								2					1		
Wilson's Snipe					1								4		
Wilson's Warbler			2	9	1					10			11		
Yellow Warbler				17		1					1		4	1	

[a]The observation for Semipalmated Plover was recorded in a map polygon coded as Riverine Tall Willow Scrub but the bird was using a patch of open River Gravels in that map polygon that was too small to map; for the assessment of impacts from mine development, the important breeding habitat for Semipalmated Plover was treated as River Gravels.

Table 7-40 Percentage of Total Observations for Each Bird Species in Mapped Wildlife Habitats at the Big Hurrah Study Area, Alaska, 3–7 June 2005. Species in bold are of conservation concern (see Table 2-4).

	Wildlife Habitat														
Avian Species	Stream or River	River Gravels	Riverine Low Willow Scrub	Riverine Tall Willow Scrub	Lowland Low Willow Scrub	Upland Dwarf Ericaceous Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Low Willow-Sedge Scrub	Upland Tall Alder Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings	Gravel Fill
American Golden-Plover						33			67						
American Pipit						100									
American Robin				33		33							33		
American Tree Sparrow			6	25	6			6		6	6		44		
Arctic Warbler			20		20				20	40					
Bank Swallow		25		50										25	
Bluethroat									17	50	17		17		
Common & **Hoary Redpoll**			9	23		5				23	9	23	9		
Eastern Yellow Wagtail			33	33						33					
Fox Sparrow				30					4	22		4	39		
Golden-crowned Sparrow				4		4	4		4	42		4	38		
Gray-cheeked Thrush				44						12			44		
Harlequin Duck	100														
Lapland Longspur						57	30	4							9
Long-tailed Jaeger							25	50							25
Mew Gull				100											
Northern Harrier								50					50		
Northern Waterthrush				100											
Northern Wheatear						100									
Orange-crowned Warbler				7	7					7		7	71		
Pacific Golden-Plover						100									
Red-breasted Merganser	100														
Savannah Sparrow			5			10	5	14	10	24	14		19		
Say's Phoebe														100	
Semipalmated Plover		100													
Spotted Sandpiper		100													
Varied Thrush													100		
Wandering Tattler		100													
Western Sandpiper		100													

Table 7-40 (Continued)

Avian Species	Wildlife Habitat														
	Stream or River	River Gravels	Riverine Low Willow Scrub	Riverine Tall Willow Scrub	Lowland Low Willow Scrub	Upland Dwarf Ericaceous Scrub	Upland Dwarf Birch-Ericaceous Scrub	Upland Dwarf Birch-Ericaceous-Sedge Scrub	Upland Low Birch-Willow Scrub	Upland Low Willow Scrub	Upland Low Willow-Sedge Scrub	Upland Tall Alder Scrub	Upland Tall Willow Scrub	Excavated Gravel & Tailings	Gravel Fill
Whimbrel								100							
White-crowned Sparrow				100											
Willow Ptarmigan								67					33		
Wilson's Snipe					20								80		
Wilson's Warbler			6	27	3					30			33		
Yellow Warbler				71		4					4		17	4	

Bald Eagles/Raptors

No bald eagles were observed at either site. One northern harrier was observed at each site. One merlin and one rough-legged hawk were observed at Big Hurrah. All raptor sightings were <1% of the total avian observations and all were listed as uncommon. Cliffs that would provide nesting habitat for raptors are not present at either site. Raptor nesting may occur along the cliffs of Mount Brynteson approximately 0.75 miles (1.2 km) to the northeast of Rock Creek.

Species of Concern

During the study, the presence of 10 species in the Rock Creek study area and 10 species in the Big Hurrah Mine study area that are considered species of conservation concern for western Alaska by one or more agencies or specialist groups were documented. Many of the same species occurred at each site. The species of conservation concern designation does not carry legal status as does the listing of a species as federally threatened or endangered, but the designation does indicate there is concern over the potential for population declines and interest in maintaining healthy breeding populations of these species in Alaska. The species of conservation concern can be of concern for one or more reasons: (1) populations in some part of the species' range have shown declines in recent years, usually on the breeding grounds; (2) relative abundance is low; (3) threats have been documented on the breeding grounds and/or in nonbreeding areas; (4) the breeding and/or nonbreeding distributions are small and therefore more susceptible to threats; (5) the species may be common but a large proportion of the worldwide breeding range occurs in Alaska (global stewardship species); or (6) the

species may be widespread but Alaska represents a large proportion of the North American breeding range (North American stewardship species).

7.7.4.2 Consequences

The Seward Peninsula, outside of the Nome area and the scattered small villages, is relatively undeveloped, which means that largely undisturbed avian habitats are available for use by breeding birds throughout the peninsula. Considering this widespread availability of common habitats at the regional scale of the Seward Peninsula, the direct impacts to breeding bird habitats from development of the proposed Project would be expected to be of much less magnitude than the impacts expected at the local scale of the Rock Creek Mine or Big Hurrah study areas. In the language of NEPA, the impacts at the local scale are probably best considered significant at Rock Creek (considering the removal of relatively large amounts of breeding habitats for several species of conservation concern) and moderately significant at Big Hurrah (considering the removal of small amounts of breeding habitats for several species of conservation concern). The impacts at the regional scale are nearly negligible. In addition the lack of correction in the survey for patchiness in bird occurrence means that the expected impacts determined here are liberal estimates (i.e., all preferred habitats in the study area are assumed to be occupied and functioning as preferred habitats when in fact some may not be occupied).

The expected mine lives for the Rock Creek and Big Hurrah mines are 4 to 5 years. Reclamation will occur at the end of mine life, restoring much of the area to upland habitat.

Rock Creek Mine/Mill Complex Local Consequences

Of the 41 bird species observed in the Rock Creek Mine study area, 34 were recorded using habitats at the site (8 species were observed only in transit over the area). The amount of preferred breeding habitat that would be lost to development of the Rock Creek Mine varies widely among the 34 bird species recorded using habitats in the study area, ranging from 0 to 415 acres (168 ha). Savannah Sparrows would lose the largest amount of preferred breeding habitat (415 acres [168 ha]) from the proposed development, substantially more than any other avian species. This loss represents 20% of their total available preferred breeding habitats mapped within the study area. At the other end of the range, waterfowl, loons, and some shorebirds will lose no preferred breeding habitats to development because no lacustrine waterbodies or wet sedge or aquatic sedge habitats fall within the development footprint. Wilson's Snipes would lose the second highest amount of preferred breeding habitat (385 acres [156 ha]) within the mine development footprint. Ten species (Whimbrel, Lapland Longspur, Wilson's Warbler, Golden-crowned Sparrow, Orange-crowned Warbler, White-crowned Sparrow, American Tree Sparrow, Gray-cheeked Thrush, Fox Sparrow, and Yellow Warbler) would lose over 200 acres (80 ha) of preferred breeding habitats from the proposed development. Other species (primarily passerines and shorebirds) would lose variable amounts of preferred breeding habitats to development, with seven species losing over 100 acres (40 ha). Bluethroats are expected to lose only 38 acres (15 ha) due to development of the proposed mine, but this represents 22% of the habitats considered important to them for breeding in the study area. Six species (American Robin, Arctic Warbler, Northern Waterthrush, Gray-cheeked Thrush, Fox Sparrow, and Yellow Warbler) are expected to lose

between 25% and 30% of their preferred breeding habitat within the 3092-acre (1251-ha) study area. The remainder of the species will lose less than 25% of their preferred breeding habitats from mine development.

The bird species found in the Rock Creek Mine area are typical for the habitat types documented (primarily passerine and shorebird species in upland scrub and tundra and riverine scrub habitat types) and are known to be associated with these habitats across the larger Seward Peninsula area (Kessel, 1989). Most of the species documented in the Rock Creek Mine study area, except waterfowl and loons, for which habitat does not exist in the mine development footprint, were listed by Kessel as abundant, common, or fairly common breeders on the Seward Peninsula, with the exception of rock ptarmigan (uncommon), northern harrier (uncommon), semipalmated plover (uncommon), spotted sandpiper (uncommon), pectoral sandpiper (rare), bluethroat (uncommon), and orange-crowned warbler (uncommon).

The most heavily-used avian breeding habitats in the Rock Creek Mine study area are the willow scrub types (in riverine, lowland, and upland situations) and one upland moist tundra type (Upland Dwarf Birch–Ericaceous–Sedge Scrub). Of these habitats, tall willow scrub is the most important: 17 (50%) of the 34 avian species documented using habitats in the area were observed in Riverine Tall, Lowland Tall or Upland Tall Willow Scrub. Riverine Tall Willow Scrub is the one of the most preferred habitats of habitat-specific species such as the Arctic Warbler and Northern Waterthrush. Upland Dwarf Birch–Ericaceous–Sedge Scrub was the most prevalent mapped habitat in the study area and was used by 12 avian species. These 4 habitats, along with Lowland Low Willow Scrub and Upland Low Willow Scrub, were considered preferred breeding habitats for 22 (65%) of the 34 avian species documented using habitats in the study area; these habitats comprise 2128 acres (861.2 ha) (69%) of the study area and 414 acres (168 ha) (68%) of the proposed mine development footprint.

Of the 41 species recorded in the Rock Creek Mine study area, preferred breeding habitat exists for 25 species within the footprint of the proposed mine. Nineteen of these 25 species would lose >100 acres (40 ha) of breeding habitat due to development of the mine site, which is equivalent to 16–28% of their available preferred breeding habitats within the entire study area. It is unknown how many breeding pairs of each species could be affected by this removal of habitat. It is also important to keep in mind that all occurrences of a species' preferred habitat may not actually support breeding activities by that species, especially in the case of less-common birds. For example, the Whimbrel (which was categorized as uncommon in the Rock Creek Mine study area), is listed as having 290 acres (120 ha) of preferred breeding habitat that will be removed by development of the mine). During our field visit, however, this species was not observed using those patches of preferred habitat within the footprint of the proposed mine, but was only observed near the point count site, RC021, in the northern portion of the study area. At the other extreme, abundant species (e.g., American Tree Sparrow, Gray-cheeked Thrush, Golden-crowned Sparrow) are expected to occur regularly in their preferred breeding habitats. Within the Rock Creek study footprint, the percent of avian habitat that will be disturbed by the proposed project ranges from 0% to 40%.

7.7.4.3 Big Hurrah Mine Local Consequences

Of the 42 bird species documented at the Big Hurrah Mine study area, 36 were recorded using habitats at the site (6 species were observed only in transit over the area). The amount of preferred breeding habitat that would be lost to development of the Big Hurrah Mine varies among the 36 bird species recorded using habitats in the study area, ranging from 0 to 53 acres (21 ha). Savannah Sparrows would lose the largest amount of preferred breeding habitat (53 acres [21 ha]) from the proposed development. This loss represents 6% of their total available preferred breeding habitats mapped within the study area. At the other end of the range, Harlequin Duck, Red-breasted Merganser, Semipalmated Plover, Spotted Sandpiper, Western Sandpiper, and Wandering Tattler will lose no preferred breeding habitats to development because no portions of larger stream or river gravel habitats (i.e., no portions of Big Hurrah Creek) fall within the development footprint. (The Little Hurrah Creek drainage was too small to map on the aerial photography.) Bank Swallows would lose 25 acres (10 ha) of preferred breeding habitat and the second highest percentage of habitat relative to total available acreage within the study area (21% of the mapped area). Say's Phoebe, which was observed only in Excavated Gravel & Tailings around buildings at the historic mine site, would lose 23 acres (9.3 ha) to development and 63% of that disturbed habitat will be altered by development. All other avian species would lose <37 acres (15 ha) from development and <8% of their total available important breeding habitats in the study area.

The Big Hurrah Mine study area is situated predominately in upland terrain below the northeast flanks of Uncle Sam Mountain and encompasses 18 different wildlife habitat types. The bird species found in the Big Hurrah Mine area are typical for the habitat types documented (primarily passerine and shorebird species in upland scrub and tundra, and riverine scrub habitat types) and are known to be associated with these habitats across the larger Seward Peninsula area (Kessel 1989). Twenty-six (72%) of the 36 species documented using habitats at the Big Hurrah Mine study area were listed by Kessel (1989) as abundant, common, or fairly common breeders on the Seward Peninsula and 10 species (28%) were listed as uncommon breeders. Kessel conducted her field work on the Seward Peninsula in the late 1960s and 1970s, and subsequently declines in some populations of some of the species noted at the Big Hurrah Mine site have been documented, although it is often unknown if declines are occurring in populations in western Alaska or on the Seward Peninsula.

The most heavily-used avian habitats in the Big Hurrah Mine study area are the willow scrub types (in upland, lowland, and riverine situations). Of these habitats, tall willow scrub is the most important: 20 (55%) of the 36 avian species documented using habitats in the area were observed using Riverine or Upland Tall Willow Scrub. Riverine Tall Willow Scrub was used exclusively by habitat specialist species such as the Northern Waterthrush. In contrast, low willow scrub (upland, lowland, and riverine types combined) were used by 12 (33%) of the avian species documented using habitats in the area. Upland Dwarf Ericaceous Scrub also was a common and important habitat type, and was used by 10 avian species. These 6 habitats were considered important breeding habitats to 26 (72%) of the avian species documented; these habitats comprise 1332 acres (539.0 ha) (69%) of the study area and 42 acres (17 ha) (44%) of the proposed mine development footprint.

Of the 42 avian species recorded in the Big Hurrah Mine study area, preferred breeding habitat exists for 30 species within the area proposed for development of the mine. With development of the Big Hurrah Mine, none of these 30 species, with the exception of Say's Phoebe and Bank Swallow, would lose more than 8% of the total study area habitats considered important for breeding. Fourteen species would lose over 20 acres (8 ha) of preferred breeding habitat, and 8 species would lose between 10 and 20 acres (4 and 8 ha).

Species of Conservation Concern

Nine of the species of conservation concern recorded in the Rock Creek and Big Hurrah Mine study area were found to favor breeding habitats that would be directly affected by development of the mine. Red Throated Loons, Arctic Terns were observed at Rock Creek, and Yellow-billed Loons and Wandering Tattlers were observed at Big Hurrah but preferred habitat for these species does not occur within the respective areas proposed for mine development. Below are brief summaries of the reasons for conservation concern for those species expected to be affected by development of the mine and a listing of the expected direct impacts.

- Hoary Redpoll: No imminent threats exist to the breeding or wintering populations and the prospect for human- induced alterations of their remote arctic and boreal habitats is low. No declines in populations have been noted. The primary concern is that the Hoary Redpoll is considered to be characteristic of a particular region. The species is abundant at the Rock Creek and Big Hurrah sites. The Rock Creek mine would remove 75 acres (30 ha) of preferred breeding habitat for this species, this represents 13% of the preferred habitats available within the study area. Development of the Big Hurrah Mine would remove 36 acres (15 ha) of preferred breeding habitats for this species and this represents 6% of the preferred habitats available in the Big Hurrah Mine study area
- Gray-cheeked Thrush: Declines in this species eastern North America population occurred from 1967 to present. On their tropical wintering grounds, the species is considered vulnerable to deforestation of broadleaf forests. It is possible that declines in breeding populations are primarily driven by tropical deforestation. A large percentage of the breeding range for this species is concentrated in Alaska. The species is abundant at the Rock Creek and Big Hurrah sites. Development of the Rock Creek mine would remove 224 acres (90.6 ha) of preferred habitat for this species, this represents 25% of the available preferred habitat in the study area. Development of the mine would remove 18 acres (7.3 ha) of preferred breeding habitats for this species (5% of the preferred habitats available in the Big Hurrah Mine study area;
- Golden-crowned Sparrow: No declines in the wintering populations in North America have been noted. The species is characteristic of Alaska. Golden-crowned sparrows are abundant at the Rock Creek and Big Hurrah sites. The species is abundant at the Rock Creek site. Development of the Rock Creek mine would remove 246 acres (99.6 ha) of preferred breeding habitat, this represents about 23% of the preferred habitat available within the study area. Development of the mine would remove 34 acres (14 ha) of preferred breeding habitats for this species (7% of the preferred habitats available in the Big Hurrah Mine study area

- Arctic Warbler: This is a species of concern because it is endemic to the state (i.e. 100% of the world population of this subspecies breeds in Alaska).There are some indications of population decline in the 1990's on the Seward Peninsula, but no know broad-scale population threats for this subspecies. Arctic Warblers are common at the Rock Creek site and borderline between common and uncommon at the Big Hurrah site. Development of the Rock Creek mine would remove 192 acres (77.7 ha) of important breeding habitat for this species, this represents 23% o the preferred habitats available on the study area. Development of the Big Hurrah Mine would remove 18 acres (7.3 ha) of important breeding habitats for this species and this represents 5% of the preferred habitats available in the Rock Creek Mine study area
- Blackpoll Warbler: There is a steady decline in breeding populations across North America. The species is highly vulnerable to the removal of tropical forests and mortality during migration from tropical storms. A large percentage of the species breeding range is in Alaska. The species are uncommon at the Rock Creek site, no observations were recorded at the Big Hurrah site. Development of the Rock Creek mine would remove 21 acres (8.5 ha) of preferred breeding habitat, this represents 6% of the available preferred habitat in the study area.
- American Golden-Plover: There is a substantial decline in the population of this species in the Northwest Territories, although the declines have not been noted in other regions. Population threats on the wintering grounds in South America are of concern. Population declines are generally suspected to occur during the non-breeding seasons. American Golden-Plovers were uncommon at the Rock Creek and Big Hurrah sites. Development of the Rock Creek mine would remove 154 acres (62.3 ha) of preferred habitat, this represents 16% of the available preferred habitat. Development of the Big Hurrah Mine would remove 6 acres (2 ha) of preferred breeding habitats for this species and this represents <1% of the preferred habitats available in the Big Hurrah Mine study area
- Pacific Golden-Plover: This species is considered to be vulnerable due to its small breeding range in western and northwestern Alaska. The species is also considered vulnerable because its winter range is limited to littoral habitat and cleared areas on islands in the tropical Pacific. The species is uncommon at the Rock Creek and Big Hurrah sites. Development of the Rock Creek mine would remove 154 acres (62.3 ha) of preferred habitat, this represents 18% of the available preferred habitat. Development of the Big Hurrah Mine would remove 6 acres (2 ha) of preferred breeding habitats for this species and this represents <1% of the preferred habitats available in the Big Hurrah Mine study area

Whimbrel

Significant population declines in the Hudson Bay population of Whimbrels are the primary reason this species is considered of high concern. An overall low population size for this species and a restricted breeding distribution in North America also are of concern. Habitat loss on the wintering grounds and at migration stop-over sites also has been noted it is possible that population declines stem from increased mortality during the nonbreeding seasons. Whimbrels were found to be uncommon at both sites (only 2 observations were

recorded at Rock Creek and two at Big Hurrah). Development of the Rock Creek Mine would remove 290 acres (117 ha) of preferred breeding habitats for this species and this represents 24% of the preferred habitats available in the Rock Creek Mine study area. Development of the Big Hurrah Mine would remove 16 acres (6.5 ha) of preferred breeding habitats for this species and this represents 7% of the preferred habitats available in the Big Hurrah Mine study area.

Varied Thrush

The Varied Thrush has experienced declines in population in western North America possibly related to forestry management practices, no significant declines have been found in Alaskan populations. Large percentages of the Varied Thrush's global breeding range are concentrated in Alaska, conservation concerns are focused on maintaining breeding populations because these species are considered characteristic of a particular region. Varied Thrushes on the Seward Peninsula are near the limit of their range in Alaska, and in non-forested areas, are using tall scrub habitats not typical of the species elsewhere; they are common in mixed forests in the interior and coastal coniferous forests in the southern part of the state. In the Big Hurrah Mine study area, Varied Thrushes were categorized as uncommon breeders (only 1 observation was recorded), no observations were recorded at the Rock Creek site.. Development of Big Hurrah the mine would remove 16 acres (6.5 ha) of preferred breeding habitats for this species (6% of the preferred habitats available in the Big Hurrah Mine study area.

Of the 10 species of conservation concern observed at the Rock Creek Mine study area, 2 species (Red-throated Loon and Arctic Tern) would lose no preferred breeding habitats to development. Of the remaining species of conservation concern, Whimbrel would lose the largest amount of preferred breeding habitat to development (290 acres [120 ha] or 24% of that available in the study area) while Blackpoll Warbler would lose only 21 acres (8.5 ha) of preferred breeding habitat (6% of that available in the study area. Five of the remaining 6 species of conservation concern would lose over 100 acres (40 ha) of preferred breeding habitat from development of the Rock Creek Mine, and the sixth species (Common/Hoary Redpoll) would lose 75 acres (30 ha). Considering only the 10 species of conservation concern, the percentages of available preferred breeding habitat within the study area that would be removed by development range from 0 to 28%.

Of the 10 species of conservation concern observed at the Big Hurrah Mine study area, 1 species (Yellow-billed Loon) was only observed flying over the site, and another (Wandering Tattler) would lose no preferred breeding habitats to development (Table 2-8). Of the species of conservation concern that would lose habitat to development, Hoary Redpoll would lose the largest amount (36 acres [15 ha] or 6% of that available), while American Golden-Plover and Pacific Golden-Plover would lose only 6 acres (2 ha) each or <1% of that available. The remaining 5 species of conservation concern would lose from 16–34 acres (6.5–14 ha) of preferred breeding habitat from development of the Big Hurrah Mine. This represents 5–7% of their preferred breeding habitats available in the study area.

Within the Big Hurrah study footprint, less than 8% of all avian habitat lies within area that will be disturbed by the proposed project, with the exception of the habitat for bank swallows,

of which 32% lies within areas that will be disturbed. The bank swallow is not a species of concern. Expansive areas of similar habitat also exist in the region, providing potential for alternative habitat during mine development and operation.

7.7.5 Essential Fish Habitat

7.7.5.1 Affected Environment

Rock Creek Mine / Mill Complex

According to the Alaska Department of Fish and Game (1998), the lower portions of Rock Creek, a tributary of the Snake River, provides rearing habitat for Dolly Varden (Salvelinus malma). Earlier surveys by ADFG before 1985 documented pink salmon (Oncorhynchus gorbuscha) in the Rock Creek drainage. The Snake River below the confluence of Rock Creek supports pink salmon spawning (ADFG, 1998).

The Lower Snake River supports chinook salmon (Oncorhynchus tshawtscha), coho (O. kisutch), pink (O. gorbuscha), chum (O. keta), Dolly Varden (Salvelinus malma), and whitefish (Prosopium sp.) (ADFG, 1998).

Based on earlier surveys by ADFG before 1985, Arctic grayling (Thymallus arcticus) are thought to be widely distributed in lakes and streams throughout the Nome area, but site specific information is lacking.

Big Hurrah Mine

Big Hurrah Creek from the confluence of the Solomon River to the confluence of Little Hurrah Creek supports Dolly Varden (Salvelinus malma) and spawning habitat for pink salmon (Oncorhynchus gorbuscha) (ADFG, 1998 FDD). Chum salmon (O. keta) were present in this watershed in the 1980s (Alaska Habitat Management Guide, 1985).

Pink salmon migrate from the Solomon River into Big Hurrah Creek to spawn in September and early October. Pink salmon spawning was documented in lower Big Hurrah Creek in 1998 (ADFG, FDD). Eggs incubate in the gravels through the winter and the alevins emerge the following spring breakup and outmigrate as fry to Norton Sound. In 1984, the Solomon River had a large pink run and large numbers of spawner carcasses were observed by ADFG in the Big Hurrah River up to the confluence with the Little Hurrah Creek (Big Hurrah Environmental Assessment, 1989).

Big Hurrah Creek historically provided spawning and incubation habitat for coho salmon (O. kisutch) but more recent surveys by ADFG have not documented coho spawning for several years.

Little Hurrah and Linda Vista creeks, both tributaries to Big Hurrah Creek, also provide rearing for Dolly Varden (ADFG, 1998 FDD), primarily in the lower reaches of the creeks.

The Solomon River supports a moderate run of coho salmon (O.kisutch) and some of these fish may spawn in Big Hurrah Creek in October and November. Most of the coho salmon

spawning in more recent years has been limited to the lower Solomon River below Manila Creek (ADFG, 2002 FDD). After incubating in the substrate over the winter, alevin emerge and seek velocity shelters and vegetative cover near the spawning redd and stay near this site until the yolk sack is fully absorbed. Fry typically will remain in their natal stream for some period before moving downstream to other rearing areas. Backwater areas along the creek bank of the Big Hurrah likely provide good summer rearing habitat for coho juveniles (Big Hurrah Creek Environmental Assessment, 1989). However, it is not known if the pools are deep enough or there are sufficient groundwater seeps to provide juvenile overwintering habitat for this species.

ADFG reports that chum salmon were found and/or observed spawning in the Solomon River below the creek confluence in 1998 and 2002 respectively (ADFG, FDD). This observation confirms earlier studies documenting chum spawning below the confluence of the Big Hurrah Creek (Buell, 1989). Historically, Big Hurrah Creek may have provided chum spawning habitat. Buell speculated that Big Hurrah Creek may provide spawning habitat for chum salmon (Big Hurrah Environmental Assessment, 1989). Spawning usually occurs in early July. Chum alevins, like pink, emerge from the gravels and remain near the redd until the yolk sac is absorbed. Also, like pinks, chum fry migrate immediately to saltwater and generally do not overwinter in freshwater habitats.

Arctic grayling (Thymallus arcticus) have been harvested at the mouth of the Big Hurrah Creek and probably migrate upstream (Buell, 1989). Grayling typically move from larger rivers into small streams and lakes to spawn during May through mid-June. It is likely that the lower reaches of the Big Hurrah River provide spawning areas for Arctic grayling. Grayling require deep pools and or groundwater accretions.

7.7.5.2 Consequences

The upper portions of Rock Creek will be diverted out of the drainage and the pit will be developed within the present creek bed. Flows to lower Rock Creek will be substantially reduced by the installation of groundwater interception wells. The discharge from these wells will be re-injected into the groundwater aquifer down gradient of the pit and are not anticipated to resurface for several years, thus not replenishing the flow to the creek during mine operations. Reduced flows in lower Red Dog creek will likely have a negative impact on fish use of the area. Fish are likely to relocate to the adjacent Glacier Creek which has historically supported a much larger fish population and recently received habitat improvements, including over wintering ponds, as part of the Glacier Creek Road realignment project wetlands mitigation. After closure Rock Creek will be re-established with flow coming from the pit lake. The presence of the pit lake after closure will also provide over wintering habitat.

There are no anticipated consequences to the fisheries in the Snake River.

Upper Little Hurrah Creek will be diverted around the edge of the Big Hurrah Mine pit and then flow back into the lower reach of Little Hurrah Creek. The presence of interception wells around the perimeter of the pit will reduce flows in Little Hurrah Creek. Fish use of Little Hurrah Creek which is minimal and primarily occurs within the lower reaches will

likely be negatively impacted. Fish will likely relocate to a nearby tributary of Big Hurrah Creek.

The fishery in the Big Hurrah River will be improved as part of the road construction project. Tailings that obstruct flow in the creek will be removed from the floodplain and used for road improvements. The stream channel that was historically disturbed by dredging will be reestablished through excavation and over wintering ponds will also be created.

7.7.6 Threatened and Endangered Species

7.7.6.1 Affected Environment

Rock Creek Mine / Mill Complex

Eight threatened, threatened, or candidate species are found in Alaska. No listed or threatened and endangered species are located in the Nome Area. USFWS reviewed the proposed project and concluded that there are no threatened or endangered species within any of the proposed project areas, nor are there any candidate species or species proposed for listing. There are also no areas designated or proposed as critical habitat within the action area of the proposed project.

7.7.6.2 Consequences

There are no threatened or endangered species or critical habitats to impact.

7.8 CULTURAL AND ARCHEOLOGICAL RESOURCES

7.8.1 Affected Environment

7.8.1.1 History of The Seward Peninsula Before Euro-American Contact

Several well-known traditions that represent past cultures, or stages in past cultural prehistory, have been established based on archaeological assemblages from the southern Seward Peninsula and to the south along Norton Sound. These include the American Paleoarctic tradition (12,000 to 7,000 years ago) with artifacts that suggest cultural connections across the Bering Land Bridge and the Northern Archaic Tradition (6,000 to 2,000 years ago).

Although earlier cultural remains in the area indicate the presence of the above-mentioned traditions on the Seward Peninsula, the earliest identified archaeological tradition on the southern Seward Peninsula is the Arctic Small Tool tradition (ASTt). At the Iyatayet site, located at Cape Denbigh in eastern Norton Sound, ASTt is represented by an assemblage named the Denbigh Flint complex, dating between 3,950 to 2,950 years before present (BP). Closest to the Solomon drainage, at the Old Beach Site on Cape Nome, a small Denbigh-tradition-related lithic assemblage was found on the earliest formed beach ridge (Beach Ridge 1) on the cape (Bockstoce, 1979). On the Seward Peninsula, other sites are found at Cape Espenberg and around Teller (Schaaf, 1988) and Cape Nome.

The archaeologically defined cultures known as Choris, Norton, and Ipuitak succeeded the Denbigh culture starting around 3,000 years BP. Overall the Choris economy appears to have been based primarily on caribou, based on faunal remains The Norton Culture dating between 2,450 to 1,480 years BP appears to have had a heavy reliance on net fishing, hunting caribou, and sealing.

Specialized cultures also developed on the Bering Sea islands at this time, such as the Old Bering Sea, Okvik, and Punuk, which focused on walrus or whale hunting. There are clear differences at sites north and south of the Bering Strait, with the Norton culture persisting south of the Strait until the arrival of the Thule culture. Typical artifacts of these sites feature checked stamped pottery, ground slate tools, large labrets of bitumen or jet, oil lamps, and net sinkers. Viewed in a larger sense, changes in stone tool technology introduced by the ASTt are interpreted by archaeologists as representative of the original Eskimo people, probably of Asiatic origin, who intensively exploited coastal as well as inland resources, and who introduced the bow and arrow (Oswalt, 1967; Anderson, 1984; Dumond, 1987; and Fitzhugh and Crowell, 1988). Linguists suggest the language at the time of earliest ASTt was the root language that split into Yupik and Inupiaq (Lutz, 1982; Woodbury, 1984; and Krauss, 1988).

The area encompassing the Seward Peninsula and Norton Sound region is considered within the Western Thule cultural influence, which also includes sites on the Siberian coast, St. Lawrence Island, the northern Alaska coast, and coasts of the Alaska Peninsula. During this time, sea mammal hunting and greater use of marine resources may have become a preferred subsistence strategy. Artifact assemblages are characterized by polished slate tools and show evidence of heavy reliance on coastal resources, especially open water hunting and the use of boats, the use of dog traction, and winter ice sealing. Sites indicate large populations focused on whale hunting, supplemented by small game and caribou. Dwellings were semi-subterranean with wood-framed walls and ceilings covered with sod (Edmonds, 1966; Oswalt, 1967; and Nelson, 1983).

7.8.1.2 History on the Seward Peninsula after Euro-American Contact

From historical accounts following contact with Euro-Americans in the 1800s, it is known that the Kauweramiut, Malimiut, and Unalikmiut Eskimo groups occupied the Seward Peninsula and Norton Sound region (Ray, 1984). Trade around northwest Alaska and across Bering Strait was well-established long before explorers entered the area. Kotzebue and Shesalik, on the north coast of Kotzebue Sound, and Point Spencer at Port Clarence, along the southwestern edge of the Seward Peninsula, were among the regional trade centers and were visited by Natives from throughout northwestern Alaska as well as from Siberia (VanStone, 1984; Ray 1984). In 1884, approximately 1,400 Natives were observed at a trade fair at Kotzebue (Oswalt, 1967). Trading partners and kinship ties were an important part of social networks; encounters between groups under circumstances other than specified trading events could be hostile (Oswalt, 1967).

The traditional settlement and subsistence pattern for most Eskimo groups has been described as a Central Based Wandering system (after Beardsley, in Oswalt, 1967). Winter was often spent in a more permanent village and summers were spent moving between camps in pursuit

of seasonal resources. Permanent winter houses were semi-subterranean with walls and roof of wood, a long entrance tunnel, and an oogruk (walrus) gut skylight.

Captain James Cook was the first European explorer to travel beyond the Seward Peninsula to as far north as Kotzebue Sound on his voyage in 1778. Kotzebue Sound was explored in 1816 by Otto Von Kotzebue, while he was looking for the Northwest Passage on behalf of the Russian-American Company. Kotzebue traded with the Native people he encountered and observed that they already had western trade goods and were very knowledgeable regarding trading practices. The Russian American Company sent a ship annually from St. Michael to Kotzebue Sound starting in 1833 (Ray, 1984). By the mid-1800s, Euro-American presence in northwestern Alaska was annual, but sustained contact did not begin until the turn of the century. As a result, major impacts to the Native culture of northwest Alaska were felt later than they were in southwestern or southeast Alaska, where permanent settlements and trading posts were established much earlier.

The first whaler to venture through the Bering Strait was the *Superior* out of Sag Harbor, New York, in 1848, and whalers from the already established North Pacific fishery soon followed. Port Clarence on the southwestern edge of the Seward Peninsula, Kotzebue Sound, and Point Hope were favored stopping points for whalers to trade (Ray, 1975; Grauman, 1977; VanStone 1984; and Williss, 1986).

Following the U.S.'s purchase of Alaska from Russia in 1867, the first U.S. government presence in northwest Alaska was by the Revenue Marine ship *Wayanda* in 1868 and by the *Reliance* in 1870. It was not until 1880, however, that annual patrols of the revenue service were instigated to control trade in guns and liquor, conduct census and scientific studies, and provide aid and rescue service.

In 1890, the U.S. government sponsored domestic reindeer herding, spearheaded by Dr. Sheldon Jackson, an agent for Education in Alaska and also a Presbyterian missionary; consequently, the reindeer herds were nearly all associated with missions and mission schools. The influence of the missions, hospitals, and schools associated with reindeer herding impacted seasonal mobility, as well as language, society, and culture (Grauman, 1977; VanStone, 1984; Williss, 1986; and Simon, 1998).

The Klondike Gold Rush of 1897 brought large numbers of people north with significant impact on the residents of the Seward Peninsula. In April 1898, the first real strike on the Seward Peninsula occurred on Melsing and Ophir creeks, and the town of Council City was founded. Over the next 30 years, the mining district around Council City would produce an estimated $12 million worth of gold (Cole, 1984). However, as Cole notes, "the Council City strike was the prelude to a far richer discovery made about 80 miles (130 km) to the west six months later near Cape Nome."

7.8.1.3 History of the Nome Region

In early September 1898, Jafet Lindeberg, Eric Lindblom, and John Brynteson, later known as the "three Lucky Swedes," discovered gold in several tributaries of the Snake River, west of Cape Nome Among the creeks that the three prospectors staked were Glacier Creek, Rock

Creek, and the richest of them all, Anvil Creek (Collier, et al., 1908; Cole, 1984). Word quickly spread, and Nome (originally called Anvil City) was born. Before the Lindeberg, Lindblom, and Brynteson discovery, the area surrounding the Snake River was primarily occupied seasonally during the subsistence rounds of local Natives, while larger semi-permanent villages were located to the east near Cape Nome (Schrader and Brooks, 1900; Bockstoce 1979). By June 1899, A. H. Brooks (1953) estimated the population of Nome to be 400 individuals, and by fall of the same year, the population had increased to 3,000. The subsequent discovery of easily obtainable gold in the beach sands in 1899 established Nome as one of the largest and most corrupt towns of the Alaska Gold Rush (Grauman, 1977).

The easy pickings along the beach were largely exhausted by 1900, but the creeks continued to produce. Anvil, Glacier, and Dexter creeks proved to be the richest in the Nome District, with the district gold fields estimated at producing $136 million (Cole, 1984). In order to mine the placer gold deposits on the creeks, a large amount of water was needed, and ditches were constructed to provide it. In 1901, construction began on the 54-mile (87-km) "Miocene Ditch" in Nome (Biggar, 1963). The Miocene Ditch was the largest and most complex of the Nome District Ditches and included sections blasted through rock, sections crossing permafrost or ground ice, inverted siphons, and a tunnel (Purington, 1905). Purington summarizes all the "water conduits" (ditches and flumes) built in Alaska as of 1905. He tabulates 157.8 miles (254.0 km) of ditches, 59.5 miles (95.8 km) of which were in the Nome district.

Between 1903 and 1934, 40 dredging projects were undertaken in the Nome district, but by 1934 only five remained (Herbert, 1934). Most of these early ventures were unsuccessful, but valuable lessons were learned which were applied by Hammon Consolidated Gold Fields when they began construction of their electric dredges in 1922 (Harlan, 1931, in Boswell, 1979). Cold water thawing, developed and patented by John Miles in 1920, and more than 100 miles of ditches were already in use in the Nome Mining District by 1931 (Harlan, 1931, in Boswell, 1979).

Though Rock Creek and Glacier Creek were among the initial discoveries of gold in the Nome region, information about the history of mining in the vicinity of the two creeks is minimal. The location of the initial claims on the two creeks by Lindeberg, Lindblom, or Brynteson is not known at this time. In 1899, Prospector D. C. Witherspoon was noted as laying claim to areas around Rock and Glacier creeks (Schrader and Brooks, 1900: Map 2; Orth, 1967). Subsequent re-mining especially by dredges, has almost certainly removed any remains of these early claims.

7.8.1.4 History of Early Alaskan Lode-Gold Mines and the Hurrah Quartz Mine

The first stamp mill at a lode-gold deposit in Alaska was built in the Indian Creek Valley near Sitka in 1879. Gold-bearing quartz veins were sought by prospectors throughout the territory, but deposits with significant yields and economic viability were not numerous. Lode mining began in the Solomon River drainage in 1903 at Big Hurrah Creek. The first placer claim had been staked in 1899 near the mouth of Big Hurrah Creek (Cobb, 1973). In the vicinity of the Solomon River drainage, Petrof recorded that the Omilak mine, located approximately 125

miles (200 km) east of Nome, had been mined for silver-lead ores, which include small amounts of gold, before 1880 (Smith, et al., 1942).

The Hurrah Quartz Mine, according to Reports of the Commissioner of Mines for the Territory of Alaska Department of Mines and by the *Nome Nugget* newspaper was active between 1903 and 1908, and remained idle until 1938. Charles D. and Anna Lane and their sons, Louis, Paul, and Tom, developed the lode mine, beginning with construction of the large mill building in 1901 and 1902. Mrs. Lane and her son Tom were the owners of the mine, and Charles was a well-known figure in the gold mining scene, described as "a practical quartz miner for forty years" (*Nome Nugget* August 20, 1902 and June 14, 1904). Charles Lane, president of the Wild Goose Company, had a number of claims on the Seward Peninsula; the family was responsible for building several long ditches in the Kougarok, Casadepaga, and Solomon mining districts, and worked claims on Ophir Creek, Anvil Creek, and Nikila Gulch, as well as others.

During the 1904 season, 10 additional stamps were added to the mill. The chartered schooner *Coryphene* from Seattle brought the stamps and 1,400 tons (1,270 tonnes) of supplies to run the mill for another year; the mill ran year-round and employed 40 to 50 people (*Nome Nugget,* June 14, 1904). By January 1905, the mill employed 55 men (*Nome Nugget,* January 20, 1905). Later that same year, the newspaper noted that prospect shafts at the Hurrah Quartz Mine were at depths of 300 feet (90 m), and the "mother ledge" of quartz "freely permeated with fine gold" was located (*Nome Nugget,* April 18, 1905).

By 1906, the main shaft was at a depth of 275 feet, with three active levels at even greater depths. The mine, now managed by son Louis Lane, reported an accident in which a magazine of blasting powder detonated, causing a portion of one of the levels to be filled with debris, though damage was small (*Nome Nugget,* February 20 and April 5, 1906). In several other articles, Hurrah Quartz Mine is consistently described as organized and well equipped.

Reports during 1907 by Smith (1907) of the USGS concurred that the mine ran smoothly and had been on the same scale for several years, and "continues to be the only productive lode-gold mine in the entire district." In Smith's 1909 report, he notes a "series of difficulties have arisen which compelled the suspension of operations at this mine during 1908"; the ore itself was not one of the difficulties, but instead there were "questions of management" (Smith, 1909).

The *Nome Daily Nugget* of January 3, 1913, reported that several mining properties received patents, among which was the "Big Hurrah quartz properties of Mrs. Anna G. Lane." The *Daily Nome Industrial Worker* of June 20, 1917, reported that the road associated with the Council City and Solomon River railroad (referenced in an earlier article reporting the salvage of the rails) was to be left intact because of interest in re-opening the Hurrah Quartz Mine. Mertie (1918) mentions the mine and confirmed its closure some years before his visit to the Seward Peninsula in 1916.

Several miners worked Big Hurrah Creek between the initial closure and the reopening; the creek was worked with a small dredge by Iverson and Johnson in 1922 and with draglines, bulldozers, and hydraulic operations by C.O. Roberts Company of Nome in the 1930s and

1940s with crews of three to seven people. During this time period, Smith, still with the USGS, reported that pending litigation concerning the Big Hurrah lode-gold mine was settled in 1937 "in favor of the Lane Investment Co." He offered the opinion that this action "should enable mining interests to consider seriously taking steps that may lead to the reopening of the well-known property, which 25 years ago was the most productive lode-gold mine in the entire Seward Peninsula region" (Smith, 1939). Partly responsible for a decade delay in reopening the mine was an order by the U.S. War Production Board in October 1942 that closed most lode-gold operations.

However, by the 1946 biannual Report of the Commissioner of Mines, the Big Hurrah Mine is listed as being operated by C.O. Roberts as "the only productive lode gold mine on Seward Peninsula" (Stewart, 1946). It is unclear if Roberts was running the lode mine for Lane Investment Co. or running a separate operation. In 1950, the Commissioner of Mines (1950) reported that "…the Big Hurrah mine was taken over in 1950 by T.P. Lane of the pioneer mining family, and plans were to rework the tailing of previous operations by cyanidation. A cyanide plant was ordered and received in the fall of 1950 that was expected to be erected and operated during 1951." Work continued at the mine between 1952 and 1954 with Travis Lane as manager. Activities were directed toward "cyaniding the mill tailings…recovering gold that was lost by the earlier incomplete milling process" (Alaska Department of Mines, 1952). It is unclear if new ores were also being mined and processed at that time. These activities ceased in late 1954 as a result of "moving ground and caving in of the shaft", though reopening the mine was considered an option.

7.8.1.5 Known Cultural Resources in the Rock Creek and Big Hurrah Areas

The most well known prehistoric/protohistoric sites in the area, designated Alaska Heritage Resource Survey (AHRS) SOL-001, 002, and 093, are on the beach ridges along Safety Sound. AHRS SOL-001, *Old Beach Site,* consists of several hundred house pits. Archaeological materials from Denbigh, Norton, Birnirk, and Thule cultures and into historic times have been recovered from the site. AHRS SOL-002, *Nuk* (*New Beach Sites)*, is a site that had more than 30 houses, but because of erosion in the 1970s now has eight house depressions with extended entryways remaining. AHRS SOL-093, *Nuglene Site (Mupterukshuk Site),* is the western locus of site SOL-002. Less well known, but closer to Big Hurrah Creek, is AHRS SOL-068, *Okpiktulik (Uqpiktuliq)*, a village at the mouth of Cache Creek with numerous house pits and graves, and AHRS SOL-111, *Imaqliq*, a site southwest of Solomon, reported to be a place where Diomede Islanders were forced to build sod houses and to overwinter because of an early storm.

7.8.1.6 Previous Cultural Resource Research for Rock Creek and Big Hurrah

Two known cultural resources are located within or adjacent to the Rock Creek project area. Site NOM-096 is the Hot Air Mining Ditch, located on the western flank of Mount Brynteson, Site NOM-097 is the Price and Tremper Ditch, located on the southeastern flank of Mount Brynteson. The characteristics of the ditches and any associated features have not been previously described.

Prior to this survey, cultural resources around the Hurrah Mine were known primarily from the Territory of Alaska Department of Mines biannual reports on staffing and types of mining activity, (Anderson, 1947; Read and Meinart, 1986; and Werdon, et al., 2004). Several anthropologists have worked in the Nome and Solomon areas, including Dorothy Jean Ray in the 1960s, J.R. Bockstoce in the 1960s and 1970s, and R.G. Buzzell and D. Gibson in the mid-1980s. Bockstoce conducted extensive testing and excavations at the Old Beach Site near the eastern end of Safety Sound, the largest known closest prehistoric site to the Big Hurrah area. Archaeologists F.G. Rainey and F. Hadleigh West also worked at the site. Buzzell and Gibson identified many of the historic sites recorded in the Alaska Heritage Resources Survey (AHRS) database pertinent to the Solomon River drainage. BIA archaeologists surveyed and recorded a number of sites in the 1970s for the Alaska Native Claims Settlement Act (ANCSA).

7.8.1.7 Current Research at the Rock Creek Mine/Mill Complex Site

Northern Land Use Research, Inc. (NLUR) archaeologists conducted a survey of the entire Rock Creek project area in October 2003. The area of potential effect (APE) consists of 976 acres (395 ha) surrounding the Rock Creek drainage and western flank of Mount Brynteson above Glacier Creek. Because of the size of the project, areas were designated as having high or low potential for the occurrence of prehistoric or cultural resources, with areas designed as high potential surveyed first. Approximately 600 acres (200 ha) were deemed as high-potential and were covered by pedestrian survey. The pedestrian survey consisted of archaeologists walking parallel transects approximately 50 feet (15 m) apart to provide sufficient inspection of the ground surface. The subsurface was examined by trowel and entrenching tool tests on a discretionary basis. All cultural resources were identified by field numbers and coordinates taken.

Two cultural resources were known to be located within or adjacent to the project area before the Cultural Resources Survey: the Hot Air Mining Ditch and the Price and Temper Ditch. Ditches were often constructed in the late 1800s and early 1900s to provide water necessary to mine placer gold deposits. The Hot Air Mining Ditch is located on the western flank of Mount Brynteson, between 400 and 450 feet (120 and 140 m) above sea level and extends from Blatchford Creek approximately 0.5 miles (0.8 km) north of the confluence of Snow Gulch and Glacier Creek. The Price and Tremper Ditch is located on the southeastern flank of Mount Brynteson, between approximately 150 and 300 feet (46 and 90 m) above sea level. According to the AHRS database, it extends from near Abbe Gulch south to Glacier Creek; however, USGS quadrangle map Nome C-1 shows it extending from Erickson Gulch southwest to Glacier Creek. Neither fulfilled the eligibility requirements for possible inclusion in the National Register of Historic Places (NRHP) under Title 36, Code of Federal Regulations, Section 60 (36 CFR 60).

A total of 13 other cultural resources were identified within or near the project area. Of these, only one item fulfilled the eligibility requirements for nomination to the NRHP under 36 CFR 60.

The other 12 cultural resource or recent use sites include:

- RC-03-01 – An isolated find of chicken wire attached to remains of a wooden crate;
- NOM-127 – A collapsed wooden structure that has lost its structural integrity;
- RC-03-03 – A 12-gauge Remington shotgun shell base;
- NOM-128 – An area of scattered piping material located on the southern flank of Mount Brynteson;
- NOM-130 – A liner depression of unknown function located on the southern flank of Mount Brynteson;
- RC-03-07 – A white Chevrolet Step Van less than 50 years old;
- NOM 132-136 – Six possible prospect pits or depressions likely relating to mining activities. While vegetation regrowth suggests that the pits date to the early part of the 20th century, there are no other structures associated with them. Prospect pits are generally not considered significant features as they can tell us little beyond the location of the mining activity;
- NOM-096 and 097 – The Hot Air Mining Ditch and the Price Temper Ditch, both of which had a rather simple construction style when compared to other ditches within the Nome region. No other features such as siphons were associated with the ditch sections and much of the structural integrity has been lost. The segments of the ditches within the project APE do not contribute further information to the already documented history of mining ditches in the Nome area other than their location; and
- NOM 131 – The remains of a collapsed wooden structure and an associated debris pile. It appears to be on or slightly outside of the southwestern APE boundary line.

The above sites were either isolated finds, could not be tied to an event or person that is significant to the mining history of Nome, or had lost their integrity and provided little historic information. All of the above sites were not considered significant cultural resource in the Nome region and do not fulfill the eligibility requirements for inclusion to the NRHP under 36 CFR 60.

Site NOM-129 was eligible for nomination to the NRHP. Site NOM-129 includes a large wooden cabin with furniture, a collapsed smaller wooden structure with a bunk bed frame, a large wooden sledge, a second collapsed wooden structure that was possibly used as a machine shop, a can dump, and other debris. NOM-129 could have been inhabited as early as 1926 and was last used as late as the early 1980s. It is located in an area of the site not expected to be disturbed by the proposed mining project. A photo of the bunkhouse at NOM-129 is presented in Figure 7.22.

Figure 7.22 Bunkhouse at NOM-129

7.8.1.8 Current Research at the Big Hurrah Site

During the 2005 investigation of the Big Hurrah site, a 100% surface pedestrian survey of the APE was conducted walking parallel transects approximately 50 feet (15 m) apart to provide sufficient inspection of the ground surface. Discretionary subsurface testing was conducted in areas of high and moderate potential for the presence of cultural resources, and photographic documentation was completed for several historic buildings and sites.

Large portions of the APE have been disturbed in the past by mining activities and exploratory drilling. These recent disturbances, however, have left intact the main feature within the APE, the stamp mill building. Significant damage has occurred within the building from deterioration of the roof, but large portions of the building appear to be structurally sound. Many of the machines, including the four stamp sets, remain in place. The other main feature, the residence, also appears to be structurally sound, but damaged inside from removal of wall materials, etc. Throughout the APE are scattered features associated with mining efforts of the past 100 years. Some appear to be directly associated with the stamp mill building during its early phase of operation from 1903 to 1908, while other features are associated with later mining efforts during the 1940s and 1950s. A summary of the cultural resources observed at Big Hurrah is presented in Table 7-41 below.

Collectively, many of the features and artifacts within the APE noted by NLUR are historically significant, and meet criteria for eligibility to the NRHP (see 36 CFR 800). Because of the importance of the Hurrah Quartz Mine as one of the first productive lode-gold mines on the Seward Peninsula, to the connection with the Lane family who were very active in the mining community of the Seward Peninsula, and to the fact that the main feature, the stamp mill building, maintains considerable structural integrity and houses many original objects, the mine and several associated features likely meet eligibility criterion requirements as a historic district. The district, as provisionally defined, contains at least 16 contributing elements, and three noncontributing elements. The district is eligible under all four National

Register Criteria: Criterion A (association with historic events), Criterion B (association with important people), Criterion C (engineering features), and Criterion D (information potential) (see *Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties*, National Register Bulletin 42, U.S. Department of the Interior, 1992). A photo of the Hurrah Quartz Mine in the early 1900's is presented in Figure 7.23 below.

Table 7-41 Summary of Cultural Resources Observed During the 2005 Survey.

Description	Field Number
Short ditch	BH-05-01
Collapsed structure and vehicle	BH-05-02
Parallel ditches	BH-05-03 west end
	BH-05-03 east end
Stamp mill bldg and rail, with assoc. scatter (site datum)	BH-05-04 northwest corner
Residence	BH-05-05
Powerhouse	BH-05-06
Collapsed ore shaft bldg, shaft and hoist mechanisms	BH-05-07
Bulldozers	BH-05-08
Driller	BH-05-09
Collapsed Quonset, vehicles, and generator	BH-05-10
Trucks	BH-05-11
Dump	BH-05-12
Settling pond gate (?)	BH-05-13
Adit	BH-05-14
"B/Foot Tube Mill"	BH-05-15
Cut pipe	BH-05-16
Banded barrels, timbers	BH-05-17
Collapsed structure on Little Hurrah Creek	BH-05-18
Modified structures	BH-05-19

Site location information is considered confidential by SHPPO and not included. Details of site location are provided in the 2005 NLUR Report on file at the Alaska Office of History and Archaeology, Alaska Department of Natural Resources.

Figure 7.23 Hurrah Quartz Mine, Solomon, Alaska 1896 - 1913 from O.D. Goetze Collection

Consequences

Based on the results of field observation and literature review, there is no reason to believe that mining development activities within Rock Creek Mine/Mill Complex APE warrants additional filed surveys under Section 106 of the National Historic Preservation Act. The one item eligible for the NRHP is not located in an area anticipated to be disturbed by the proposed mining project.

At the Big Hurrah site, the proposed mine would require demolition of the residence and would also impact a variety of other features. The main feature, the stamp mill, would not be impacted by the proposed mine plan.. Mine owners are willing to store significant artifacts either at the site or in a warehouse in Nome to the extent practicable. Recommendations for mitigation of potentially adverse effects will need to be developed in consultation with the State Historic Preservation Office (SHPO) for the Big Hurrah site. Documentation of some of the key structures within the district according to Historic American Building Survey /

Historic American Engineering Record (HABS/HAER) standards (see *HABS/HAER Standards*, U.S. Department of the Interior, 1990) could obviate the need for in situ preservation and preserve the knowledge associated with the site. With proper documentation and preservation of the stamp mill and many of the artifacts, the loss of historic knowledge available from the site will be minimized.

No indications of burials or other human remains were observed within the surveyed area at either site; therefore, barring an unforeseen discovery during the undertaking, there are no further considerations expected.

7.9 SOCIOECONOMIC AND COMMUNITY IMPACTS

7.9.1 Demographics

7.9.1.1 Affected Environment

Malemiut, Kauweramiut, and Unalikmiut Eskimos occupied the Seward Peninsula historically. During the early 1900s, this Native population was complemented by prospectors, gamblers, claim jumpers, saloon keepers, and other colorful characters to reach an all-time high population total of 20,000. However, the gradual depletion of gold, a major influenza epidemic in 1918, the Great Depression, and finally World War II took their toll on Nome's population. A 2002 study by a state demographer shows the population to be 3,493.

According to the 1990 U.S. Census, the percentage of males to females in Nome, Alaska, was 54% and 46%, respectively. The total population at that time was 3,500 and has only increased to 3,505 according to the 2000 U.S. Census. Similarly, the 2000 Census revealed the male and female ratio as 53% and 47%, respectively, only a slight change over the previous decade. Ethnically, Nome is composed of 58% Alaska Native, followed by 37% Caucasian, 0.8% African American, 1.5% Asian/Hawaiian Native, 2% Hispanic origin, and 2.4% of other races. Table 7-43 below shows the Nome Race/Ethnic Composition.

The distribution of population in villages across the region is shown in Table 7-42.

Table 7-42 Population of the Bering Strait Region by Community in 2002

Community	Population
Brevig Mission	261
Council	0
Elim	284
Gambell	636
Golovin	161
Diomede	172
King Island	0
Koyuk	280
Mary's Igloo	0
Nome	3,511
Port Clarence	19
Saint Michael	329
Savoonga	615
Shaktoolik	231
Shishmaref	537
Solomon	0
Stebbins	507
Teller	278
Unalakleet	798
Wales	165
White Mountain	212
Other	89
Total	**9,085**

Note: Source: Alaska Department of Community and Regional Affairs

In 2005, the population of Nome is primarily a mixture of Inupiat Eskimos and non-Natives. A comparison of 1990 Census data to 2000 Census data shows that these proportions have changed slightly. The Caucasian population went down by 15.6%, and the Alaska Native and American Indian population rose by 11.3%. Increased proportions in other minority groups ranged from a 1.2% increase in Asian/Hawaiians to a .8% increase in African Americans. Ethnic composition of the Nome population for 2000 is presented in Table 7-43 and Figure 7.24 below.

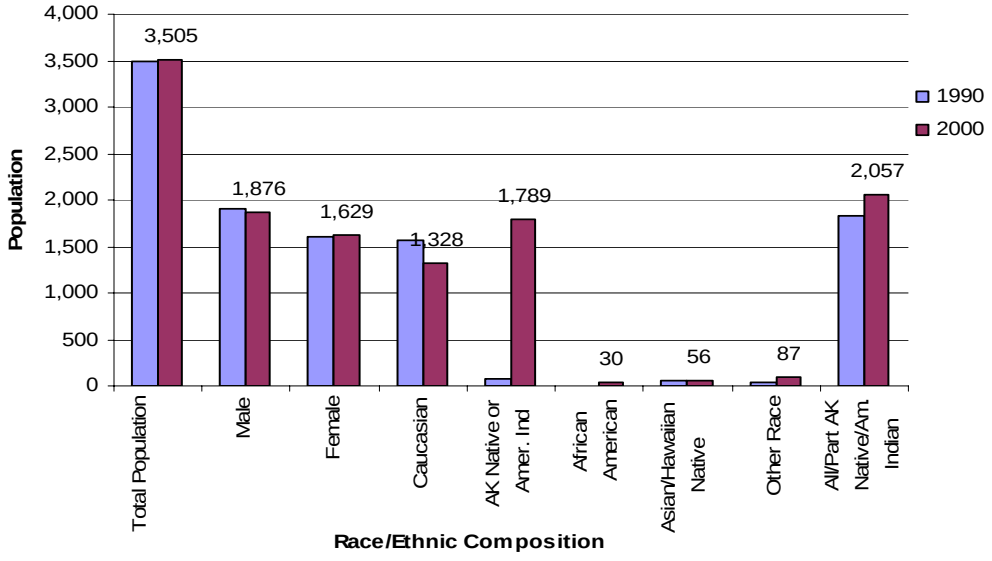
Table 7-43 Nome Race / Ethnic Composition 1990 and 2000

	1990	2000
Total Population	3,500	3,505
Male	1,902	1,876
Female	1,598	1,629
Caucasian	1,574	1,328
Alaska Native or American Indian	68	1,789
African American	6	30
Asian/Hawaiian Native	49	56
Other Race	47	87
All/Part Alaska Native/American Indian	1,824	2,057
Hispanic Origin*	N/R	72
Non-Hispanic**	N/R	3,433
Percent Native***	52.10%	58.70%

Notes:
N/R=Not Reported
*Residents of Hispanic origin may be of any race.
**Residents of Non-Hispanic origin may be of any race.
***Percent reporting Alaska Native alone or in combination with one or more races.

Figure 7.24 Nome Race/Ethnic Composition 2000

*Data from U.S. Census 2000



According to the year 2000 Alaska Department of Labor and Workforce Development estimates, the average age of Nome residents is 32.4 years, which matches the Alaska statewide average. The largest groups of individuals in Nome are between the ages of 25 and 54. There is a small percentage of people over the age of 59 and a relatively small number of individuals between the ages of 20 and 24. Table 7-44 and Figure 7.25 show the distribution of the Nome population by age in 2000.

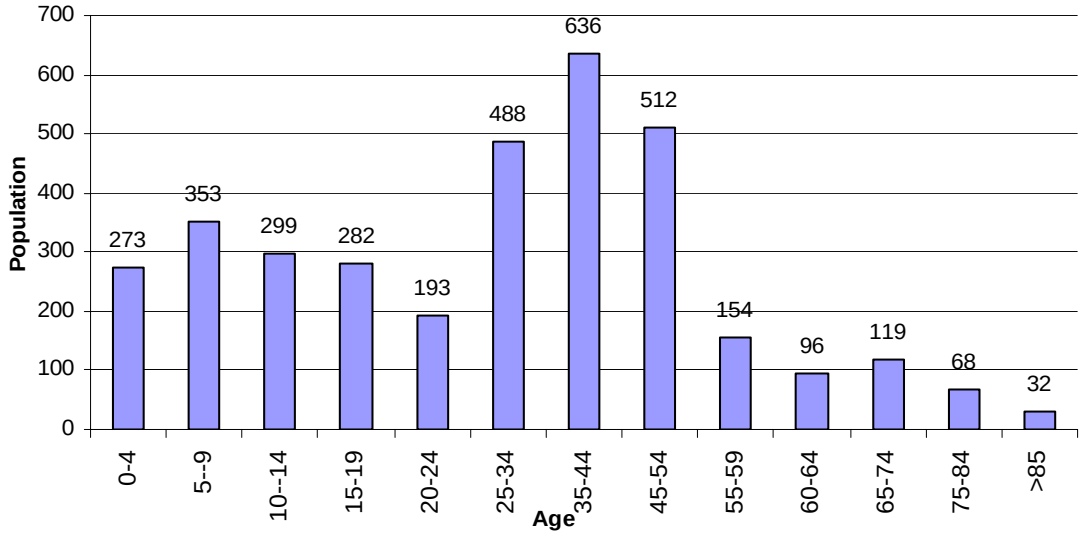
Table 7-44 Nome Population by Age 2000

Age	Total
0-4	273
5--9	353
10--14	299
15-19	282
20-24	193
25-34	488
35-44	636
45-54	512
55-59	154
60-64	96
65-74	119
75-84	68
>85	32
>18	2,387
>21	2,268
>62	272

Note:

Source: Alaska Department of Labor and Workforce Development

Figure 7.25 2000 Nome Population by Age



7.9.1.2 Environmental Consequences: Demographics

It is difficult to estimate the origin of in-migration for the new jobs at the proposed Rock Creek Mine; however, interviews with Nome area employment coordinators with regional recruiting responsibilities, coupled with the mine developer's local hire policy, lead to the following projected split: of the 130 new jobs that the mine would introduce to the community, it is estimated that 42 positions will be filled by Nome residents, 69 positions by residents of other villages within the Bering Strait region, and 18 positions filled by individuals who will come from outside of the region.

In order to extrapolate the total in-migration that would accompany the estimated 87 workers from outside of Nome, it is important to understand 1) average household size in the region's villages, and 2) rental versus ownership preferences among village residents. Table 7-45 shows the average Bering Strait household size in 2000.

Table 7-45 Average Bering Strait Region Village Household Size in 2000

Bering Strait Region Community	Average Household Size
Brevig Mission	4.06
Diomede	3.4
Elim	3.73
Gambell	4.08
Golovin	3.2
Koyuk	3.71
Stebbins	4.45
Saint Michael	4.09
Savoonga	4.43
Shaktoolik	3.83
Shishmaref	3.96
Teller	3.53
Unalakleet	3.33
Wales	3.04
White Mountain	2.94
Median	**3.72**

Note: Source: Alaska Department of Community and Regional Affairs

Of those villages with populations more than 100 in the Bering Strait region, average household size ranges from 2.94 to 4.43 persons. The median household size for the villages is 3.72, much higher than Nome's 2.79 persons per household. The size of Nome's households is very close to the statewide average of 2.74 persons per household. Thus, if all of the new workers that come from outside of Nome were to choose to relocate to Nome for either the life of the mine or permanently, then the total population in-migration could be as high as 286 people.

However, it is important to understand the region's new-worker commuter patterns and housing preferences as exhibited since 1980. (These are detailed in the Housing section) To summarize, interviews with the region's larger employers indicate that many, if not most, of the village workers will likely choose to either stay with relatives or share rent with a co-worker during their shifts in Nome, and then travel back to their home villages during their intermittent time off. In fact, the developer states that the on/off work schedule has been selected specifically in order to be better able to attract workers from the villages who often prefer to maintain their primary households in their village of origin. Based on this local knowledge of workforce preferences, it is estimated that approximately one third of the village workers will choose to relocate to Nome with their families. On the basis of the

operations history of other mines in Alaska, it is estimated that the 18 workers who are likely to move to Nome from outside of the region will make a permanent move with their families, accounting for a total of 49 new residents when workers' family members are counted. An estimation of the total in-migration of workers to Nome is shown in Table 7-46 below.

Table 7-46 Estimated In-migration of Workers for the Red Dog Mine.

Workers New to Nome/Origin	Average Household Size	Estimated Total In-migration
69 from Bering Strait Villages	3.72 persons/household x 33%	85
18 from Outside of the Region	2.74 persons per household	49
Total New Workers: 87*		**134 people**

Note: *87 workers new to Nome; 39 mine workers who are already Nome residents

Thus, it is estimated that a total of 134 new residents will make Nome either their permanent or intermittent new home as a result of employment opportunities with the Rock Creek Mine. This would represent a 3.6% population increase for the community of 3,505 residents.

The demographic composition of the new residents is not expected to be unlike the current Native/non-Native composition of the Nome population. If the mine operator is successful in recruiting as many village residents as the company's target goals indicate, then the percentage of Native (63%) to non-Native (37%) in-migration will be greater than the overall Nome population distribution of 58% Native and 42% non-Native.

The final factor affecting the potential for demographic effects on Nome is the life of the mine. Today the mine life for Rock Creek is estimated at 4 to 5 years. However, the company will engage in ongoing exploration that may or may not yield additional gold reserves, and thus a longer mine life. Thus, the population increase outlined in this section may be sustained for 4 to 5 years, or it may be sustained for the period of a longer ultimate mine life.

7.9.2 Economics

7.9.2.1 Affected Environment: Regional Economics

It is difficult to subsist in an arctic climate, much less make a cash living, but both Native Alaskans and new residents have found means of survival on the Seward Peninsula and have made this land their home. The Bering Strait region encompasses an area of 570 miles (920 km) of coastline, including Norton Sound and portions of the Bering Sea and Arctic Ocean. Over the past 10,000 years, more than 9,000 people have lived at these continental crossroads and have developed region-specific methods of economic survival.

The community of Nome serves as the regional transportation and service hub for 15 surrounding villages, which are mostly situated on the coasts of Norton Sound and the adjacent Bering Straits. The local economy is dominated by the service sector, including transportation, trade, finance, and services. In outlying communities, the primary source of

year-round employment is with regional schools, health clinics, and city and village organizations. Other seasonal activities in the region include commercial fishing, fish processing, firefighting, and reindeer herding. Communities on St. Lawrence and Diomede islands rely primarily on subsistence harvesting of marine mammals and fish. An aerial view of Norton Sound is presented in Figure 7.26.

Figure 7.26 Norton Sound near the Bering Sea

The Bering Strait region is a mixed cash and subsistence economy. The cash economy is largely derived from tribal, federal, state, and local government employment; mining and mineral companies; commercial fishing; Native Corporations; Norton Sound Health Corporation; construction work; reindeer herding; traditional arts and crafts; local retail stores/services; and numerous temporary, seasonal and part-time employment opportunities.

Throughout the region, unemployment rates are extremely high compared to statewide averages, with an average of 13.4% in 2002. July 2003 showed an even higher regional unemployment rate at 17%. The region's unemployment rate was 7.6% higher in 2002 than the national average. Job opportunities outside of Nome are limited where cash employment is a rare opportunity.

On January 15, 1997, Kawerak Incorporated's Bering Strait Alaska Regional Development Organization (ARDOR) Committee was formed to implement an Overall Economic Development Plan and to represent the region's economic interests in fisheries, transportation, tourism, and mining. Specifically, this program assists residents of the region in developing and expanding their local economies through job creation by providing technical assistance in the form of research into funding opportunities, grant applications, and the development of business plans.

Traditional Arts and Crafts

Traditional arts and crafts are other marketable commodities that bring supplemental income to Alaska families. It is estimated that more than 2,000 people throughout the region increase their annual cash income through production of arts and crafts (Kawerak, 1999). Alaska Natives are the only people in the United States allowed to harvest marine mammals for subsistence purposes. In addition to subsistence, the Natives use the mammals (walrus, seals,

whale, and polar bear) to create products such as carved walrus ivory, whale baleen, seal pelts, dolls, masks, grass baskets, dance fans, kayaks, jewelry, parkas, mukluks, fur mittens, fur hats, sealskin slippers, and other Eskimo crafts. However, these products have proven to be difficult to market, given the excessive distances and costs involved with flying to larger cities (such as Fairbanks, Anchorage, or Juneau) to sell the goods. For this reason, and with one notable exception in Nome, many of the small arts and crafts producers rely primarily on tourism within their villages in order to sell their products.

Hunting and Fishing

Many rely on subsistence hunting and fishing for their main food source; however, it is still necessary for them to purchase costly equipment in order to maintain the subsistence lifestyle. The high cost of living expenses in the Bering Strait region often counterbalance attempts to lower costs through subsistence practices. Necessary hunting and camping equipment such as boats, outboard motors, all-terrain vehicles, canvas tents, camping stoves, and heavy outdoor clothing, for instance, come at a considerable price in rural Alaska. Villages in the region have a 29% to 62% higher cost for products (as opposed to services) than does Anchorage. Cost of goods in Nome and the villages are 156% to 222% higher respectively than products in Atlanta, Georgia, for example. For this reason, many Alaskans have high relative poverty rates and find the need to supplement their subsistence harvests with alternative means of cash income.

Fish in the Bering Straits region are harvested mostly by commercial fishermen; however, many of the region’s residents also rely on fish as a primary food staple. Alaska king crab is also used heavily by residents and wasn't harvested by commercial fisheries until April 1977 (Kawerak, 1999).

Mining

Following the discovery of the 'golden sands of Nome' in 1899 (yielding more than $1 million dollars worth of gold within a two-month period), the Bering Strait region became known for its gold potential. This led to more than 17,000 acres (6,900 ha) of patented mining claims, including Alaska's largest producer of placer gold, Alaska Gold Company (Sparks, 1998). Despite the mining potential, 65 mining employees lost their jobs as gold prices fell in 1998, adding a significant impact on the region's economy (Kawerak, 1999). Besides gold, the Bering Straits region also holds other unique mineral deposits beneath the earth. Sulfide deposits (containing lead, zinc, silver, barium, and fluorine in layered iron deposits) have been found in the region. In addition, more than 4 million pounds of tin have been mined on the Seward Peninsula, and several other areas contain great prospecting potential.

The historic importance of mining to Nome is demonstrated by statues of the Three Lucky Swedes erected in the city center. The Three Lucky Swedes were the historic miners who started the Nome gold rush. A partial view of the statues is presented in Figure 7.27.

Figure 7.27 Mining History Commemorated in the Center of Nome

Reindeer Herding

Reindeer were introduced to the Bering Strait region in 1892 after over-harvesting of whales and walrus, decreasing caribou herds, and epidemics threatened the survival of the indigenous people. Since their introduction, reindeer herding has proved itself as a valuable economic occupation, increasing local employment and fulfilling demands for reindeer products (Kawerak, 1999).

Tourism

Despite this region's cold and harsh environment, tourism plays a significant role in the regional economy. Nearly 23,000 people travel from outside the region to Nome each year, spending almost 0.4% of the $598 million spent by tourists in the entire state (Nome Convention and Visitors Bureau). Compared to the rest of rural Alaska, the road system in the southern portion of the Seward Peninsula is relatively extensive. Many tourists are attracted to the region because remote parts of Alaska are accessible from Nome by automobile for wildlife viewing, especially bird watching.

7.9.2.2 Affected Environment: Local Economics in Nome

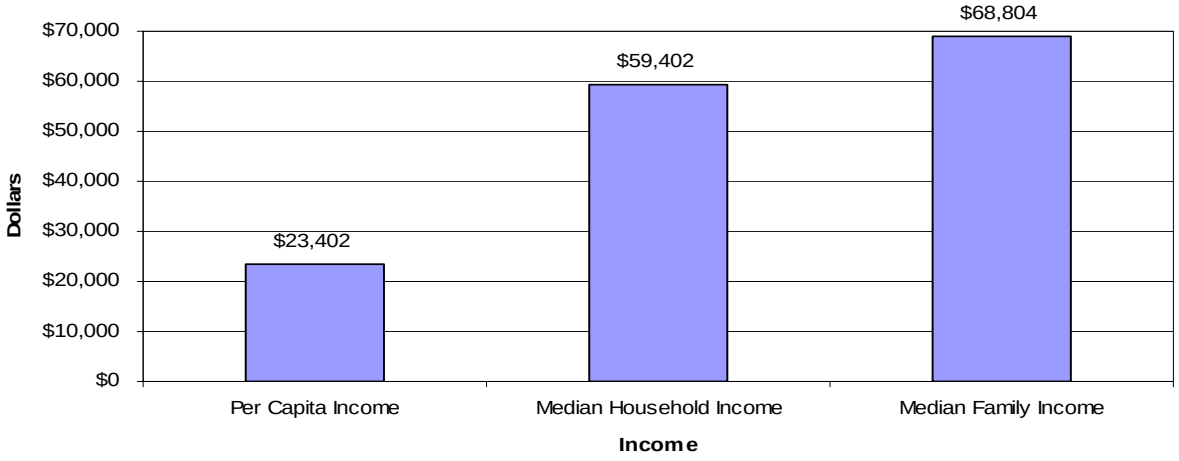
Nome is the supply, service, and transportation center of the Bering Strait region. The labor force of Nome is supplemented by residents who travel from villages throughout the region (ranging from Stebbins on the southern portion of Norton Sound to Shishmaref on the northern portion of the Seward Peninsula). This means that a large number of skilled, semi-skilled, and unskilled people are available for work in Nome. The 2000 U.S. Census revealed that 6.3% of the Nome population is below the poverty level, with an average household income of $59,402. Table 7-47 and Figure 7.28 below shows the income and poverty levels in Nome in 2000. Table 7-48 shows the distribution of employment in Nome in 2000.

Table 7-47 Income and Poverty Levels, Nome Alaska

Per Capita Income	$23,402
Median Household Income	$59,402
Median Family Income	$68,804
Persons in Poverty	212
Percent Below Poverty	6.30%

*Source: 2000 US Census

Figure 7.28 Income and Poverty Levels, Nome Alaska



The largest contributor to the Nome economy is government services, followed by additional key basic industries including fishing, retail, transportation, mining, and medical services. The Nome area has an 11% unemployment rate for individuals who are seeking work opportunities, and a 39.4% unemployment rate when individuals who are unemployed and not seeking cash employment are counted as well.

Table 7-48 Employment in Nome, Alaska

Total Potential Work Force	2,547
Total Employment	**1,544**
Civilian Employment	1,535
Military Employment	9
Civilian Unemployed (And Seeking Work)	189
Percent Unemployed	11.00%
Adults Not in Labor Force (Not Seeking Work)	814
Percent of All 16+ Not Working (Unemployed + Not Seeking)	39.40%
Private Wage and Salary Workers	971
Self-employed Workers (in own not incorporated business)	0.94
Government Workers (City, Borough, State, Federal)	456
Unpaid Family Workers	14

*Source: 2000 US Census

Additional Local Economic Contributors

Several local construction businesses in Nome employ a total of 137 individuals. These businesses include the following: Anvil Construction, Edsearco Backhoe and Drilling Services, Miller Construction, Outsider's Construction Inc., and Pomeranz Construction.

During 2002, local business occupations contributing to the Nome economy rendered employment to 530 individuals. An additional 310 jobs were in the service sector, and 403 individuals were employed with sales or office work. In this sector, the largest employers in the Nome Census area were the Bering Strait School District with 567 employees and the Norton Sound Health Corporation with 420 employees. One hundred fifty-three people found jobs in production, transportation, and material moving; and 137 were employed in construction, extraction, and maintenance. Very few individuals cited farming, fishing, or forestry as their primary occupation. The numbers of jobs held in Nome for the main occupational categories is presented in Figure 7.29 Employment by Occupation, Nome, Alaska and Table 7-49 Employment by Industry in Nome.

Figure 7.29 Employment by Occupation, Nome, Alaska

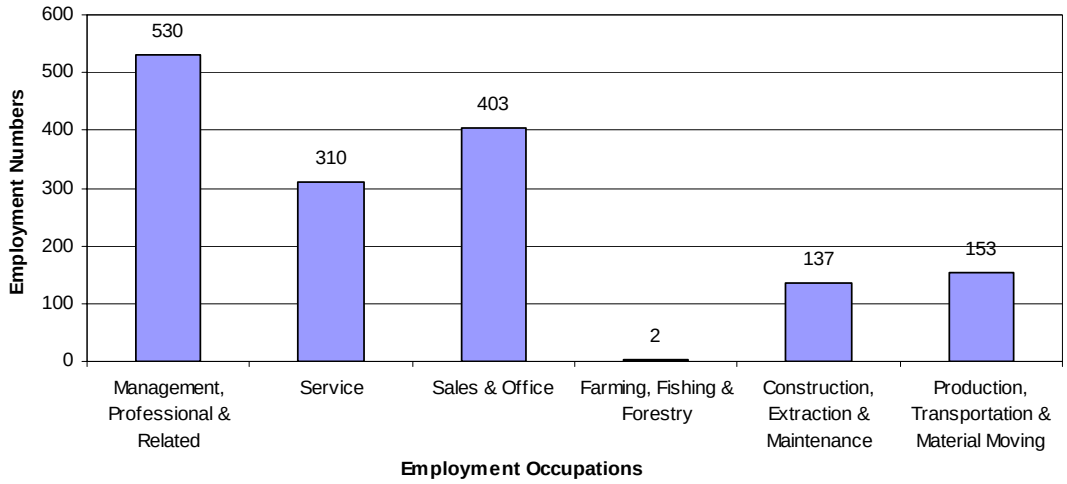


Table 7-49 Employment by Industry, Nome, Alaska

Agriculture, Forestry, Fishing and Hunting, Mining	36
Construction	55
Manufacturing	9
Wholesale Trade	3
Retail Trade	156
Transportation, Warehousing and Utilities	183
Information	53
Finance, Insurance, Real Estate, Rental and Leasing	40
Professional, Scientific, Management, Administrative andWaste Management	24
Education, Health and Social Services	474
Arts, Entertainment, Recreation, Accommodation and Food Services	170
Other Services (Except Public Administration)	109
Public Administration	223

*Source: 2000 US Census

Commercial Fishing and Hunting

Sixty residents held annual commercial fishing permits during 2000, according to the U.S. Census. However, according to U.S. Census statistics, only two individuals were employed under farming or fishing occupations during 2000; this confirms the State of Alaska's contention that U.S. Census data gathering in rural Alaska does not always yield accurate information. The commercial salmon fishing season for chinook and chum was closed by regulations because of poor runs in 2003 (ADFG, 2003). King crab harvesting also contributes to the economy. The Norton Sound Seafood Products processing center has made a significant contribution to the local economy by providing value-added products to the retail

market. Several other Nome businesses licensed to provide either fish and meat products or guiding services include: Teller Fish and Meats, Steve's Guide Service, Solo Creek Guide Service, Smitty's Fishing Service, and Alaska River Camps. Alaska's reindeer industry is centered in the Nome area. Historically, the local reindeer industry has added significantly to the local cash economy. During the 1990s, for instance, 15 herds were active producing nearly $1 million annually in economic contributions (Kawerak, 2003).

Government Services

Government services provide the majority of employment for residents, accounting for a total of 456 workers in the Nome area. Nearly 30% of Nome's workers were employed by the city, borough, state, or federal government during 2000.

Mining

Mining began in the Nome area in 1865, but it wasn't until 1898 that literally thousands of miners came to the region during the gold strike on Anvil Creek. That year yielded over $1 million dollars in the summer season. The discovery led to the construction of the Nome-Anvil Creek railroad in 1900. By 1902, the claims that were easily accessible to individuals without substantial equipment had been mined out, and larger mining companies with better equipment took over the area. Since the gold strike on Anvil Creek, Nome's gold fields have yielded a recorded $136 million. The gradual depletion of gold (and a decline in gold prices in the 1990s) contributed to the decline in population and available work in this sector since the initial discoveries. Several smaller gold mines continue to provide some employment opportunities in this sector. Today, the Nome District contains more than 17,000 acres (6,900 ha) of patented mining claims (Sparks, 1998). State of Alaska records indicate, and locals confirm, that in addition to Alaska Gold Company, the following mining operations were active in the 2004 season:

- Anderson & Sons Mining
- APP Mining
- Carlisle / Benchoff Mining
- Gumear Mining; Stout Mining
- Hanson Mining
- K&S Leasing
- Kelliher Family Mining
- Kralik Mining
- Krutsch-Johnson Mining
- N.B. Tweet and Sons
- Northcoast / Martinson Mining

- Outdoor Channel
- Pomerenke Mining

Other local businesses with mining operations in Nome include: Bering Straits Native Corporation, Chukchi Mining, Gray's Mining Company, Golden Glacier, Inc., Innovation Mining, McHenry Mining, and Sitnasuak Native Corporation.

Retail

Carved ivory and other Eskimo crafts are a significant part of the trade in Nome and provide a year-round income for many locals. Local businesses AC Value Center and Hanson Trading Company are important centerpieces of Nome's grocery and general merchandise industry. Other local retail businesses include: Alaska Goods, Arctic Trading Post, Anvil City Sporting Goods, Anvil Electronics, Builders Supply, Chuhotka-Alaska, Inc., Country Store, Fossil Ivory Sales, Foster Gun Company, Jorgensen ATV Repair, Maruskiya's of Nome, Lovell Toy Sales, and Webster Arts and Crafts, among others. Local restaurants and service providers round out the retail sector. Views of the AC Value Center and the Hanson Trading Company are presented in Figures 7.30 and 7.31 resepctively.

Figure 7.30 AC Value Center in Nome, Alaska

Figure 7.31 Hanson Trading Company in Nome, Alaska

Tourism

Tourism has increased in importance in recent years. Approximately 20,000 to 23,000 visitors are lured to Nome each year, largely due to its gold rush history (Nome Convention and Visitors Bureau). Forty-six percent of these individuals purchase a package tour and travel on major airlines; 17 percent are independent travelers. Exit surveys show that 84% travel to Nome for vacation and pleasure; 11% come to Nome for business and pleasure; and only 6% come for business purposes only. Nome's visitors spent $2.3 million in 1993. Local tour operators, hotels, bed-and-breakfast accommodations, restaurants, bars, retailers, and transportation providers all yield economic benefit from this market sector.

Most visitors spend less than one night in Nome, while the average stay in Alaska is 13 days (Alaska Tourism Marketing Council, 1999). During 2001, there were 10,449 total visitors to the Bering Strait region (Kawerak, 2003). Increasing the tourism industry in Nome would largely depend on reduction of high travel costs; expansion of annual activities; and improvement of accommodations, local businesses, and services. Additionally, the Nome Visitor Center is discussing plans to promote Nome as an emerging bird-watching destination, as well as promoting other potential tourism development opportunities. During summer 2003, four cruise ships of 100+ passengers docked in Nome; seven cruise ships are expected during the summer of 2004 (Kawerak, 2003).

Nome is the finish line for the 1,100-mile Iditarod Sled Dog Race from Anchorage that is held each March. It is known as "The Last Great Race on Earth," attracting participants and spectators from all over the world to race the 1,049 miles (1,688 km) from Anchorage to Nome. The sport is also popular throughout the winter and is used by many locals as a means of transportation for carrying supplies to and from areas without road access. Figure 7.32 presents the marker for the official end of the Iditarod Sled Dog Race, Nome Alaska.

Figure 7.32 Marker for the Official End of the Iditarod Sled Dog Race, Nome

Future Economic Development Prospects

In addition to the proposed Rock Creek Mine, Nome has several other relatively large projects on the near horizon at this writing.

The Norton Sound Health Corporation is building a new hospital. No net gain in hospital beds is anticipated. The current hospital facility will be used as a Quyana Elder Care facility.

The National Guard is building a new armory. The existing facility is scheduled for reuse by another entity.

The Bureau of Land Management is building a new Iditarod Race interpretive visitor center.

The school will undergo a major renovation.

DOT&PF will proceed with ongoing road improvements and a possible expansion to the airport.

Construction has begun on a new port and causeway.

The cost/benefit analysis for the new port project reported a strong 2.5 multiplier for the region. But this project is the exception among those that are creating a construction boom in Nome at present; all of the other projects are either replacement facilities or are expected to take advantage of staff resources that are already in Nome for the most part.

Goal 5 of the Nome Comprehensive Plan (NCP) is "Create economic opportunities for residents and businesses in Nome compatible with the local lifestyle." Specific objectives listed under this goal include:

Objective 5.1: Research strategies for attracting new industry and investment.

Action 5.1.2 Ensure that there are adequate land use areas for industrial and economic development.

Objective 5.5 Encourage resource exploration and development.

Action 5.5.5 Mining: sand, gravel, and gold.

The NCP's Goal 7 states "Allow growth to occur in a manner that protects the quality of land, water, air, open space, and critical habitats." Under this goal, specific objectives include:

Objective 7.2 Guide development to areas which will produce the least adverse impacts.

Objective 7.3 Protect existing open spaces, natural drainage patterns, and subsistence use areas.

7.9.2.3 Environmental Consequences: Economics

The potential economic consequences of the Rock Creek Mine, coupled with its satellite operation at Big Hurrah, should both be permitted to operate, would derive from the following factors:

- direct employment,
- indirect and induced employment,
- displacement potential,
- capital expenditures, and
- operating phase expenditures.

Employment at the mine will be approximately 130 full-time jobs for the currently identified 4 to 5 year life of the mine.

While it is not possible to accurately predict exactly how many of the jobs at the mine would be filled by Nome residents, by village residents, or by workers from outside the region, an estimate has been developed for purposes of this analysis. A strong local hire effort by the developer and the experiences of other large regional employers who recruit locally and within the region, combine to suggest that the local/regional/beyond-the-region distribution will likely yield:

- 42 mine workers who are already Nome residents,
- 69 mine workers from outlying villages, and
- 18 workers from outside of the region.

Detailed econometric modeling (which is beyond the scope of an Environmental Assessment or Environmental Impact Statement) of both Nome's local economy and the Bering Strait regional economy would be required to definitively determine the exact multiplier that will result from the introduction of 130 new jobs within the region. At the Fort Knox Mine, which is within 20 road miles (30 km) of the highly developed Fairbanks economy, the multiplier is 2.0; that is, for every new job that was introduced at the Fort Knox Mine, another new job was created in Fairbanks in order to adequately support the new jobs at Fort Knox. (McDowell Group, 2001.) On the other hand, in Delta Junction, which has a relatively underdeveloped service and support sector, the multiplier effect of the Pogo Gold Mine was only 1.3, that is .3 new jobs were created locally in Delta to support each new mining job at Pogo. (Baker Engineering & Energy, Inc., 2002). Easy access to the Fairbanks marketplace by Pogo mine workers resulted in far less induced employment in nearby Delta Junction.

Nome's remote location means that construction materials and heavy equipment must be imported from as far away as Fairbanks, Anchorage, or the Lower 48. These latter communities, in turn, become the locations that benefit from the dollars spent by the Rock Creek Mine developer/operator. While it is true that the manufacturing sector of the Nome economy is not well developed, the service and supply sectors that support existing mining

activity in the area are relatively well developed. Thus, it is safe to assume that this sector, coupled with the retail service and supply sector that would support the new employees and their families, would drive the local multiplier effect in Nome, conservatively, to 1.6. It is important to note that there is room in the Nome economy for even greater growth in the industrial service and supply sector that could support a mine the size of the proposed Rock Creek Mine operation. Two examples of retail sales income that currently flow directly out of the region are heavy industrial hardware and industrial tire supply; if local distributorships were established in Nome for these and other industrial supplies, the local multiplier effect could be raised approximately 0.1 to 0.2% higher. Based exclusively on the conservative 1.6 multiplier, the 130 new jobs at Rock Creek Mine would create an additional 78 jobs in the service and supply sectors. Almost all of these additional jobs (unlike the direct employment at the mine) would be in Nome, as opposed to other villages in the region. This would render the total new employment impact at 208 new jobs.

Because of the fact that both the 11% unemployment rate in Nome (compared to 6.5% statewide and 5.7% in the U.S) and the 17% unemployment rate in the Bering Strait region (Kawerak, 2003) are extremely high, the economic impact of 208 new jobs would have a significant positive effect.

Project operating costs for the Rock Creek Mine will average about $22 million per year. Eight and one half million of this total dollar amount will be spent locally in salaries and wages; the total economic benefit of $8.5 million in direct wages, when combined with the indirect and induced local expenditures, result in a total annual economic benefit in wages and salaries to the region of $13.6 million. In addition, an estimated 11.5% of the remaining $13.5 million in annual materials and supplies expenditures (or $1.5 million) will be spent by Alaska Gold within Alaska each year.

The comparative wage analysis is critical to analyzing the displacement potential of the Rock Creek project. Rock Creek salaries, with the exception of the one Mine Accountant/Controller position, do not fall above the mid-range of similar positions in western Alaska (Department of Labor and Workforce Development, Research and Analysis Section). This means that Nome and the Bering Strait region will be able to avoid the potential workforce displacement that is often termed the "Pipeline Effect"; that is, wages at the mine will not be inordinately high for the region which means that these new jobs would not likely have the potential to lure residents away from existing jobs that are critical to maintaining structure in communities. Thus, a potential negative impact is avoided.

Initial capital expenditures on construction of the mine are detailed in Table 7-50 below.

Table 7-50 Summary of Initial Capital Cost

Category	Cost ($ millions)
Infrastructure	1.7
Buildings and Support	2.5
Major Mining Equipment	10.4
Ancillary Support Equipment	1.0
Milling and Processing	16.5
Tailings	0.8
EPCM: Engineering and Procurement	1.1
Indirects	1.0
Owners Cost	2.1
Allowances	2.1
Total	**39.2**

Note: EPCM = _____???

Most of these construction materials, manufactured buildings, and equipment are not currently available for purchase through any existing business entity within the region; if local entrepreneurs do not grow the supply sector of the economy, then almost all of the economic benefit from construction phase capital expenditures will accrue to businesses both outside of the region and outside of Alaska. Alaska suppliers and distributors are currently in a position to capture an estimated $4.5 million (through portions of the infrastructure, buildings/support, ancillary support equipment, and indirect expenditures) of the total $39.2 million construction phase economic benefit; however, here too, both the direct economic benefit and the multiplier effect could be greater should the Fairbanks market stage itself to supply more of the equipment and materials needed for construction of the Rock Creek Mine.

7.9.3 Community Facilities and Services

7.9.3.1 Affected Environment

Health and Social Services

Nome is located in Emergency Medical System (EMS) Region 5A in the Norton Sound Region and is classified as a large town/regional center. The emergency services have limited highway, airport, and coastal access; therefore, most of the emergency and health care services are provided by either the 911 telephone service or volunteers.

Health care services within the Nome region are provided by primarily volunteer and nonprofit entities. Auxiliary health care is provided by the Nome Volunteer Ambulance Department and the Norton Sound Health Corporation. Hospital and health clinic services are provided at Norton Sound Regional Hospital, which is privately owned and City operated. The clinic was renovated in 1994 and is a qualified acute care facility that provides medevac

service. The hospital provides 34 beds (including those in nonparticipating or nonlicensed areas), and 19 beds that are totally certified. The range of care includes five full-time on-staff physicians, one dietician, one inhalation therapist, one licensed practitioner nurse, and 65 other salaried personnel. There are 12 registered nurses and two registered pharmacists on staff. Additionally, Nome has one outpatient clinic, two dental clinics, one eye clinic, one pharmacy, and one chiropractor. Acute renal dialysis, anesthesia, radiology, and alcohol and/or drug services are provided under contract at the hospital. The average cost for a hospital room in Nome is $878, nearly 22% higher than a hospital room in Anchorage, and 63% higher than a hospital room in Atlanta, Georgia. A view of the Norton Sound Regional Hospital is presented in Figure 7.33.

Figure 7.33 Norton Sound Regional Hospital, Nome Alaska

Special Care Facilities

The only long-term care facility in Nome is the Quyaana Elder Care Center. Norton Sound Community Mental Health Center is another care facility within Nome in addition to Saquigvik, a turning point and transitional living facility available for special care services. The Nome Senior Center rounds out the local profile of special care services.

Child Care, Family, and Youth Services

Nome Child Care Center funds child care and youth services through a variety of businesses. Child care service providers in Nome include: All My Children, Children and Elders Special Advocacy Services, Debra's Home Care, Elsie's Care Home, Granny's Child Care, Horton's Daycare, Jamie Kyle's Daycare Home, Little Saints Daycare, Lois McManus Daycare, Marie's Child Care, Mini Start Daycare, Minnie A. Tucker, Njels Daycare, Nome Daycare, Paukan's ABCs and 123s, Paniataaq's Place, Pooh's Corner Childcare, Quizuna's Day Care, Tender Care, Tina Weyiouanna, Uncle Sam's, Wee Care, and Yvonne's Child Care. A view of Nome Child Care is presented in Figure 7.34

Figure 7.34 Nome Child Care Center

Mental health services, a safe home program, an alcohol rehabilitation center, and alcohol treatment community services are provided in Nome. Additional community assistance programs include village health services, water quality services, environmental health services, and an infant learning program. Several family and household assistance programs are available through the State of Alaska, including: Alaska Temporary Assistance Program (ATAP); welfare-to-work services; food stamp program adult public assistance (APA); heating assistance program (HAP); and general relief assistance (GRA).

The Nome Comprehensive Plan, Phase I, states as its eighth goal: Coordinate with health and social service agencies to provide adequate health and social services to Nome area residents.

The Nome Comprehensive Plan states in Objective 3.7, "Ensure that the Police Department, Nome Volunteer Fire Department, Nome Ambulance Department, and Search and Rescue have adequate resources to provide for the safety of Nome and area residents."

Mail and freight arrive Monday through Saturday in Nome. Mail is sorted at a U.S. Postal Service mail processing annex. The Nome Comprehensive Plan speaks to this public service in Action 5.7.2, "Pursue potential freight or mail hubs for the region."

Education

There are six schools located in the Nome City School District, attended by 739 students. Forty-eight teachers are present in Nome, yielding a student/teacher ratio of 15.2. Nome has a dropout rate (grades 9-12) of 1.2% and has an average expenditure of $8,424 per student (FY 2001). The geographic cost differential multiplier for residence in Nome is 1.16. The schools range in size from nine students at a pre-school to 401 at the high school. Private schooling is offered through the Seventh Day Adventist Church for grades 1 through 9, with a total of 40 students taught by three teachers.

From 1990 to 1998, the Nome Public Schools increased by 30 students. High school education attainment for the Bering Strait Region, however, lagged behind both the state and national averages. In fact, 34% of the region's total population lacks a high school diploma. However, nearly 75% of the population 20 years and older within Nome has a high school diploma. A list of the schools in Nome is presented in Table 7-51 below.

Table 7-51 Schools Located in Nome

Nome School District School Name	Grades Taught	Number of Students*	Number of Full-time Teachers*
Anvil City Science Academy	5 thru 8	44	2.5
Nome Elementary School	P thru 6	373	19
Nome Youth Facility	9 thru 12	10	1
Nome-Beltz Jr./Sr. High School	7 thru 12	341	20

*Current as of October 2004.

Within the Nome Comprehensive Plan is Objective 13.1, which states, "Coordinate with Nome Public Schools to strategize improvements to the educational system, including the curriculum used in the schools."

Fifteen instructors teach 500 students at the University of Alaska Fairbanks, Northwest Campus, in Nome. It is located at the east end of town and maintains a conference room and three classrooms available for meetings and breakout sessions. Additionally, the campus has audio conference bridges and media equipment available on a rental basis. A view of the Northwest Campus, University of Alaska, Nome, Alaska is presented in Figure 7.35

The Nome Comprehensive Plan states in Objective 5.9, "Support expansion and promotion of the Northwest Campus of the University of Alaska Fairbanks." It also addresses vocational training in two objectives:

- Objective 5.8, which states "Support the human resources of the region with training programs that promote workforce development."
- Objective 13.3, "Facilitate the establishment of a regional training center in Nome for the Bering Strait area."

Figure 7.35 Northwest Campus, University of Alaska, Nome, Alaska

Parks and Recreation

The Nome Recreation Center has a meeting capacity of 700 and banquet space for up to 650. The center is used regularly for conventions, trade shows, banquets, performances, and other large functions. There is an adjoining multipurpose room available for exhibit space or breakout sessions. Additionally, the Recreation Center has a kitchen, small restaurant, 9,000-square-foot (840-square-meter) gymnasium, two racquetball courts, a bowling alley, and a game room. A view of the Nome Recreation Center is presented in Figure 7.36.

Figure 7.36 The Recreation Center, Nome, Alaska

The Bering Land Bridge National Preserve is located near Nome and is only accessible by float/ski plane, small boat, dog sled, or snowmachine. The park offers hiking, backpacking, hunting, fishing, and boating during summer months and skiing, dog sledding, snowmachining, and cross-country skiing during the winter. (National Park Service).

Additional facilities are used for public gatherings in the community. The Mini Convention Center, which is located within walking distance of downtown, has banquet space for 200, meeting space for 250, as well as two adjoining conference rooms. The Pioneer Igloo is a two-story turn-of-the-century-style building that seats 250 people and maintains a full kitchen on the main floor; it is used for exhibits, displays, or musical performances. Old St. Joseph's

Hall, seating 140, is a restored turn-of-the-century church now used for community services, meetings, trade shows, catered dinners, performances, weddings, and receptions.

Community goals and objectives related to recreation are abundant in the recently adopted Nome Comprehensive Plan. Some of these follow.

Goal 2: Enhance the quality of life in Nome.

Objective 2.10 Actively pursue grants that will increase the quality of life in Nome through more recreational facilities, environmental restoration, enhancements, or access to subsistence resources.

Goal 4: Guide the use of land in a manner that provides for orderly and efficient community growth, including adequate opportunities for recreation.

Action 4.10.4 Develop a land use plan for City properties outside municipal boundaries, including Sunset Firing Range.

Goal 9: Increase recreational opportunities for all user groups.

Included under Goal 9 (above) is a series of four programmatic objectives supported by 24 specific action directives for the community, thus demonstrating the community's commitment to enhancing recreation in Nome.

Public Utilities

7.9.3.2 Water and Sewer

Public infrastructure, such as piped water and indoor plumbing, are a rare commodity in most of Alaska's rural communities. In 1990, of the 2,371 homes in the Norton Sound region, 86% (2,039) lacked complete plumbing facilities (U.S. Census Bureau, 1990). However, this percentage does not hold true in Nome. Today, 95% of the homes in Nome have complete plumbing where sewage is piped away from the home; however, some residences still haul their own honeybuckets (haul service is not provided) and have water delivered to home tanks. Major expansion of sewer and water lines was completed in 1984, accommodating an additional 1,500 people not accounted for on the previous system. Additionally, the sewer/water lines in the Icy View Subdivision were installed in 1995. Current sewage treatment has been converted from anaerobic digestion in a lagoon system to a more updated aerobic digestion system. Three wells at Moonlight Springs serve as the primary water source for the community. The water undergoes treatment at the Snake River Power Plant and is stored in a 1-million gallon tank. An additional million-gallon tank downtown is also available for backup use. The water is heated and pumped to residences through a direct buried sclaircore piping network that replaced a 1960-era wooden utilidor. Another option for more remote residences is water delivery. Nome Joint Utilities System (NJUS) completed a 6-phase construction upgrade in 2003, including drilling of additional wells at Moonlight Springs and construction of an underground utilidor replacement with arctic piping. Other

projects within NJUS' 5-year planning horizon include replacement of the pumping station and water storage tank, and development of a water source closer to town.

A separate section of the comprehensive plan is devoted to the Nome Joint Utilities System. It contains:

- Objective 12.1 Coordinate with NJUS to continue providing utilities to the Nome area.
- Action 12.1.1 Participate in preparation of a NJUS Master Plan.

However, the importance of public utilities to residents of this rural community is evident in the number of additional references to the provision of additional utilities in the rest of the comprehensive plan:

- Objective 2.7 Extend NJUS water, sewer, and electrical services to all residential areas.
- Objective 3.4 Extend city water and sewer as warranted by local conditions and resident preferences.
  - Action 3.4.1 Link the extension of public services to land use developments.
  - Action 3.4.2 Adopt a NJUS Master Plan.
- Objective 3.5 Expand electrical service into areas not currently provided with electricity.
- Objective 4.10 Develop a land use plan for City properties outside the municipal boundaries, including Moonlight Springs.

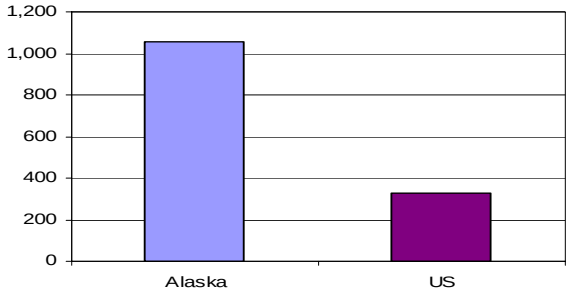
7.9.3.3 Solid Waste

Refuse collection services are provided by a private contractor and refuse is hauled to the local Class 2 Nome landfill for a cost of $17.25 per month. The landfill is located on Beam Road within Nome. The Green Star, Inc., nonprofit organization has a branch in Nome, which works with local businesses to incorporate waste reduction, energy conservation, and pollution prevention techniques into their business plans.

7.9.3.4 Energy

In 1990, the national average for energy consumption was 326 million British thermal units (BTUs). As a result of long, cold winter seasons, Alaska uses 1,058 million BTU's per year, nearly triple the national average, making it number one in the nation for energy consumption (Kawerak, 1999). Electricity services are offered through NJUS for an average cost per day of $0.15 per kilowatt hour. NJUS produces 60% of the energy in the Nome census area (Kawerak, 2003). Other primary heating sources in Nome include the following: bottled, tank, or liquid propane gas; and coal or coke. Alaska's Energy Consumption per person in 1990 is presented in Figure 7.37

Figure 7.37 Alaska's Energy Consumption per Person in 1990 (in million BTUs)



7.9.3.5 Communications

Throughout the Bering Strait Region, data transfer and communication technologies were not installed until 1995 when earth station and T-1 frame relay circuits were established in Nome (Kawerak, 1999). In-state phone service is through the Mukluk Telephone Company/TelAlaska ($26/month business rate, $20/month residential), with AT&T Alascom and GCI as long-distance providers. GCI and Nome.net offer internet service within Nome. A competitive wireless infrastructure that will allow further internet connectivity among the region's remote villages is currently being planned (Kawerak, 2003).

Three television stations can be received in most Nome households: ARCS, KUAC, and KYAC. Additionally, Nome has three video rental businesses and a weekly newspaper, The Nome Nugget. Anchorage and Fairbanks daily papers arrive by plane with a half-day delay. Radio stations include KICY-AM/FM and KNOM-AM/FM, and GCI provides cable services with 49 channels. Teleconferencing is available through Alaska Teleconferencing Network and through the Legislative Information Office.

7.9.3.6 Environmental Consequences: Community Facilities and Services

The incremental service burden imposed on local and regional community services and facilities (other than housing, which is discussed in detail in Chapter 6 of this document) by the proposed mine project would appear to be marginal. This is attributable to the fact that a large majority of the mine employees will be recruited from within the region. Specifically, interviews with other large employers in Nome, coupled with Alaska Gold's documented commitment to hire from within the region to fill most job descriptions, suggest that the breakdown will approximate the following:

- 42 mine workers who are already Nome residents,
- 69 mine workers from outlying villages, and
- 18 workers from outside of the region.

It is not expected that the workers coming from the unemployed population within the region will add any burden to the health and social service infrastructure – again, with the exception of some additional pressure on the housing market. In fact, it is expected that providing this

level of unemployment relief to the region's population will lessen the demand for multiple health and social services. Experience among regional employers in this area suggests that of the 69 workers that come in from the outlying villages, most if not all of them will choose to either stay with relatives or rent apartments during their on-shift in Nome and then return to their families in their own villages in between their on-duty shifts. Thus, the mine workers recruited from outlying villages are likely to wield measurable impacts in three areas in this sector: health care, education, and utilities.

Health and Social Services

Impacts on the health and social service sector will be felt when villagers seek health care services from the facilities in Nome rather than waiting to see the health care providers in their own village clinics. A new hospital will be completed in 2006 but it will replace services already provided by the existing facility with updated infrastructure, rather than adding net new capacity to the health care system. Thus, demand for hospital services by the mine employees who are recruited from villages within the region will likely increase slightly. Statistically, demand for health and social services by the 18 new employees from outside the region and their families is likely to be relatively low, given the age and economic status of those employees with specialized and/or management skills that must be recruited from outside the region.

Education

The anticipated 18 workers that come from outside of the region will likely bring with them an estimated 20 new students to enroll in the Nome City School District. A recent interview with the Nome City School District Business Manager suggested that an average of one student per family can be expected to accompany a professional worker moving to Nome. Thus, for purposes of this analysis, it is projected that a conservative total of 20 new students may enroll in the Nome City School District as a result of new Rock Creek employees. This number of new students is not expected to significantly impact the school district; Nome City schools have assimilated an additional 29 students over the past 6 years without disruption.

Utilities

Demand on the NJUS will increase as a result of the Rock Creek mine project. Two factors will contribute to the increased demand: the increase in housing market demand, and the need for power at the mine site. Residential demand will drive the need for upgrades to existing power lines. Proposed new subdivisions will be served by the existing power grid, but will need upgrades.

The need for 9-11 megawatts of power at the mine site will require 1) installation of a new 25 kV power line from the NJUS power plant in town to the mine site approximately 3 miles west of town, and 2) a step-up transformer at the NJUS generating plant in town. In addition, a new power line will need to be installed along the Glacier Creek Bypass Road to the mine site.

Power to the Big Hurrah Mine facilities plant will be provided by a diesel-electric generator sufficient to provide ample power for a shop, office and water handling facility.

7.9.4 Transportation

Nome serves as a regional transportation hub for 15 villages on the Seward Peninsula.

Air Traffic

The most reliable and common mode of year-round transportation throughout the Bering Strait region is air services. Although Alaskans comprise only 2% of the nation's population, Alaskans use 13% of all commuter airlines and air taxi trips in the U.S., including commercial goods shipped via air freight. Residents, consequently, use airlines 65 times more often than the average U.S. citizen (ADOT&PF, 1997). There are two state-owned airports in the Nome area to accommodate the large demand on the airports. The Nome Airport has two paved runways, one 6,000 feet (1,830 m) in length and the other 5,500 feet (1,676 m). There is also a 1,950-foot-long (600 m) gravel airstrip referred to locally as "City Field". Nome is one of three surrounding communities that has runways 4,500 feet (1,370 m) or longer. The most common type of aircraft in the region are small, single- or twin-engine commuter airplanes. Scheduled jet flights are available to and from the Nome Airport, as well as charter and helicopter services. Airline service in Nome is available through the following companies: Alaska Airlines, Frontier Flying Service, Arctic Transportation Service, Baker Aviation, Bering Air, Cape Smythe Air Service, Grant, Hageland, Olson, Evergreen Helicopters, Lynden Air Cargo, and Northern Air Cargo.

Regional Roads

No road system connects Nome to any of Alaska's major cities; however, this area does contain more roads than any other rural location in Alaska. There are three main roads leaving Nome: Nome to Teller (73 miles [117 km] west); Nome to Council (72 miles [116 km] east); and the Taylor Highway, which extends 83 miles (134 km) north from Nome.

Local Roads

A relatively small grid system of seven east/west collectors and about 17 north/south local roads provides interconnections within downtown Nome. Seventh Avenue, or "Bypass Road" as it is called by locals, runs along the northern perimeter of town and allows direct transport from the port or the airport on the west end of Nome all the way to the eastern edge of development in the community.

Glacier Creek Road can be accessed off Bypass Road; this dirt road provides important industrial and recreational linkages for Nome residents and resource developers. Glacier Creek Road traffic is composed of: 1) placer mine operators and workers; 2) Native corporation shareholders and nonshareholders going to leased campsites; 3) Native corporation shareholders involved in subsistence activities (primarily berry picking and hunting) south of Rock Creek; 4) tourists and tour group operators; and 5) local residents on recreational or sightseeing outings (R&M Consultants, 2003). Improvements to the road that will lessen environmental impact and improve access and annual maintenance concerns are expected by 2005. Public testimony at a Alaska Department of Transportation and Public Facilities hearing regarding Glacier Creek Road suggested that the traffic volume on Glacier Creek Road is 30 to 40 vehicles per day during the peak summer season travel period. During

summer months, it is common to see heavy equipment along the road south of Rock Creek. This narrow, winding portion of the road lacks shoulders and is considered to be the most dangerous part of Glacier Creek Road (R&M Consultants, 2003). Additionally, a spur road off the Taylor Highway leads to the old Pilgrim Orphanage, which is the site for the peninsula's most accessible Hot Springs (Kawerak, 1999).

During the winter, the only maintained road system around Nome is the area directly in town. However, with a dog team, mushers can access winter recreational cabins and other nearby villages on established mushing trails.

Vehicles

Several taxi companies provide transportation service in town: Checker, Nome Cab, Gold Rush, and Alaska Cab. Additionally, there are several car rental companies: Budget, Stampede and Bonanza. Privately owned snowmachines, all-terrain vehicles, dog sleds, trucks, and automobiles are the primary modes of land transportation in this area. All-terrain vehicles and snowmachines are treated very similarly to automobiles, given their use to haul drinking water, food, trash, and hazardous waste materials. Additionally, they are utilized for hunting, trapping, fishing, and for visiting and bartering with other communities (Kawerak, 1999).

Port

Community residents along the coast use rivers and coastlines as important transportation routes during summer months (Kawerak, 1999). Residents frequently use boats with outboard motors to travel to fishing, hunting, and whaling camps. Nome Harbor contains an entrance channel and an inner harbor with berthing facilities. These facilities are annually dredged to an 8-foot (2.4-m) depth. Nome's Port Facilities have a 2,700-foot (820-m) causeway with offloading and berthing facilities available for use, accommodating vessels with up to 18 feet (5.5 m) of draft. Designed and built for 400-foot-long (120-m-long) cargo and petroleum offloading vessels and cruise ships with embarkation and disembarkation, the facilities maintain an average water depth of 20 feet (6 m). Marine freight to the Bering Strait Region is seasonal, but still offers a good way to haul bulk goods and materials and offers a more economic solution to hauling freight than air travel. Goods such as gasoline, heating oil, canned and dry goods, construction equipment, automobiles, boats, snowmobiles, and houses are transported via marine freight services after the ice breaks up in late May (Kawerak, 1999).

A 3,350-foot-long (1,020-m-long) sea wall of granite boulders surrounds Nome on its seaward side, protecting it from large waves and high tides. Costing over a million dollars, these huge rocks were trucked in from Cape Nome, spanning a total distance of 13 miles (21 km). Currently, the U.S. Army Corps of Engineers is designing a new entrance and breakwater harbor channel. Additional future improvements include City-funded harbor dredging, two seasonal floating docks, and a boat launch.

The Transportation section of the Nome Comprehensive Plan begins with the following goal statement: Promote a well-designed and safe transportation system within and serving Nome

in order to support business, industry, and residents' needs and Nome's growing tourism industry. It is supported by the following objectives.

Objective 11.1 Actively pursue that Nome and the surrounding region receive sufficient and appropriate share of ADOT&PF transportation funding.

Objective 11.2 Seek ADOT&PF funding for TRACK projects.

Objective 11.3 Support transportation improvements to and within Nome for various modes of travel including automobiles, pedestrians, and all-terrain vehicles.

Objective 11.4: Provide for the efficient and reasonable transport and transfer of airplane passengers and cargo.

Objective 11.5 Provide for the efficient movement of cargo at the Port of Nome.

7.9.4.1 Environmental Consequences: Transportation

The Rock Creek Mine and its satellite operation at Big Hurrah will employ a total of 130 people. It is anticipated that six of these people will work in Nome proper and therefore will not make a daily round trip to the mine site. Eleven of these employees will be management personnel who will each make one round trip between town and the mine site an average of six days per week. The remaining 113 will be divided into four crews with rotating on/off schedules.

The traffic effect per day generated between town and the Rock Creek mill site will be two 26-person crews. In the most impactive scenario, each person could result in one round trip per day between the mine site and town. This impact does not take into account any mitigation that may occur as a result of carpooling, the initiation of a van transportation service by the local business community, or busing. In addition, an estimated three medium trucks and two large trucks per hour would be expected to make trips to and from the mine site each hour.

It is important to note the potential public safety impact implied by the mine traffic that will pass by the public high school on a rural collector (classification) road. While some students are bused to school, others walk, bike, or snowmachine to school from residential areas that require crossing the road that would be carrying the increased traffic to the mine. If timed strategically, this potential impact could be avoided by setting the 12-hour mine work shifts such that they would not interfere with the typical 7-to-9 hour school day.

In addition, at this stage in the mine planning process it is anticipated that the satellite operation at Big Hurrah will operate 12 months per year and include two ore trucks hauling loads 24 hours per day, seven days per week, in 90-minute round-trip cycles. For three to four months per year there will be a crew van going to the property and returning each day. The occasional truck will carry supplies to the mine site from town and/or the airport or port. In addition, minimal unscheduled pickup truck traffic will travel back and forth with emergency repair parts, staff, etc. Employee traffic could range from 40 personal vehicle trips

between Nome and the Big Hurrah site 50 road miles (80 km) south of town at the most impactive, to two personnel bus round-trips per day at the least impactive.

7.9.5 Local Government Organization, Powers, Finances

7.9.5.1 Affected Environment

Local Government Organization

Unlike that in the Lower 48 states, Alaska law provides for a variety of local government organizational options to accommodate the wide range of social, cultural, political, and physical environments that comprise this state. The result is a mixture of local government and other community, regional, and tribal organizations operating under separate authorities (Department of Community and Economic Development).

City and borough municipal governments provide services to community and regional locations, respectively. City governments are municipal corporations and political subdivisions of the state that generally encompass single communities. Services and powers are intended to be provided on a regional basis through organized boroughs, which are larger than cities. (Department of Community and Economic Development)

Alaska's Constitution requires that the entire state be divided into boroughs, organized or unorganized. As a result, a large portion of the state that has not incorporated as an organized borough is designated "the unorganized borough." Nome is one of the many communities that do not fall within an established, organized borough in Alaska; thus, Nome is in the Unorganized Borough.

The Municipality of Nome is organized as a first class city under Alaska Statute, Title 29, and as such has regularly elected and appointed officials. Table 7-52 shows the breakdown of government positions within the City of Nome, Alaska.

Table 7-52 Local Government Organization, City of Nome

Job Title	Number of Positions
Mayor	1
City Council	6
School Board	5
Planning Commission	6
Assessor	1
Attorney	1
Administrative Assistant	1
City Clerk/Treasurer	1
Controller	1
Fire Chief	1
Manager	1
Museum	1
Police Chief	1
Port Director	1
Recreation Director	1
Superintendent of Schools	1
Utilities Manager	1
Visitor Center Director	1

*Source: Department of Community & Economic Development

Municipal Powers

The City of Nome is a first class city government in the Unorganized Borough. The two fundamental units of municipal government within Alaska are: 1) cities and 2) organized boroughs. Both act as political subdivisions and municipal corporations within Alaska. The Unorganized Borough has not incorporated a borough form of government or county equivalent. The Unorganized Borough is not a municipal corporation or political subdivision of Alaska, but is an instrumentality of the State…a unit of state government (Bockhorst, 2000).

Nome is located within the Bering Strait Regional Education Attendance Area; however, educational services are not the responsibility of the local public, because of Nome's status as a first class city (Bockhorst, 2000). Although Nome is located within the Bering Strait Coastal Resource Service Area (CRSA), the city has been excluded from that CRSA, which

would have allowed it to recommend for state approval a coastal management plan for the area within the boundaries of the CRSA (Bockhorst, 2000).

Nome Municipal Finances

Nome incorporated in 1901 as a first class city. Located in the Cape Nome Recording District, it encompasses 12.5 square miles (32.4 square km) of land and 9.1 square miles (24 square km) of water valued at $203 million, according to a 1996 property assessment. According to state law, $85 million worth of that property is exempt from taxation and $118 million is taxable. The remaining $23 million falls in the personal taxable category. The City maintains an area-wide 12.6 mill property tax and a 4% accommodation tax. In addition, Nome has a 4% sales tax. All land in the Bering Strait Region is owned by one of the following entities: the federal, state, or municipal governments; Native corporations; Alaska Native tribes (conveyed through the 1971 Alaska Native Claims Settlement Act); individual Native allottees (through the 1906 Allotment Act and the 1926 Township Act), or other private sector land owners subject to municipal taxation by the City. With more than 14,000 acres (5,700 ha) of land holdings locally, Alaska Gold Company, Inc. is the single largest private sector landowner in or near Nome.

The approved 2001 municipal budget for the City of Nome was $23 million; $6.9 million of that revenue came from enterprise funds, $6.2 million came from education funds, $5 million from taxes, and $2.5 million from other state and federal revenue. Revenue distribution is shown below in Table 7-53.

Table 7-53 Nome Municipal Budget, Year 2001

Revenues (in $000)	2001
Taxes	5,004,339
License/Permits	449,357
Service Charges	641,896
Federal Operating	10,114
State Revenue Sharing	131,307
State Safe Communities	87,463
Other State Revenue	45,175
State/Federal Education Funds	6,210,083
Other State and Federal Revenue	2,357,658
Other Local Revenue	1,032,673
Enterprise funds	6,995,939
Total Revenues	**22,966,577**

Source: Alaska Department of Community and Economic Development
Research and Analysis Section

A significant decrease in municipal revenue sharing funds from the state level to the municipal level of government has caused many Alaska municipalities to panic over the past five years. A review of Nome's municipal budget shows a variety of revenue sources, many of which are generated locally. While the loss in coming years of what was almost $2.4 million "other state and federal revenue" in 2001 will certainly be felt by Nome. It has already taken much local responsibility for operating its own local government services.

The city expenditures for 2001 totaled $18.2 million, with the largest amount ($7.8 million) geared towards education. The city's budget for education during 2001, however, was only $6.2 million. The city used $1.6 million more on education than was budgeted. Nome had no expenditures during 2001 for council/assembly, planning/zoning, ambulance, roads, ice roads, refuse/landfill, phone utility, or the clinic/hospital. Electric utility and other public works ranked as the second- and third-highest Nome expenditures, at $3 million and $2.5 million, respectively.

The Municipal Government section of the Nome Comprehensive Plan includes Objective 3.8: "Investigate expanding the City municipal boundaries to encompass developed land contiguous to municipal limits." Under this objective is Action 3.8.1, "Identify appropriate areas and proceed with state process."

7.9.5.2 Environmental Consequences: Local Government

The primary impact in the municipal finance sector would be a result of local government taxation of 1) new residential development and 2) increased personal spending, driven by the Rock Creek Mine project employment and spending levels.

According to the assumptions contained in the housing market analysis in Chapter 6 of this document, it is feasible and necessary that approximately 27 new housing units be constructed in Nome in order to accommodate the increased demand for housing that will accompany the development of the Rock Creek Mine project. Assuming an average new home value of $280,000 (see Chapter 6) in this remote and highly subsidized housing market, the net new property tax revenue to the City of Nome at the existing mill rate of 12.6% would be $952,560 per fiscal year.

As noted in the economic analysis contained in Chapter 2 of this report, $8.5 million will be spent locally by Alaska Gold on the Rock Creek project in salaries and wages; the total economic benefit of $8.5 million in direct wages, when combined with the indirect and induced local expenditures, result in $13.6 million in annual wages and salaries to the region. Forty-six percent of this economic effect will be realized by wage earners living full-time in Nome. This could result in approximately $6.256 million worth of expenditures in the municipality of Nome. Typically in a remote economy like Nome's, approximately 40% of these expenditures, or $2.502 million, would be in the retail sector and thus would be subject to the local 4% sales tax. Thus, the net increase in municipal revenues would equal an average of approximately $100,096 per fiscal year of mine operation. In addition, it is assumed that the daily living expenditures by the 54% of the Rock Creek work force from the villages would spend no more than 20% of their salaries and wages to purchase taxable local goods and services in Nome during their work shifts. In other words, of the total salaries and

wages earned by regional residents renting in Nome, coupled with the indirect and induced effects of these earnings ($7.344 million), only 20% ($1.468 million) would likely be spent on local goods and services subject to Nome's 4% sales tax. This would result in an additional $58,752 annually in municipal tax revenue to the City of Nome. Thus, the total estimated municipal tax revenue generated by Rock Creek Mine project direct and indirect employment and induced effects is predicted to be $158,848 per year of mine operation.

The fact that Rock Creek Mine and the Big Hurrah satellite operation are both located outside of the municipal boundary of the City of Nome means that no new tax revenues would be generated directly from the mine operations.

7.9.6 Housing

7.9.6.1 Affected Environment

Substandard housing conditions exist throughout most of Alaska. Rural Alaska is in need of new housing development because of the deterioration of marginal homes. Many of the homes in Nome were hastily constructed during one of the community's several boom cycles, and have not fared well in the long run given the arctic conditions. Much of the housing stock is reaching the end of its useful economic life. Constructing new homes, however, involves costly construction in an economy that does not have the economic access to affordable building materials that the state's more urban areas do (AHFC, 1995). Cold temperatures, alternative plumbing systems, and the presence of permafrost also contribute to the high construction costs (Kawerak, 1999). Rural Alaska also has a lack of competition among suppliers which nearly doubles the cost of construction materials in rural parts of the state.

The availability of low-interest mortgage loans from the state-founded Alaska Housing Finance Corporation created explosive growth in the demand for and construction of apartments, condominiums, and single family dwellings between 1981 and 1985 in Nome, as it did in the rest of Alaska. However, new housing construction slowed in the latter part of 2000 due in large part to a significant rise in construction costs. This condition continues to depress the Nome housing market. Currently, market prices of single family homes have reached a level that provides insufficient profit for local builders to speculate on new construction. According to the 2000 U.S. Census, the homeownership rate in the Nome region was 58%, reflecting the housing shortage that exists within the community.

An example of existing housing along the waterfront in Nome is presented in Figure 7.38.

Figure 7.38 Multi-family and Single Family Homes near the waterfront in Nome

Existing Housing Stock

The housing stock in Nome was studied by 1) on-site reconnaissance, 2) interviews with local builders, realtors, and housing providers, 3) study of photographs and maps, and 4) a statistical review of all local, state, and federal assessments of the Nome housing stock. Many housing units in Nome are considered substandard and include many units of subsidized housing in various conditions of repair. The median age of the housing stock in Nome is 34 years.

Construction Costs

Compared to Juneau, Anchorage, Kenai, Wasilla, Sitka, Fairbanks, Kodiak, Bethel, and Barrow, Nome has the second highest housing Construction Costs (Alaska Department of Labor). The cost of housing in Alaska is directly related to the transportation costs, with rural sites tending to have the highest costs (AHFC, 1995). Additionally, high housing costs in Nome are associated with the few suppliers in rural Alaska, and high freight costs. Numerous estimates from local builders, realtors, and housing providers indicated that construction costs currently range from $140 per square foot ($1,500 per square m) to $166 per square foot ($1,790 per square m) for residential construction.

During 1990, 57% of the homes in the Bering Strait Region were owner-occupied. Residential housing is available for both sale and rent in the Nome area, however rental units are limited during the summer season. During 2000, 654 people resided in renter-occupied homes while only 530 resided in owner-occupied homes. A 2002 survey showed 58.1% of the population owning homes and only 41.9% in rentals, a large decrease from 2000 (Kawerak, 2003). The average rent paid in 2000 was $939, compared to the much lower average in 1990 of $665. Table 7-54 below shows the housing characteristics in Nome.

Table 7-54 Housing Characteristics, Nome, Alaska

	2000 Census	1990 Census
Total Housing Units	1,356	1,334
Occupied Housing (Households)	1,184	1,119
Vacant Housing	172	215
Owner-occupied Housing	530	487
Median Value Owned Homes	$110,600	$79,900
Renter-occupied Housing	654	632
Median Rent Paid	$939	$665
Average Household Size	2.79	2.9
Family Households	750	751
Non-family Households	434	368
Population Living in Group Quarters	202	30

*Source: 1990, 2000 US Census

Table 7-55 shows the number of housing structures in Nome during both 1990 and 2000. Single family detached homes are most prevalent with a total of 750 structures.

Table 7-55 Housing Structure Types, Nome, Alaska

Housing Type	2000 Census	1990 Census
Single Family (Detached)	750	766
Single Family (Attached)	27	22
Duplex	98	130
3 to 4 units	207	152
5 to 9 units	104	106
10 to 19 units	120	66
20+ units	5	26
Trailers/Mobile Homes	57	45
Boats/Other Types	0	21

*Source: 1990, 2000 US Census

The second largest group by structure type is 3 to 4 unit complexes with a total of 207 counted during the 2000 Census, an increase of 55 units from 1990.

Apartment rentals are in very short supply in Nome. The vacancy rate is under 3%. A vacancy rate under 5% is considered a shortage. Perhaps because of the limited housing rental options, hotels and bed and breakfast accommodations within Nome are fairly abundant, given the 180 available units in Nome. Rental rates are presented in Table 7-56 below.

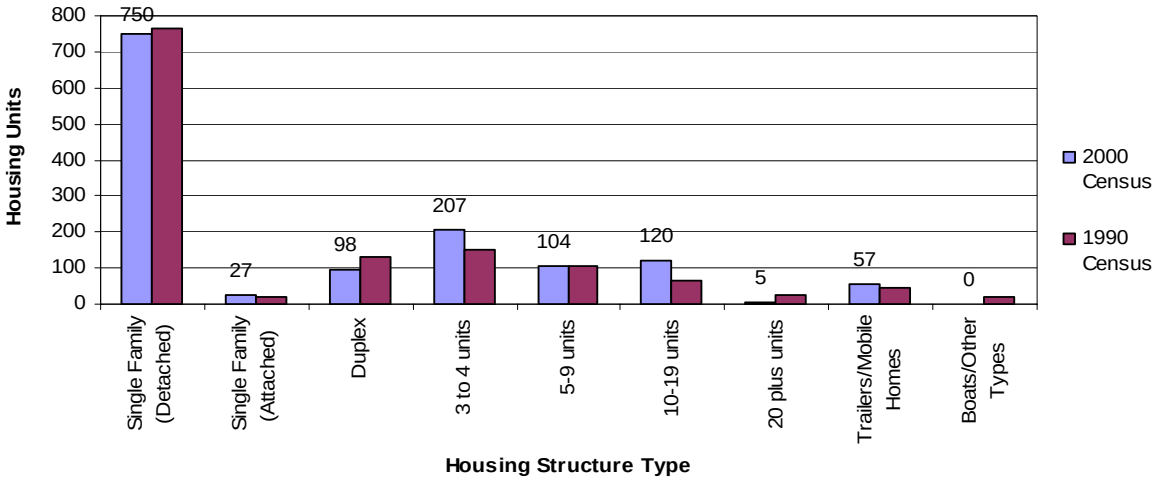
Table 7-56 Housing Rental Rates, Nome

	Rental Cost
1-Bedroom Apartment	$500-$850/month
3-Bedroom Apartment	$1,000-$1,500/month
3-Bedroom House	$62,000-$180,000/month

Source: City of Nome

Housing density levels within the Bering Strait Region exceed both the state and national levels, probably because of the number of children born per household, extended family member residence, and high costs involved with purchasing and shipping construction materials to build new residences. As a result, many homes are large, single-family housing structures. A graph of the distribution of housing types is presented in Figure 7.39.

Figure 7.39 Housing Structure Types, Nome, Alaska



*Source: 1990, 2000 US Census

During the 2000 Census, 93% of the homes described above used fuel oil and kerosene as their primary heating source. Phone service had gone down nearly 22% since 1990, probably as a result of the increased use of cellular phones. Additionally, homes that lacked complete plumbing and complete kitchens have gone down almost 4% since 1990. A summary of utilities available in Nome housing is presented below in Table 7-57.

Table 7-57 Utilities (Plumbing, Kitchen, Phones, Heating) Nome, Alaska

Characteristic	2000 Census	1990 Census
Lack Complete Plumbing	5.3%	9.1%
Lack a Complete Kitchen	5.2%	9.1%
Lack Phone Service	2.5%	25.6%
Electricity	2.6%	1.5%
Fuel Oil, Kerosene	92.9%	95.3%
Using Wood	0.3%	0.6%
Piped Gas (utility)	0.3%	0.0%
Bottled, Tank, LP Gas	1.8%	0.0%
Other Fuel	2.2%	2.6%

*Source: 1990, 2000 US Census

Housing Financing

In the Nome area, there are many housing finance programs that assist Alaska Natives with subsidies for new housing purchase, construction, and remodeling. The Bering Strait Housing

Authority targets low- to moderate-income households with its down payment and closing cost assistance programs. A down payment subsidy of $40,000 for an Alaska Native purchaser can be used to "buy down" the purchase price of a $280,000 house thus making the house affordable at a purchase price of $240,000.

An estimated 80 to 90% of all real estate sales in Nome have been connected with (NAHASDA/ USDA) financing. This is a subsidized market that allows for turnover of small substandard units to qualified Native households. Subsidies available serve to buy down the cost of housing for qualified buyers. A new house constructed in 2005 and sold for $280,000 could be affordable to an Alaska Native household with access to a subsidy program; however, this amount would be above what the median household in Nome can currently afford. A view of subsidized duplex units in Nome is presented in Figure 7.40.

Figure 7.40 Subsidized Duplex Units in Nome

The Alaska Housing Finance Corporation (AHFC) participates in financing more than 80% of the homes in Nome. The policies set by AHFC regarding whether or not they will accept cost-of-construction as the cost basis for a loan (as opposed to the more conventional appraised value cost basis) could greatly contribute to relief for the housing shortage in Nome.

Market Demand

The real estate market in the Nome Census Area was in a stable mode throughout the 1990s. The Nome area has traditionally experienced a high level of governmental employment which continues to provide a stable year-round base, and which buffers cycles in other industries. Nome did not experience the dramatic real estate downturn suffered in other parts of Alaska in the 1980s because of its relatively slow growth rate.

Still, today the Nome housing market offers few choices to residents or newcomers seeking new housing, upgrades, or rental properties.

Nome Comprehensive Plan: Housing

An entire section of the Nome Comprehensive Plan is devoted to the subject of housing. The primary goal statement is, "Provide high quality and affordable housing with a diversity of housing options to meet the needs of all citizens." This is foloowed by detailed objective statements.

- Objective 10.1 Improve the quality of Nome's existing residential housing inventory.
- Objective 10.2 Develop a diverse and high quality housing supply with affordable options for all income levels.
- Objective 10.3 Coordinate with state and federal agencies to provide high quality housing.

7.9.6.2 Environmental Consequences: Housing

Today, there is an extreme housing shortage in Nome. Although the population growth has been flat for 30 years (U.S. Census, 1980, 1990, and 2000), housing remains in short supply. As reported in this section, many of the houses in Nome are in extremely poor to very poor condition. Over half of the housing stock is more than 40 years old and reaching the limits of functionality. With the important exceptions of Icy View and Devereux, subdivision growth that occurred in the mid 1990s has reached its limits in terms of infill. Very few vacant lots remain. New housing is expensive to build and, historically, infrastructure development lags behind the demand curve.

While the economic development opportunity presented by the development of the Rock Creek Mine project is substantial, new worker demand on the already stressed housing market could be significant, if not mitigated. In order to better understand the details of the Nome housing market, and then devise a plan to work with the community to meet the demand for new housing, NovaGold, Inc., commissioned Kelley Hegarty & Associates, LLC, and Alaska Enterprise Planning to conduct an assessment of the Nome housing market in July 2004.

This research demonstrates the need for very specific housing for three distinct populations: people currently living in Nome who will go to work on the Rock Creek Mine project; those persons from villages within the region who most likely will seek rental housing when they relocate to Nome for jobs; and, finally, a relatively small number of people who will move to Nome from outside the region for jobs. The target population expected to have the greatest need are those persons relocating from villages who are low-income, and persons new to the region.

In order to determine the amount and type of housing necessary to meet the demand of the Rock Creek workforce, it was necessary to determine income levels sufficient to pay for housing. According to the 2000 U.S. Census, more than 20% of the homeowners in Nome pay more than 35% of their income in housing costs. Almost 19% of rental households pay more than 35% of income for housing. Household income characteristics are presented below in Table 7-58.

Table 7-58 Household Income Characteristics

Percentage of household income	Owner Costs	Rental Costs
Less than 15 percent	35.3	29.2
15 to 19.9 percent	16.3	15.8
20 to 24.9 percent	14.7	7.8
25 to 29.9 percent	7.5	6.1
30 to 34.9 percent	4.8	7.4
35 percent or higher	21.0	18.4
Not computed	0.3	15.3

Source: U.S. Census 2000

Specific to Nome is the high percentage of homeowners who do not have a mortgage (49.9%). This high figure is indicative of the preference in the Nome community not to mortgage debt, but to pay for their homes out-of-pocket as they are being built. It is also reflective of the high number of owner-built substandard housing units in Nome that depress the market values overall, and are difficult to resell. This unique characteristic of the Nome housing market greatly influences which housing development options are viable locally.

In order to mitigate the impact that the Rock Creek workforce would have on the Nome housing market, Alaska Gold (in addition to building five houses for management personnel in the summer of 2005) has submitted three subdivisions for platting approval at this writing.

7.9.7 Noise and Land Use Sensitivity

7.9.7.1 Affected Environment

Land uses within a 50-mile radius of the Rock Creek and Big Hurrah mine sites were investigated to identify ambient noise levels and sensitivity to noise and vibration. The 50-mile radius was used to include potential future haul and access routes to the proposed mine sites. Current land use in the study area includes recreational, residential, commercial, light and heavy industrial, as well as undeveloped lands. Noise-sensitive land uses include cabins, residential land uses, and designated recreational areas.

Major noise sources common to most areas include existing mining and exploration, snowmachines and all-terrain vehicles (recreational and local access use), sled dog teams, occasional aircraft over-flights, and highway vehicle traffic. Additional noise sources close to Nome include miscellaneous residential, recreational, and commercial activities including: chain saws, generators, localized construction, and other associated noise sources common to populated areas in Alaska. Noise related to ongoing mining exploration and other industrial activities is 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.

Measured Noise Levels

Noise levels were measured at the nine locations shown on Figure 7-41 between June 14 and June 17, 2005. These locations are along main travel routes for workers and haul trucks associated with the project. The Goldengate Creek and the Safety Roadhouse were monitored using an unattended noise monitoring terminal. The other seven locations were monitored for periods of 15 to 20 minutes, at least three times over a three-day period. A summary of measured noise level by time of day is given in Table 7-59. On-site noise monitoring data and measured noise data from similar areas were used to project existing noise levels in areas that may be affected by the operation of the Project.

Figure 7.41 Noise Monitoring Stations

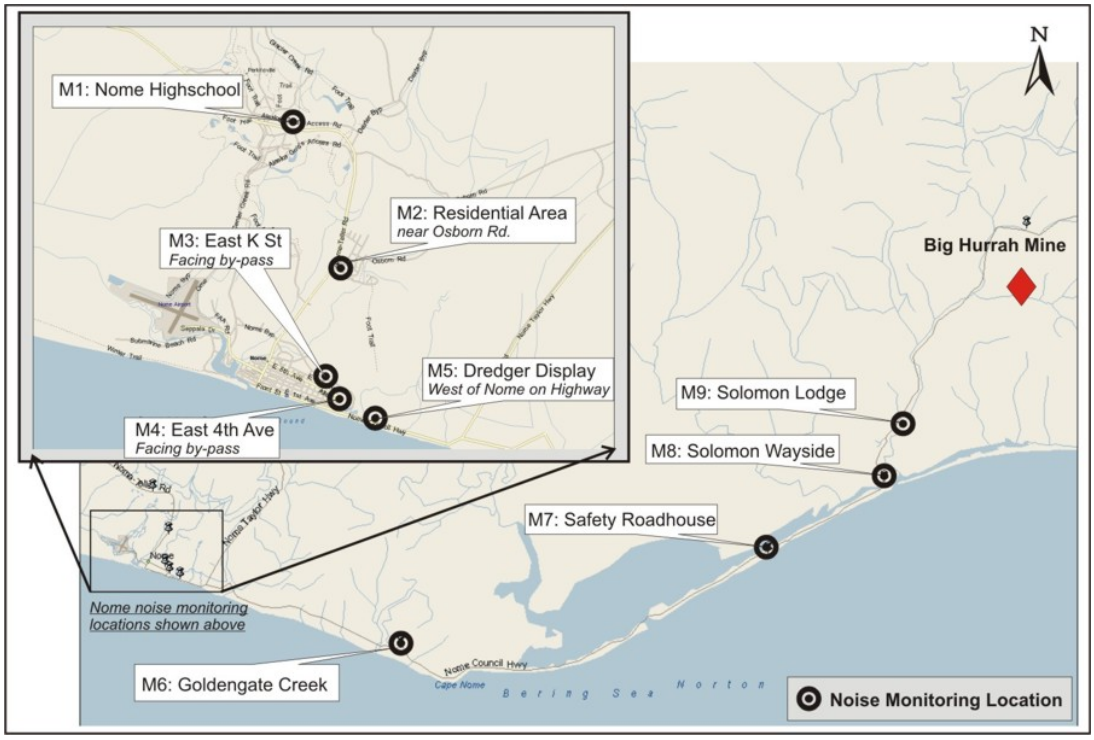


Table 7-59 Measured Ambient Noise Levels for Nome and Surrounding Area

		Daytime[1]	Evening[2]	Nighttime[3]
Mon #	**Location**	**L_{eq}**	**L_{eq}**	**L_{eq}**
1	Nome High School	53.0	46.0	42.8
2	Residential Development (on Osborn Road)	55.1	55.2	44.5
3	East K Street	55.6	54.0	47.9
4	East 4th Avenue	46.0	51.3	44.1
5	Dredge Display	60.0	57.5	49.5
6	Goldengate Creek	52.6	51.9	49.5
7	Safety Roadhouse	54.4	51.1	47.5
8	Solomon Wayside	44.8	52.1	47.8
9	Solomon Lodge	38.5	49.7	38.0

[1]Daytime is defined as 7:00 a.m. to 7:00 p.m.

[2]Evening is defined as 7:00 p.m. to 10:00 p.m.

[3]Nighttime is defined as 10:00 p.m. to 7:00 a.m.

L_{eq} = Equivalent Continuous Noise Level (4db exchange rate)

Table 7-60 contains the range of noise levels projected for this area.

Table 7-60 Ambient Noise Levels for Nome and Surrounding Area[1]

Season	Daytime[2] Hourly L_{eq}		Nighttime[2] Hourly L_{eq}	
	Rural Areas	**Inner City**	**Rural Area**	**Inner City**
Winter Months[3]	37 – 52	53 – 62	32 – 37	48 – 53
Summer Months[3]	40 – 55	56 – 65	35 – 40	50 – 55

[1]Data derived from on-site noise monitoring in Nome, and data from similar rural areas along with data from the U.S. Environmetnal Protection Agency.

[2]Daytime is defined as 7:00 a.m. to 10:00 p.m., and nighttime is defined as 10:00 p.m. to 7:00 a.m.

[3]For the analysis, summer is April – August; winter is September - May.

L_{eq} = Equivalent continuous noise level (4db exchange rate)

Noise level along the Nome/Council Highway ranged from 39 to 60 dBA L_{eq}, with short-term maximums of 72 to 90 dBA L_{max}. The highest noise levels were recorded closest to the highway. Noise data were used to make an approximate estimate of 4.3 vehicles per hour or 102 vehicles per day on the Nome/Council Highway passing Goldengate Creek.

The Nome/Teller Highway would be a main commute route to the Rock Creek Mine/Mill Complex. Table 7-61 provides a summary of projected ambient noise levels at different distances from the highway. Actual noise level will depend on the topography and shielding between the roadway and receiver. Summertime noise levels are projected to range from 45

to 61 dBA L_{eq}. Winter noise levels are projected at 41 to 61 dBA L_{eq}. Ambient noise levels for the Nome/Teller Highway are presented in Table 7-61 below.

Table 7-61 Ambient Noise Levels for Nome/Teller Highway[1]

Season	Daytime[2] Hourly L_{eq}		Nighttime[2] Hourly L_{eq}	
	50 to 150 ft (15 to 45 m)	150 to 300 ft (45 to 90 m)	50 to 150 ft (15 to 45 m)	150 to 300 ft (45 to 90 m)
Winter Months[3]	54 – 62	48 – 53	47 – 54	41 – 47
Summer Months[3]	56 – 62	53 – 56	49 – 54	45 – 49

[1]Data derived from on-site noise monitoring at Nome High School, Osborne Road, supplemental data from similar areas, along with U.S. Environmental Protection Agency traffic noise modeling and data.

[2]Daytime is defined as 7:00 a.m. to 10:00 p.m. and nighttime is defined as 10:00 p.m. to 7:00 a.m.

[3]For the analysis, summer is April - August and winter is September - May.

ft = feet L_{eq} = Equivalent continuous noise level (4db exchange rate)

Noise levels along Glacier Creek Road are projected to be the highest in the winter months with recreational snowmachine activity along this route. Although in the summer months active placer mining activity in the area, as well as traffic on the Nome/Teller Highway, contribute to existing noise levels. Ambient noise levels are projected at 32 to 54 dBA L_{eq} during the winter and 35 to 56 dBA during the summer, with the higher noise levels occurring near the Nome/Teller Highway and noise levels up to 10 dBA lower away from the highway. Table 7-62 provides a summary of projected ambient noise levels for the Glacier Creek area.

Table 7-62 Ambient Noise Levels for Glacier Creek Road/ Rock Creek Mine Access Area[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	48 – 54	32-37	41 – 47
Summer Months[3]	42-45	53 – 56	35-40	45 – 49

[1]Data derived from on-site noise monitoring and data from Ester, northern Fairbanks, traffic noise modeling and from the U.S. Environmental Protection Agency.

[2]Daytime is defined as 7:00 a.m. to 10:00 p.m., and nighttime is defined as 10:00 p.m. to 7:00 a.m.

[3]For the analysis, summer is April - August and winter is September – May.

L_{eq} = Equivalent continuous noise level (4db exchange rate_

Winter noise levels at the Rock Creek Mine/Mill Complex site are projected to range from 27 to 35 dBA L_{eq}, with summer months ranging from 30 to 37 dBA L_{eq}. These are minimal noise levels. It is expected that there are times when noise levels are substantially higher during mine exploration and at areas that see recreational use of snowmachines. Table 7-63 provides the expected range of nominal noise levels for summer and winter months near the proposed mine site.

Table 7-63 Ambient Noise Levels for Rock Creek Mine Site 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 and data from the Olnes subdivision and the Fort Knox area before the mine was constructed, along with information from the U.S. Environmental Protection Agency.

[2]Daytime is defined as 7:00 a.m. to 10:00 p.m., and nighttime is defined as 10:00 p.m. to 7:00 a.m.

[3]For the analysis, summer is April - August and winter is September - May.

L_{eq} = Equivalent continuous noise level (4db excahnge rate)

Max = maximum

Min = minimum

Noise levels along the Nome Bypass were measured at 38 to 56 dBA $L_{eq.}$ Noise levels along the Nome/Council Highway ranged from 38 to 60 dBA L_{eq}. Table 7-64 provides a summary of the projected noise levels along the Nome Bypass and the Nome/Council Highway. Noise levels at the Solomon Lodge, which was undergoing renovation during monitoring, ranged from 38 to 50 dBA L_{eq}.

Table 7-64 Ambient Noise Levels, Nome Bypass/Nome/Council Highway[1]

Season	Daytime[2] Hourly L_{eq}		Nighttime[2] Hourly L_{eq}	
	50 to 150 ft (15 to 45 m)	150 to 300 ft (45 to 90 m)	50 to 150 ft (15 to 45 m)	150 to 300 ft (45 to 90 m)
Winter Months[3]	46 – 60	40 – 46	42 – 49	38 – 42
Summer Months[3]	49 – 60	43 – 49	44 – 49	40 – 44

[1]Data derived from on-site noise monitoring at six locations along the Nome Bypass and the Nome/Council Highway, along with information from the U.S. Environmental Protection Agency.

[2]Daytime is defined as 7:00 a.m. to 10:00 p.m., and nighttime is defined as 10:00 p.m. to 7:00 a.m.

[3]For the analysis, summer is April - August, and winter is September - May.

ft = feet

L_{eq} = Equivalent continuous noise level

Winter noise levels are projected to range from 27 to 35 dBA L_{eq}, with summer values ranging from 30 to 37 dBA L_{eq}. These are minimal noise levels. It is expected that there are times when noise levels are substantially higher during exploration and at areas with recreational snowmachine use. Table 7-65 provides a summary of the range of nominal noise levels for the summer and winter months near the proposed mine site.

Table 7-65 Ambient Noise Levels for Big Hurrah Mine 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 and data from the Olnes subdivision and the Fort Knox area before the mine was constructed, along with information from the U.S. Environmental Protection Agency.

[2]Daytime is defined as 7:00 a.m. to 10:00 p.m., and nighttime is defined as 10:00 p.m. to 7:00 a.m.

[3]For the analysis, summer is April - August, and winter is September - May.

L_{eq} = Equivalent continuous noise level

Max = maximum

Min = minimum

7.9.7.2 Consequences

Increases of 5 to 7 dBA or more in noise are noticeable; a 10-dBA change is judged by most people as a doubling of the sound level. The impact criteria used to determine significance for the Rock Creek and Big Hurrah projects are given in Table 7-66.

Table 7-66 Significance of Noise Impacts

Generally Not Significant	Possibly Significant	Generally Significant
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 3 dBA at noise-sensitive sites.	Increases in noise levels with project implementation are expected to be between 3 dBA and 10 dBA, and the overall project-related hourly average noise level does not exceed 50 dBA Leq. Determination of significance also considers existing noise levels and the presence of noise-sensitive sites.	Project activity would cause an increase in the existing noise levels of more than 10 dBA, and overall project-related hourly average noise levels of more than 55 dBA Leq. Determination of significance also considers existing noise levels and the presence of noise-sensitive sites.

Source: Environmental Protection Agency and Bureau of Mines.

dBA = decibels averaged

L_{eq} = Equivalent continuous noise level

In addition to the above criteria, noise-sensitive receivers along haul routes that exceed the Federal Highway Administration (FHWA) 67 dBA residential impact criteria or have 10 dBA increase in noise levels because of mine related traffic will be considered as having a significant traffic noise impact.

There are several major noise-producing components of mining projects. The three main noise components for the Rock Creek and Big Hurrah mine projects would be general mining activities (those activities related to ore retrieval and processing), blasting, and mining-related traffic.

Noise Level Calculations

Operational noise level projections were made using the methods described in EPA (1971b), as well as with information from other acoustical sources. Reference noise levels for equipment were taken from measured noise levels of equipment in use at construction or mining operations, and from EPA and FHWA sources. Table 7-67 provides reference noise levels for mining and construction equipment.

Table 7-67 Reference Mining and Construction Equipment Noise Levels

Description[1]	Hourly Use (Minutes)[2]	Sound Level[3]
Blasting	Daily, 5 days per week	105 to 120 dBC @ 100 feet[4]
Haul Trucks, four to five 100 ton off-road haul trucks	45 – 60	72 – 88
Hydraulic mine shovel	20 – 40	84 – 88
Front-end loader, Caterpillar 992 or equivalent	20 – 40	84 – 88
Rock Drill, IR-DM-M2, TEI Jumbo or equivalent	10 – 15	90 – 92
Bulldozer, Caterpillar D10/11 or equivalent	20 – 40	88 – 92
Motor Graders, Caterpillar 24H or 16H or equivalent	20 – 40	78 – 82
Backhoe, Caterpillar 325 or equivalent	20 – 40	76 – 80
Medium-duty trucks, such as fuel trucks, water trucks, and fork lifts	30 – 60	72 – 86
Light-duty trucks, service trucks, compressors, pumps, light plants, and other small-engine-powered equipment	45 – 60	65 – 81[5]

[1]Normal equipment used for mining operations like those proposed for the Rock Creek project.

[2]Average use per hour during normal mining activities.

[3]Range of noise levels under normal operation as measured at a distance of 50 feet (15 m). For haul trucks, both the idle and nominal maximum operational noise levels are provided.

[4]Typical blast levels for this type of mine taken from on-site measurements at other sites.

[5]Assumes a mixture of compressors, light plants, small-engine-powered generators, welders, and other operational and maintenance equipment. This is a minimal component of sound under normal operation and is not expected to result in significant changes in the overall noise levels.

dBC = _____

Noise levels are expected to be highest during the initial construction phase. Once construction is completed, and most of the noisiest equipment is in the mine pit, noise levels for mine operation would be dominated by haul trucks, loaders, maintenance facilities, and other mine-related facilities. Noise from ore processing will not be a significant source when compared to the mining process.

General Operational and Construction Noise

For the Rock Creek and Big Hurrah mine projects, two separate calculations were performed: one representative of the summer months, and another for the winter months to account for

the more efficient sound propagation in cold air during winter months. The winter calculations are representative of the operational noise levels at distances greater than 500 feet from the mine site during periods when temperatures are below 20 °F (-7 °C) and assume soft ground cover, such as snow. The summertime calculations assume a higher temperature and slightly softer ground cover representative of field grass or other foliage. The calculations do not provide for actual noise reductions from area topography.

For noise-sensitive receivers located in the vicinity of Nome and the immediate surrounding areas, noise from general construction or operations at the Rock Creek Mine site are not projected to result in any change over the existing noise environment. Projected noise levels from mine construction and operations are projected to remain below maximum hourly L_{eq} noise levels of 31 to 40 dBA, on the basis of distance from the mine site and topographical reductions. There may be times, however, when atmospheric conditions make some noise from mine activities audible at certain locations. Even under extreme conditions, however, no impacts are projected.

The linear distance from the Big Hurrah Mine to Nome is more than 40 miles (64 km), therefore, the operation of the mine will not be audible in Nome. There may be times when mining operations are audible at the Solomon Lodge and Solomon Wayside; however, the noise reduction with distance is projected to reduce mine related noise to below 30 dBA L_{eq}.

Noise levels in the Glacier Creek Road and Bypass areas, near the Nome/Teller Highway, are projected to range from 42 to 45 dBA during the initial construction phase of the Rock Creek Mine. Mine operational noise in this area is projected to range from 39 to 42 dBA. Because this area is frequented with noise from motorized vehicles such as all-terrain vehicles and snowmachines, no significant noise impacts are projected.

Noise levels in the Solomon Lodge, Solomon Wayside area, and at fishing camps along the Nome/Council Highway near the Big Hurrah Mine are not projected to exceed 40 dBA during construction. Mine operational noise levels in the same area are not projected to exceed 30 to 40 dBA. Closer to the Big Hurrah Mine site, near Quigleys Camp, noise levels during construction and operation of the Big Hurrah are projected to range from 36 to 44 dBA L_{eq}. Because this area is primarily used for recreation, and frequented with noise from motorized vehicles such as all-terrain vehicles and snowmachines, no significant noise impacts are projected.

Noise from blasting was also investigated for potential noise impacts. Blasting would be required at both mine sites and is expected to occur five days per week, once per day. The EPA allows for up to one blast per day with noise levels of 125 dBC at the nearest noise-sensitive receiver location. During the initial construction phase, when blasting is performed near or on the surface, noise from the blasts will likely be audible at some recreational and residential locations near the mine site. However, once the blasting activities move in to the mine pit areas, noise from the occasional blast is not projected to result in any significant impacts as defined by the EPA blasting standards. No blasting-related noise impacts are projected during the construction or operation of the Rock Creek and Big Hurrah mines.

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

Mine Access Noise

Mine access noise consists of a mixture of passenger vehicles and medium and heavy trucks. Noise along the access routes was projected for operation of the Rock Creek Mine only, and for operation of the Rock Creek and Big Hurrah mines simultaneously, with the ore from Big Hurrah being trucked to the Rock Creek Mine for processing. Both analyses assume maximum projected traffic conditions during normal operation. Traffic noise calculations assume a direct line of sight to the roadway, and do not assume any topographical shielding or reduction due to foliage. Noise from traffic would occur during shift changes, from hauling supplies to and from the mine, transferring ore from the Big Hurrah Mine to the Rock Creek Mine for processing, and from other general mine-related traffic. The assumptions for Rock Creek and Big Hurrah mine-related traffic used in the noise calculations is discussed below.

Rock Creek Mine Traffic Assumptions: The Rock Creek Mine will employ 120 people. Six of these people will work in Nome proper and therefore will not make a daily round trip to the mine site. Eleven of these employees will be management personnel who will each make one round trip between town and the mine site an average of 6 days per week. The remaining 103 will be divided into four crews with rotating on/off schedules. The traffic effect per day will be two 26-person crews; under the worst case scenario, each person could generate one round trip per day between the mine site and town. This impact does not take into account any mitigation that may occur as a result of carpooling, the initiation of a van transportation service by the local business community, or busing. In addition, an estimated three medium trucks and two large trucks per hour would be expected to make trips to and from the mine site each hour.

Big Hurrah Mine Traffic Assumptions: Under the worst case conditions, there will be a crew van making daily round trips to the Big Hurrah Mine. In addition, occasional large supply trucks, unscheduled pickup trucks, and emergency repair vehicles will also access the mine on an as-needed basis. These vehicles will use the Nome/Council Highway from Nome to the mine site. Ore will be sent to the Rock Creek Mine for processing using tractor trailers capable of hauling dual trailers with maximum legal loads. Ore hauling will occur 24 hours per day, 7 days a week using two haul trucks operating in cycles of approximately 90 minutes. The haul route for the ore and other traffic between the two mine sites would be the Nome/Council Highway to the Nome Bypass, to the Nome/Teller Highway, to the Rock Creek Mine.

Hourly L_{eq} noise levels were calculated along the Rock Creek Mine access route north of Nome using the worst case scenario of 26 passenger vehicles and three medium and two heavy trucks per hour from Nome to the Rock Creek Mine, along with two tractor trailers from the Big Hurrah Mine transferring ore to the Rock Creek Mine. Additional calculations were performed for the Nome Bypass assuming four passenger vehicles, one medium truck, and two tractor trailers traveling between the two mines. Traffic noise calculations were also performed for traffic accessing the Big Hurrah Mine from Nome along the Nome/Council

Highway assuming two passenger vehicles, two medium trucks, one heavy truck, and two tractor trailers per hour.

Hourly noise levels along the route to the Rock Creek Mine ranged from 62 dBA L_{eq} at 20 feet (6 m) to approximately 50 dBA L_{eq} at 400 feet (120 m). The FHWA criterion for traffic noise is 67 dBA L_{eq} and therefore no traffic noise impacts are projected for the travel route between Nome and the Rock Creek Mine.

Hourly mine-related noise levels along the Nome Bypass ranged from 57 dBA L_{eq} at 20 feet (6 m) to approximately 45 dBA L_{eq} at 400 feet (120 m). The FHWA criterion for traffic noise is 67 dBA L_{eq}; therefore, no traffic noise impacts are projected along the Nome Bypass.

Hourly noise levels along the Nome/Council Highway to the Big Hurrah Mine ranged from 59 dBA L_{eq} at 20 feet (6 m) to approximately 46 dBA L_{eq} at 400 feet (120 m). The FHWA criterion for traffic noise is 67 dBA L_{eq}; therefore, no traffic noise impacts are projected for the travel route between Nome and the Big Hurrah Mine. Furthermore, the majority of noise-sensitive land uses along the Nome/Teller Highway are at least 100 feet (30 m) from the roadway, and therefore maximum 1-hour L_{eq} noise levels or 52 dBA or less are projected.

Cumulative Noise Levels

Because most of the additional noise sources would be sporadic in nature, and would occur over a large area, it is not possible to accurately quantify and provide cumulative noise levels. Existing and future noise sources, however, when combined with noise levels from Rock Creek Mine operation, are not projected to result in any significant local long-term noise impacts. There may be times, in certain areas, where the combined noise from different sources might result in a noise level increase of greater than 3 dBA, which has been defined as probably significant. Such an increase, however, most likely would be short-term in nature, and would not result in more than a short-term noise impact.

Finally, there is the potential for noise level increases within 2 to 3 miles (3 to 5 km) of the Rock Creek and Big Hurrah mines during construction and 1 to 2 miles (1.5 to 3 km) of the mine during operations. In addition, noise level increases can be expected within 1,000 feet (300 m) of the haul routes. Because this is a remote rural area, with low existing noise levels, there is the potential for noise level increases along trails and other areas that are frequented by nonmotorized users, such as cross-country skiers, hikers, and dog sledders. The actual increase in noise would depend greatly on the distance from the mine to the trail, weather conditions, and topography between the trail and the mine or haul route. However, unless the trail is within 2 miles (3 km) of the mine, the noise level increase is projected to be less than 3 to 5 dBA, and therefore no significant noise impact would be identified. There will be times, however, when the mining operations may be audible at greater distances because of atmospheric conditions, but, as stated, noise level increases are still projected to be within the EPA criteria, and overall, mine-related noise levels would remain at or below 32 to 35 dBA.

7.9.8 Visual

7.9.8.1 Affected Environment

Visual resources in the Rock Creek Gold Mine/Mill Complex area are described based on the approach described in the U.S. Forest Service publication, *Landscape Aesthetics: a Handbook for Scenery Management* (USFS, 1995). The analysis conducted here uses two of the primary landscape elements described in that document, landscape character and visual absorption capability, to describe the visual resources in the project area. A viewshed analysis was conducted to determine the visibility of the proposed Rock Creek Mine/Mill Complex within the existing landscape. The Big Hurrah Mine site was not included in this analysis. The Big Hurrah Mine is located within the Big Hurrah Valley. The valley is not visible from any major roadway or community and therefore will be discussed on a more subjective basis.

Visual Resources

Landscape character identifies the particular attributes of a landscape that give it a visual image and make it identifiable or unique. Topography, vegetation, and existing land uses were used as the attributes to define the landscape character surrounding the proposed Rock Creek Mine/Mill Complex.

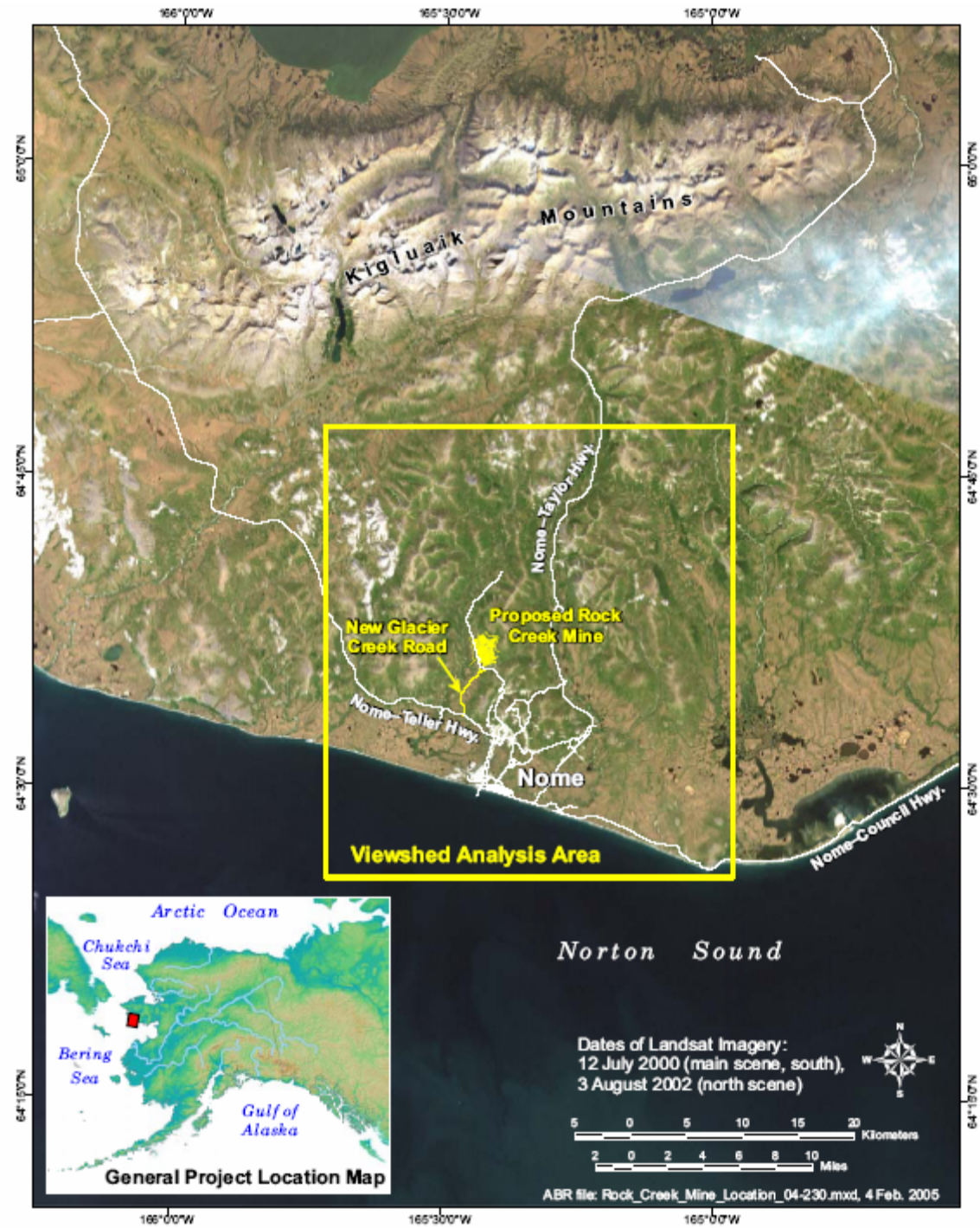
Visual absorption capability is described using three physical factors: slope, vegetation (including landscape texture), and geology (landform dissection). Visual absorption capability classifies the relative ability of a landscape to accept human alterations without a loss of landscape character or scenic quality.

Landscape Character

The proposed Rock Creek Gold Mine/Mill Complex is in the foothills of the Kigluaik Mountains, approximately 6.8 miles (11 km) north of Nome (Figure 7.42). The project area lies on the east side of the broad Snake River Valley, and the landscape character in this area is defined in part by the gently-rolling terrain and low foothills mountains (<1,800 feet [550 m] elevation) on either side of the valley bottom. The area is covered by a mixture of low shrub and graminoid-dominated tundra (<1.6 feet [0.5 m] tall) and patches of low willow (Salix sp.) and shrub birch (Betula nana) thickets (<3.2 feet [1 m] tall). Tall willow thickets also occur in patches on slopes, but are most common in the lower riparian areas where the plants range from 7 to 10 feet (2 to 3 m) in height. The existing landscape in the project area is typified by gently-sloping terrain on the lower slopes of Mount Brynteson (1,760 feet [536 m] elevation). Mount Brynteson itself rises above the proposed mine and is the prominent visual feature in the local area. On the lower slopes of the mountain, there are locally steep slopes above creek beds and, farther downslope, a broad, flat floodplain occurs in the confluence area of Rock Creek, Glacier Creek, and the Snake River. The existing landscape character in this area is largely defined by natural features, although alterations from human land uses are clearly evident. In particular, the existing Glacier Creek Road traverses the slope below the proposed mine and evidence of disturbance from past mining and exploration activities and old mining roads are prominent in the Rock Creek and Glacier Creek drainages.

Using terms described in the above-cited document, the landscape would be classified as Natural Appearing, defined as a “landscape character that expresses

Figure 7.42 Location of the proposed Rock Creek Mine, near Nome, Alaska. The spatial extent of the viewshed analysis is also indicated.



predominantly natural evolution, but also human intervention including cultural features and processes". If we consider landscape character within a larger regional context (the greater Nome area), we would want to augment the conclusions above to account for the prevalence of human activities in that larger area. The existing landscape in the Nome area has been strongly influenced by mining. Mining was the original stimulus for economic development in the area and active mining equipment as well as historic remnants remain prominent features on the landscape.

> The proposed Big Hurrah Mine site is located in the Big Hurrah Valley near the Uncle Sam Mountains in an area typified by broad and narrow valleys. The vegetation is similar to the Rock Creek Mine/Mill Complex site with a greater predominance of open tundra and fewer willow shrubs and willow thickets. The site also exhibits past mining disturbances, but to a greater extent. Remaining at the site are historic mining structures including a stamp mill, residence, power house, camp buildings, and several sea containers. Much of the valley has been previously mined. There is an abandoned mine shaft, along with old vehicles, a large pile of steel drums, and other debris.

This evidence of mining is part of the tourist attraction for Nome, and even at some distance from the city, cuts and water collection channels from past mining operations are evident on some hillslopes and old mining equipment is often left in place. Incorporating this information, the landscape character in the greater Nome area could be classified as mix of Natural Appearing and Historic, the latter defined as a "landscape character expressing valued historic features that represent events and period of human activity in the landscape" (USFS, 1995).

Visual Absorption Capability

The visual absorption capability of the landscape surrounding the proposed Rock Creek Mine/Mill Complex is largely driven by slope and vegetation, with geology also contributing. The location of the proposed mine on the slopes of Mount Brynteson affords little visual screening, and similarly the low tundra and shrub vegetation would not provide effective visual screening for human alterations on the landscape. This is as opposed to a landscape on relatively flat ground, where tall forest vegetation would provide more effective visual screening (for viewers from the ground). The landscape in the Rock Creek Mine/Mill Complex area does show some texture in the repeated patterns of open graminoid/low shrub tundra alternating with taller willow thickets. This texture, however, is rather modest and does not substantially break up the visual continuity of landscape alterations such as the existing roads and disturbances from past mining activity. Similarly, the landforms in the rolling terrain of the local project are not heavily dissected with steep slopes or exposed rock faces that could help to break up the visual continuity of landscape alteration.

Considering these factors, the landscape in the area of the proposed Rock Creek Mine/Mill area can be described as having a low level of visual absorption capability. In other words, the landscape is relatively sensitive to visual alterations.

The Big Hurrah area shares a similar location on a slope with low tundra characteristics and likely provides minimal visual screening as well.

7.9.8.2 Environmental Consequences:

The viewshed analysis describes the visibility of the proposed Rock Creek Mine/Mill Complex from the surrounding area, in this case using the cumulative visibility from local roads, publicly and privately held properties, and the city of Nome. Viewer position, viewshed type, and view distance were all considered in this analysis. The viewshed analysis is the primary mechanism used to describe the visual impacts from the project.

The proposed Rock Creek Mine/Mill Complex would not be visible from the city of Nome, except at the western edge of town beyond the airport. Banner Peak and Bonanza Hill would block the view of the Rock Creek Mine/Mill Complex facilities from most of Nome. The mine would not be visible from the Nome–Taylor Highway or the Nome–Council Highway, either. The proposed mine would be visible from the lower Snake River Valley, including from the Nome–Teller Highway where it crosses the valley. From several surrounding hillsides an observer would have a complete view of the proposed mine, including the south-facing slopes of Mount Brynteson, the northwest slopes of Banner Peak and Bonanza Hill, the peak of Anvil Mountain, the southwest slopes of Twin Mountain, and several other unnamed peaks and ridges to the west and north of the mine. Along most of the New Glacier Creek Road, an observer would have clear views of the mine. The Old Glacier Creek Road runs up the Anvil Creek valley for the first 3.7 miles (6 km), and on this approach the mine would not be visible until the road crested the shoulder of Bonanza Hill.

Portions of the proposed mine project would be visible from the middle Snake River Valley below the mine, and from Glacier Creek Road as it traverses the base of the mine project. Visibility would diminish as the viewer moves northward, until the mine would disappear from view behind the western shoulders of Mount Brynteson.

From Boulder Creek, lower Sledge Creek, and lower Glacier Creek, an observer would have clear views of the proposed mine, although the tall willows along the creeks may block some views. The same would be true for several smaller creeks feeding into the Snake River, to the immediate west and south of the mine project area.

Views of the proposed mine from south of the Nome–Teller Highway, including from the coastal plain and the ocean, would be constrained by Banner Creek to the east and an unnamed ridge to the west. Near the Nome–Teller Highway crossing of the Snake River, the Snake River Valley narrows to about 1.2 miles (2 km). Here the proposed mine would be more visible, and would be visible from a wider area at an increasing distance to the south, as the Snake River Valley approaches the coast. At the same time, however, the apparent size of the mine would diminish as distance increased from the mine. From the ocean, viewers looking up the Snake River Valley on a clear day would be able to see the mine. The proposed mine would not be visible from the mouth of the Snake River, in the city of Nome.

Finally, several more distant high ridges and mountain peaks would have limited views of the proposed Rock Creek Mine/Mill Complex, including several unnamed peaks west of the Nome River, and some peaks to the north and west, including Mount Distin. The proposed mine likely would be visible from a few peaks outside the area of analysis.

The simulated views depict the shape, orientation, and perceived size of the mine project components, though not their color and texture. From the Nome–Teller Highway, as it crosses the Snake River Valley, the entire mine project would be visible; its width would appear to be equal to the width of Mount Brynteson from this vantage point, though the mine would only occupy the lower slopes. From this perspective, the previous mining activities near Rock Creek are quite obvious, and the lower slopes of Mount Brynteson already have visual impacts from mining.

New Glacier Creek Road approaches the site from the south on the broad floodplain of the Snake River, from a very shallow angle. Again, from this road, the proposed mine would appear as wide as Mount Brynteson, but would only occupy the lower portion of the view of Mount Brynteson. As a viewer traveling the road got closer to the Rock Creek Mine site, the tailing storage facility and the rock dumps would look much larger. From this view, too, there is much evidence of previous mining activity, especially in the Rock Creek Valley.

Although the Rock Creek Mine/Mill Complex would generally not be visible from Old Glacier Creek Road until cresting Bonanza Hill (see above), the landscape in that area is characterized by active and abandoned mining operations and heavy equipment. After leaving the Anvil Creek Valley, the road descends towards Glacier Creek, which is also heavily mined, with prominent gravel berms in the floodplain. The southeast edge of the proposed Rock Creek Mine/Mill Complex would be visible on the hillside above Glacier Creek, with the south rock dump, the tailings storage facility, a diversion channel, and two overburden stockpiles in the foreground, and other portions of the project in the background.

From a vantage point on the upper slopes of the unnamed peak directly across from the mine project (at approximately 1,200 feet [370 m] elevation), the view includes the lower slopes of the peak in the foreground, the Snake River and Glacier Creek floodplains, the foothills in the distance, and, of course, Mount Brynteson and the proposed mine. From this perspective, an observer would view the mine from above, rather than edge-on as with the views from lower roads, and the different components of the mine would be more distinguishable.

Viewshed Analysis Discussion

The high visibility ratings of the proposed Rock Creek Mine/Mill Complex from the Snake River Valley are explained by the large size of the mine as viewed in the context of the local topography. The footprint of the mine would be approximately 1.4 square miles (3.5 km²). The proposed mine would be sited on the lower slopes of Mount Brynteson, facing down the valley, with an unobstructed view of the ocean at the valley mouth. These lower slopes provide a view up and down the Snake River Valley and several small tributaries. The low shrub and tundra vegetation on the broad floodplain and hills facing the mine project will generally allow unobstructed views of the mine. At the same time, the hilly terrain and the location of the proposed mine on the lower slopes of Mount Brynteson restrict broader, regional visibility, so that outside the Snake River Valley and facing hillsides, the proposed mine would be visible only from rarely-traveled higher elevations.

Viewers of the proposed mine in the Snake River Valley are expected to be a diverse group. Some tourists, including birdwatchers, may travel the Glacier Creek Road system in the summer,

although other road systems in the Nome area likely will receive more use from tourists. Local residents also may travel the Glacier Creek Road system in summer for recreation and berry picking. In the fall, residents of Nome likely will travel by car, by 4-wheeler, and on foot in the Snake River Valley, especially during moose hunting season. In the winter, numerous off-road trails are used in the Snake River Valley by dog mushers and snowmachine riders.

This viewshed impact analysis does not account for effects of vegetation, which could reduce the visual impact of the proposed mine, although only to a negligible extent because of the low height of the existing vegetation in the region. Also, the digital elevation model (DEM) data for northern Alaska used in this analysis are relatively coarse-scale and this level of accuracy introduces some error into the viewshed estimates. Improvements in the viewshed modeling used here likely would change the details of the visibility results, but not their main conclusion: large portions of the proposed mine would be visible from most of the Snake River Valley, including most of the private parcels in the lower valley. The proposed Rock Creek Mine/Mill Complex would be highly visible from New Glacier Creek Road and portions of Old Glacier Creek Road and the Nome–Teller Highway. The proposed mine, however, would not be visible from the city of Nome, except at the western edge.

The visual impact varies for different project components. The plant site would be dwarfed in size by the rock dumps and tailing storage sites, but would be well-lit and would likely be the most prominent feature in low light or darkness. The overburden stockpiles would be planted with grass to reduce erosion, and after several years they should begin to blend with the vegetated hillsides. The overburden stockpiles will be moved upon mine closure and could be used in reclamation efforts. Long linear features such as roads and diversion channels would be highly visible in daylight. The rock dumps and tailings storage facilities would be easily visible, as they are unvegetated, with tall gravel berms at their lower edges, and they face several likely viewing angles. They also would cover extensive areas at the proposed mine. The visual impact of the mine pit would largely depend on the viewing angle—from the shallower angles of local roads, it may blend in with the rock dumps and tailings storage facilities, which are constructed from material excavated from the pit. From higher view angles on a nearby mountain, or from aircraft, the depth of the pit would become apparent, especially when lit with artificial lights.

This analysis indicates that visual impacts in the Nome area clearly would occur from construction of the Rock Creek Mine/Mill Complex. The magnitude and even the direction of the impact (positive or negative) depends, however, upon the viewer's physical position in the region at the time of observation and upon the viewer's perspective on mining in general. In other words, the level of visual impact will depend on location and on the perceptual background of the observer (i.e., the observer's preferences for landscape character, [USFS, 1995]). Those viewers with knowledge of the Nome area and Alaska's mining history likely will not see the proposed mine as a unique landscape alteration that is out of character for the area. However, the large physical size of the alteration will make the Rock Creek Mine/Mill Complex stand out clearly in the landscape.

Visual impacts from the proposed Rock Creek Mine/Mill Complex will be more pronounced during the construction and operations phases (expected to last 5 to 12 years). During this period, the mine pit, rock dumps, and overburden stockpiles will stand out in the landscape as unvegetated or partially vegetated disturbance. Lighting also will contribute to the visual

impacts especially during the long winter nights that occur in this region of northwest Alaska (64° 30' N latitude), although use of this area, especially by tourists, will significantly decrease during the winter months. After mine closure and reclamation efforts, some of these visual impacts will be lessened. In particular, recontouring of disturbed areas, and revegetation of the rock dumps with native plant species will help these areas blend visually with the surrounding terrain, and the cessation of lighting will reduce visual impacts during periods of low light and darkness.

The Big Hurrah mine will be located on an unimproved road right-of-way that branches off the Nome-Council Highway The road right-of-way generally requires 4-wheel drive vehicles to access. The Nome-Council Highway is open from May to October. The Big Hurrah Valley is not visible from the main highway system or any nearby community. The closest community is Solomon, about 10 miles (16 km) away. There are two cabins within the Big Hurrah Valley. The proposed mine would likely be visible from higher elevations along the surrounding slopes and mountains. However, travelers to these higher elevations would be few.

The Big Hurrah Mine would consist of a small open pit, rock dump, and ore stockpile. There would be a small temporary office structure and shop building that would remain in place for approximately 3 – 4 years. The new buildings would be of similar or smaller size than the existing and historic buildings presently located at the site. Many of the existing buildings, with the exception of the historic stamp mill, would be removed during mine construction, reducing some of the pre-existing visual impacts. Reclamation at closure and removal of the buildings will lessen the visual impacts after operations have concluded.

Overall, the significantly smaller size of the Big Hurrah Mine in comparison to the Rock Creek Mine/Mill Complex, its more remote location within the Big Hurrah Valley, and the more extensive presence of past human, particularly mining, disturbance to the area result in relatively low visual impacts at this site.

7.10 HAZARDOUS WASTE

7.10.1 Affected Environment

7.10.1.1 Hazardous Materials

According to the ADEC, there are 20 known hazardous material sites in and around the City of Nome, including 13 leaking underground storage tanks (ADEC, 2005).

The Big Hurrah gold mine was investigated as a possible EPA Superfund site in 1981, in response an observation of 10 to 20 drums labeled sodium cyanide at the site. In 1982, 20 drums of cyanide were removed from the site by Anaconda Company. Follow-up site assessments were conducted in 1982 and 1984, and soil samples were collected in 1992. There was no evidence of hazardous substances present at the site in 1982, and the 1992 soil samples indicated the soils were within compliance for total and Toxicity Characteristic Leaching Procedure (TCLP) metals, cyanide, and polychlorinated biphenyls (PCBs), the exception being elevated levels of arsenic; however, TCLP results indicated low leachability and that arsenic concentrations were consistent with regional background data.

7.10.2 Consequences

The project does not overlie or abut any of the known hazardous waste sties.

8.0 TRANSPORTATION CORRIDOR

8.1 NOME TO ROCK CREEK MINE/MILL SITE

8.1.1 Rock Creek Mine Traffic Assumptions

The Rock Creek Mine will employ 120 people. The traffic effect per day will be two 26-person crews; under the worst case scenario, each person could result in one round trip per day between the mine site and town. This impact does not take into account any mitigation that may occur as a result of carpooling, the initiation of a van transportation service by the local business community, or busing. In addition, an estimated three medium trucks and two large trucks per hour would be expected to make trips to and from the mine site each hour.

Traffic from Nome to the Rock Creek Mine/Mill site will primarily follow the Nome-Teller Highway from Nome to Glacier Creek Road and Glacier Creek Road out to the mine site. The Center Road and Old Glacier Creek Road are possible alternate routes, but are not likely to be used by the majority of the workers.

8.1.2 Regional Location

8.1.2.1 Affected Environment

The Nome-Teller Highway heads north from downtown Nome on the coast of Norton Sound and passes through gently sloping and rolling open tundra for approximately 3 miles (5 km) before turning westward and paralleling the coast to its terminus in Teller. The transportation route follows the first 4 miles (6.5 km) of the Teller Highway to the turnoff to New Glacier Creek Road. New Glacier Creek Road is located within the foothills of the mountains north of Nome. It lies entirely within the broad valley of the Snake River between the western slopes of Banner Peak and Bonanza Hill and the eastern slopes of an unnamed ridge to the west. The road alignment runs primarily at the base of Banner Peak and Bonanza Hill on an upland terrace above the floodplain of the Snake River to the east. New Glacier Creek Road rejoins the pre-existing Glacier Creek Road (also known as the Snake River Road) just north of Glacier Creek near the entrance to the Rock Creek Mine/Mill Complex. The landscape is typified by very gently sloping and flat terrain running from the base of Banner Peak and Bonanza Hill.

8.1.2.2 Consequences

Use of the existing highway will be congruous with existing road purpose at this location.

8.1.3 Past and Present Land Use

8.1.3.1 Affected Environment

The Nome-Teller Highway is a state-maintained road that originates from Bering Street in downtown Nome; passes by the municipal airfield, two housing subdivisions, a ball field, and active and dormant placer mining claims; and finally passes the high school before meeting up with New Glacier Creek Road. After the turn-off to New Glacier Creek Road, the Nome-Teller Road passes a small subdivision of houses before continuing on through open tundra to the village of Teller, approximately 80 miles (130 km) to the west. Along the route to Teller are the remains of several historic mining camps as well as active mining operations.

The original Glacier Creek Road passes by several active and inactive mining operations along Anvil Creek before joining the new alignment at Rock Creek. Access into the anvil Creek area was first established in 1900 with the first narrow gauge railroad in Northwest Alaska constructed to support the gold rush miners. New Glacier Creek Road, was constructed to improve year-round access, reduce maintenance, and to avoid travel through the City of Nome's water supply recharge area. The new alignment runs through primarily undeveloped tundra, passing a few recreational cabins and one year-round residence. It lies primarily outside of the Nome city limits. There are several mining claims along the Nome-Teller end of New Glacier Creek Road, along the alignment for about 0.6 to 1.2 miles (1 to 2 km) near the middle of the road, and others on Mary's Gulch.

Land ownership along the Nome-Teller Highway between Nome and the New Glacier Road turnoff primarily consists of mining claims, with private residential ownership near the two subdivisions, and a mixture of municipal and private ownership along Bering Street where the road originates in Nome. Land ownership on the Glacier Creek Road where the new highway rejoins the old highway is dominated by mining claims. Land ownership, outside of mining claims, is primarily Native corporation-owned lands, BSNC owning the subsurface and Sitnasuak owning the surface estate. The area in which New Glacier Creek Road lies is used for a two-week moose hunt, and offers bear habitat as well. Recreational uses include canoeing, dog mushing, snowmachining, and fishing.

The Nome-Teller Highway is used for transportation of gravel resources and mining equipment. It is also used for a variety of commercial services in support of the residences and school located along the route. Old Glacier Creek Road has been used for the transport of mining equipment and gravel resources indicating that New Glacier Creek Road will likely be used in a similar manner. There has been little, if any, past commercial use of Glacier Creek Road. Tourism occurs along the transportation route, particularly bird watching in the Snake River Valley.

Residential use of the area adjacent to the Nome-Teller Highway occurs primarily at the Icy View Subdivision, and a smaller subdivision in the same general vicinity, but slightly to the southwest of Icy View. There are a few seasonal residential cabins located along Glacier Creek Road, and one year-round resident.

Institutional uses of the Nome-Teller Highway are primarily located near its origination on Bering Street. These include the Fire Department, Police Department, and the Norton Sound Regional Hospital. The hospital will be relocated to a new location off the Nome-Teller Highway, but the facility will likely continue to be used as a health care facility. The Nome Beltz High School is located along the north side of the Nome–Teller Highway, approximately 1 mile (1.6 km) from the turnoff to New Glacier Creek Road, and is the only other institutional land use along the transportation route. There are no institutional uses of the new, or old, Glacier Creek Road.

8.1.3.2 Consequences

Before construction of the road, ADOT&PF contacted BSNC regarding the proposed project, relative to their lands and the people they represent. It was stated in the Environmental Assessment for Glacier Creek Road that BSNC viewed the road project as positive and as a means to ensure the economic viability of the City of Nome and surrounding area for all residents.

Subsistence, recreational, and bird watching opportunities are abundant throughout the region and the Snake River Valley. Traffic to and from the mine site will be limited to the first 3 miles (5 km) of Glacier Creek Road, leaving the rest of the valley free of mine-related impacts. Traffic is not constant, but based around the arrival and departure of two shift changes and the passing of two ore trucks traveling in tandem approximately every 45 minutes at a maximum. Most traffic-related impacts to subsistence, recreational, and tourism use of the area can be avoided by scheduling around the two shift changes at the mine. Tourism may be positively impacted by the presence of the mine. For many tourists, the opportunity to view an operating gold mine is an asset; this may be particularly true in an historic gold mining region such as Nome.

8.1.4 Water Quality

8.1.4.1 Affected Environment

The Nome-Teller Highway does not cross any major drainages between Nome and the Glacier Creek Road turnoff; the road does cross a small drainage at Dry Creek. Glacier Creek Road parallels the Snake River and crosses over Crystal, Lynn, Mountain, and Gold creeks and their associated channels for a total of eight stream channels (these channels carry water only during high years of rainfall). The road then crosses over Glacier Creek just before the proposed mine entrance. Culverts that exceed the ADFG minimum fish passage requirements will be installed in all creeks, with the exception of Glacier Creek, which will be bridged. Water quality for the Snake River and Glacier Creek are discussed in the water quality section for the Rock Creek Mine/Mill Complex. Several emerging springs are located in the general vicinity of Glacier Creek Road. The Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, is quoted in the Glacier Creek Road EIS as defining the area as follows:

> …a series of springs that emerges along the northwestern base of the Banner Peak-Bonanza Hill ridge…The groundwater emergence, evidenced by a series of springs is associated with organic-rich swamp deposits along and just below the 100-foot contour. Bedrock was mapped as predominantly gray, slightly

> graphitic, calcareous quartz schist by Hummel (1962). Spring locations may be controlled by bedrock structure, the upper limit of a fairly thick till fill in the Snake River valley, or by the upper limit of thick continuous permafrost…the water is probably being produced from a karst system developed in the marble bedrock of the area…

There are no Clean Water Act 303(d)-listed waters along this transportation route.

8.1.4.2 Consequences

The Nome-Teller Highway is a state highway designed for public use. It has been utilized historically and presently for mining access and support. Industrial, commercial, and local use all pre-exist on the road. The traffic of commuting workers and transport of ore from Big Hurrah to the proposed Rock Creek Mine/Mill Complex is congruous with the present use of the road. Glacier Creek Road was designed and approved in anticipation of a major hard rock mine being developed at the proposed site (Glacier Creek Road EIS, _____) and should therefore have no negative impacts as a result of land clearing or road use. Increased traffic on the road surface should not result in any negative impacts to the water.

The mine will refine the gold concentrate into a gold doré bar so there will be no transportation of ground ore concentrate that could spill into the creeks along the route. Ore being transported along the route from Big Hurrah will not yet have been milled and will pose little threat in the form of blasted rock chunks. The mine is being powered by electric lines, minimizing the volume of diesel to be transported to the site, and therefore minimizing the threat of a petroleum spill to the creeks along the route. All trucks will carry fuel spill cleanup kits to minimize any impacts should a spill occur.

8.1.5 Biological Resources

8.1.5.1 Affected Environment

Both the Nome-Teller Highway and Glacier Creek Road pass through moist tundra areas underlain by permafrost, an extensive wetland type throughout the Seward Peninsula. Along the Nome–Teller Highway there are areas where the tundra has been altered by past mining activities and/or filled with mine tailings to accommodate development. The Coastal Zone Plan (need reference) does not show the area as a unique or valuable resource area. The EIS for Glacier Creek Road characterizes the vegetation as the region as follows:

> *Cotton grass tussock and dwarf shrubs predominate with mosses and lichens growing in between the tussocks. Associated vegetation includes shrubs such as dwarf birch, willows and Labrador tea; herbs like mountain avian, bistort, and saxifrages. Berries include lingonberries, cloudberries and blueberries. Along the stream beds and especially on mine tailings, alders and willows have taken hold.*

The Nome-Teller Highway passes over Dry Creek, which is a listed anadromous stream for coho and Dolly Varden rearing habitat (ADFG, 1998). Glacier Creek Road passes over Glacier Creek just before the proposed mine entrance; Glacier Creek is a listed anadromous stream that has

been documented for coho, pink, and chum salmon spawning both upstream and downstream of the creek crossing. Dolly Varden have been documented in the stream as well.

Native species of large game animals in and around the Nome area consist of muskox, grizzly bear, and moose. During the spring and fall, moose concentrations tend to follow the river valleys, especially the Snake, though they tend to stay closer to the riparian areas than the area on the plateau where the road is located (Glacier Creek Road EIS). Reindeer herding is conducted throughout the Seward Peninsula. The Nome-Teller Highway and Glacier Creek Road are within the Davis reindeer allotment area; however, there are no land use permits in effect at this time for this area.

Bird watching is a popular local and tourist activity. The bird surveys conducted for the Rock Creek Mine/Mill site are likely indicative of the bird species found in the general area of the Glacier Creek Road (see Section 7.7.4).

8.1.5.2 Consequences

The roadway was vegetated, which stabilizes the slopes and prevents erosion; therefore, use of the roadway should not cause degradation of fish habitat. Hunting may increase with improved access, impacting the large mammal populations; however, this is monitored and managed closely by ADF&G and should not result in a significant impact over time. Large mammals in the Nome area are often seen in and around the local roadways and appear to adjust well to human presence. The traffic to the mine will not be constant, but based around the arrival and departure of two shifts. Ore transport trucks will pass in tandem approximately every 45 minutes at a maximum. Wildlife may choose to avoid the transportation corridor during shift change and ore transport periods, but they may also pass through the area between shift changes without any interference.

8.1.6 Hazardous Wastes

8.1.6.1 Affected Environment

Hazardous Materials

According to ADEC, there are 20 known hazardous material sites in and around the city of Nome, including 13 leaking underground storage tanks (ADEC, 2005).

8.1.6.2 Consequences

Hazardous wastes are not anticipated to be transported in association with the proposed operation.

8.1.7 Archeological and Cultural Resources

8.1.7.1 Affected Environment

The Glacier Creek Road EIS stated that coordination with SHPO indicated that there were no registered historical properties directly in the road alignment. Evidence indicates that early

Alaska mining activities occurred throughout the area and could be found adjacent to the road alignment. Evidence of early Alaska mining activities, including old mining equipment and dredges, also occurs along the Nome-Teller section of the transportation corridor. A military hangar from World War II and other World War II military relics also exist along the route. The hangar was recently purchased for a proposed military museum.

8.1.7.2 Consequences

The transportation corridor uses existing roadways and does not involve the disturbance of any additional lands that could impact archeological or cultural resources.

8.1.8 Visual

8.1.8.1 Affected Environment

The Nome-Teller Highway section of passes through residential, industrial, and open tundra vistas. The Glacier Creek Road EIS states that the area around the new road is not unique from the perspective of visual resources. The scenic vistas along both the existing road and the preferred alignment are both quite common to this region.

8.1.8.2 Consequences

The use of this transportation corridor is congruent with its present uses and should not impact the visual resources.

8.1.9 Noise

Noise for the transportation corridor is addressed in Section7.9.7 Noise and Land Use Sensitivity

8.2 BIG HURRAH TO NOME

8.2.1 Big Hurrah Mine Traffic Assumptions

Under the worst case conditions, there will be a crew van making daily round trips to the Big Hurrah Mine. In addition, occasional large supply trucks, unscheduled pickup trucks, and emergency repair vehicles will also access the mine on an as-needed basis. These vehicles will use the Nome/Council Highway from Nome to the mine site. Ore will be sent to the Rock Creek Mine for processing using tractor trailers capable of hauling dual trailers with maximum legal loads. Ore hauling will occur 24 hours per day, 7 days a week, using two haul trucks operating in cycles of approximately 90 minutes. The haul route for the ore and other traffic between the two mine sites would be the Nome/Council Highway to the Nome Bypass, to the Nome/Teller Highway, to the Rock Creek Mine.

8.2.2 Affected Environment

The Nome/Council Highway is a state-maintained gravel road with a 200 to 400 foot (60 to 120 m) right-of-way for many sections of the roadway. This unpaved road serves the mostly seasonal mining communities and tourists visiting Solomon, Council, and Safety Sound.

From Nome, the road alignment proceeds south along the narrow coastal plain of the Bering Sea and Norton Sound over relatively flat terrain towards Cape Nome. At Cape Nome, the highway grade increases around Cape Nome before descending to the barrier islands separating Safety Sound from Norton Sound.

The highway continues south on the barrier islands following the Iditarod National Historic Trail adjacent to Safety Sound over the Bonanza River and past the tidal marsh at the present site of the village of Solomon. From Solomon, the highway proceeds east following the left bank of the Solomon River to the confluence of Big Hurrah Creek. A gravel road will be constructed along an existing state right-of-way from the Nome-Council Highway paralleling Big Hurrah Creek to the proposed mining operation at Little Hurrah Creek.

The occurrence of severe storms in the Safety Sound and Solomon areas were first reported in the early 1900s (Buzzel, et al., 1986). The barrier islands and the village of Solomon experienced severe storms in 1900, 1913, 1945, and 1974. The 1974 storm and less severe storms since the 1970s have caused considerable damage to the community and the Nome-Council Highway. The road is currently under emergency repair by ADOT&PF as a result of winter storm damage in 2004 and 2005.

8.2.2.1 Consequences

Use of the existing Nome-Council Highway is consistent with the purpose and intent of the existing road. No measurable environmental impact is anticipated along the road corridor from the transport of ore, equipment, and supply trucks between Big Hurrah and the Rock Creek facilities.

8.2.3 Past and Present Land Use

8.2.3.1 Affected Environment

The beginnings of the Nome-Council Highway date back to the early 20th century. The Bonanza mining district was organized in June of 1899. Prospectors found evidence of gold in the gravels throughout almost the entire length of the Solomon River and many of its tributaries. In the early 1900s, the village of Solomon served as a supply hub for gold mining activities in the Solomon River drainage. Supplies from the Lower 48 were shipped to Nome or Solomon, then transported by pack horses or wagons up the broad gravel bed of the Solomon River. A rough trail inland followed the gradual rise of the braided river bed to the various mining camps. Access to the Big Hurrah mine followed the Solomon River upstream to the confluence with the Big Hurrah Creek. Travel into the mine site followed the gravel beds of Big Hurrah Creek to the site at the confluence with Little Hurrah Creek.

Hotels and roadhouses were constructed at Solomon and along the trail inland to provide travelers with meals and lodging. The wide gravel bed of the Solomon River and its easy grade provided relatively easy access to the interior, compared to the difficult conditions encountered when miners attempted to carry supplies and equipment overland by wagons across the tundra. During the winter, stage and freight services operated between Nome and Council.

The first standard gauge railroad on the Seward Peninsula was built to connect Solomon the Council in 1903. Progress on the line was slow and a stage line opened to connect the railroad to inland mining camps. In 1905, the railroad was plagued by financial problems and the Nome Nugget newspaper encouraged the newly created Alaska Road Commission to build a better road that would provide a commercial link needed between the coast and the interior gold fields around Council. In September 1906 the head of the road commission visited the Seward Peninsula and agreed that improving the route from Nome to Council was of "first importance in the district". In 1905 the Alaska Road Commission began upgrading the trail that ran through the mountain passes from the East Fork railroad station on the upper Solomon River to Council. The Alaska Road Commission also began subsidizing the operations of ferrys at Port Safety and the Bonanza River. This opened up a wagon route from Nome to Solomon during the summer utilizing the privately owned toll roads between Nome and Fort Davis and around Cape Nome.

The termination of regular rail service at the end of 1907 left miners on the lower Solomon River utilizing a rough wagon trail through the stream bed, gravel bars and tailings piles of the Solomon River to get supplies to their mining camps. The growing importance of dredging operations on the lower Solomon River, the suspension of the railroad's operations, and increased traffic over the wagon route from Solomon to East Fork prompted the Alaska Road Commission to take over maintenance of this route. In 1911 the Road Commission began relocating the road to the west side of the river bank and construction to a more substantial standard. When the Road Commission ran short of funds on the project a group of miners met at Shovel Creek on July 11, 1912 and contributed a significant amount of money to keep the project going. The project was completed in 1917. In 1921, 1923, and 1929 repair work was done on the Solomon – East Fork section of the Nome-Council Road. The Alaska Road Commission considered this section of toad to be most important since stages operated on the road weekly and "the most important mining camps of the district" were located along the section (Buzzell and Gibson 1986).

In 1950, a portion of the Nome-Council Highway north of East Fork through the mountains was completed to allow automobile access. In the late 1950s, a bridge was constructed over the Bonanza River, replacing the ferry which had operated there since 1925.

After Alaska became a state in 1959, maintenance was conducted by the Alaska Department of Highways, the forerunner to the Department of Transportation and Public Facilities. In 1974, the Nome-Council Highway was heavily damaged by a severe coastal storm. Portions of the road were rebuilt by ADOT&PF in 1974 and a new bridge was constructed over the Bonanza River in 1977. During the following years, a new bridge was constructed over Safety Sound Inlet, allowing the Nome-Council Highway to be the principal transportation corridor through the Solomon River basin.

Subsistence hunting and fishing by local residents and people from Nome are still important activities in the area. However, gold mining which has altered the landscape and transformed the lifestyle of the Eskimos in the area during the last 85 years, remains the predominate commercial activity in the area.

Safety Sound provides considerable opportunity for bird watching for local residents and tourists. The Nome area attracts tourists from all over the world. Serious bird watchers come to

the area to add several Eurasian species to their life lists. There are a number of businesses in Nome that offer bird watching tours along the Nome-Council Highway. Tourism continues to play an important economic role for the community of Nome. Approximately 20,000 to 23,000 visitors come to Nome each year, the majority in the summer (Nome, 2005)

Land ownership from Nome to Big Hurrah Creek consists of Native Conveyed, Native Selected, State Selected USFWS, Conflicting Selections, and Bureau of Land Management (BLM) lands.

In Safety Sound, the USFWS land was included into the Alaska Maritime National Wildlife Refuge with the passage of the Alaska National Interest Lands Conservation Act. The refuge boundary extends from the bridge over Safety Sound Inlet south for approximately 4 miles. Adjacent to the bridge there is a 70-acre (30-ha) parcel available for parking and bird watching. This site was proposed for Interpretive Site Designation in 1995 by the Alaska Maritime National Wildlife Refuge (AMNWR, 1995). There are two additional parcels of land administered by the refuge located further south towards the Bonanza River

The Iditarod National Historic Trail, which is part of the National Trails System, includes 16 miles (26 km) of trails in Safety Sound (AMNWR, 1995). USFWS manages the trail and associated sites in a manner which protects and interprets their historic values.

Safety Sound is within the Bering Straits Coastal Resource Area and is considered to be an Area Meriting Special Attention (AMSA) because of the importance of the natural resources to local residents. The preservation of the area's natural resources and access for subsistence uses are major considerations in the AMSA plan for Safety Sound.

8.2.3.2 Consequences

Utilization of the Nome-Council highway for access and support of mining activity is congruent with the roads origins, past and present use, and its past financing.

Given the infrequency of the truck traffic on the highway, opportunities for viewing away from the road right-of-way, and the availability of the parking area near Safety Sound Inlet, no measurable impacts are anticipated on the tourist industry and bird watching opportunities.

8.2.4 Water Quality

8.2.4.1 Affected Environment

The Nome-Council Highway crosses Safety Sound, a number of wetlands, the Nome River, and 14 streams from Big Hurrah to Nome. No analytical data have been collected on water quality for these water bodies. There are no Clean Water Act 303(d)-impaired water bodies in or near the project area (ADEC, 2003).

8.2.4.2 Consequences

No adverse impacts are anticipated to water quality along the Nome-Council Highway from the operation of trucks and equipment.

8.2.5 Biological Resources

8.2.5.1 Affected Environment

The Nome-Council Highway runs along the coast from Nome to Solomon through Safety Sound. The topography is relatively flat with some rolling hills as you proceed inland from Norton Sound.

From Nome to Cape Nome and Solomon to Big Hurrah Creek the vegetation consists of palustrine emergents such as sedges (carex sp.) and shrub scrub vegetation including shrub birch, willow, and Labrador tea; herbaceous plants such as alpine bistort; and saxifrages. Alders and willows are the dominant plant species along the stream channels and on abandoned mine tailings. Other vegetation in the area consists of lingonberry, cloudberry, and blueberry. Schuman (1985) identified eight separate plant communities from Solomon to the Big Hurrah Creek area.

Safety Sound

Safety Sound, an inlet of the Bering Sea, is a large saltwater estuary separated from Norton Sound by a barrier island running from Cape Nome to Solomon. The Safety Sound barrier island is low and flat with numerous ponds. The sandy soils are covered by moist tundra and marsh vegetation.

Habitat types common along the coastal lowlands include dunes, low shrub-water sedge (tussock tundra), lichen–sedge (coastal tundra), and sedge (wet meadow). The most common plants include dune grass, sea peavine, large-flowered spear grass, water sedge (Carex aquatilis), Bigelow sedge (C. bigelowii), Alaska bog willow, and white cotton grass (Eriophorum scheuchzeri). Low shrub–water sedge occurs in combination with Bigelow sedge, water sedge, Labrador tea, and dwarf arctic birch.

Wetlands habitats in the Safety Sound area from Cape Nome to Solomon consist mostly of marine subtidal and intertidal areas with some estuarine subtidal and estuarine emergent habitats represented. A large wetland complex is located on the Safety Sound side of the highway from Cape Nome south for approximately 2 miles (3 km). National Wetland Inventory data were not available to determine if this is a saltwater marsh or freshwater wetland.

The Safety Sound estuary supports unique communities of plants and animals specifically adapted to saltwater and freshwater environments. Estuarine environments are among the most productive on earth, producing more organic matter each year than any other ecosystem.

Safety Sound supports mammals such as rodents, parka squirrels, tundra hare, ptarmigan, otter, muskrat, mink, musk oxen, and moose. Predators include brown bear, polar bear, arctic fox, red fox, raptors, and jaegers. Sea mammals include walrus and seal. While large mammals may be present on the Safety Sound barrier island from time to time, the area is dominated by waterfowl, shorebirds, and passerines.

Safety Sound provides extremely valuable resting, feeding, nesting, and migratory habitat for most species of North American waterfowl. As many as 188 species of waterbirds, passerines,

and raptors are found on the Seward Peninsula. Of these, 73 use the wetlands, mudflats, and tidal marshes of Safety Sound. Migratory waterfowl include black brant, tundra swan, Canada goose, American wigeon, and northern pintail. Locally abundant species include arctic tern, tree and cliff swallows, arctic warblers, gray-cheeked thrush, yellow wagtail, yellow warbler, American tree sparrow, pelagic cormorants, and eiders.

Arctic terns and common eiders use the upper beaches for nesting. Beaches and tidal flats provide habitat for feeding shorebirds, gulls, and waterfowl. Habitat use by these species is very high during post-breeding, fall migration periods, and during breeding (local bird populations). Nearshore waters of Safety Sound support loons, waterfowl, and gulls.

The Nome-Council Highway to the Big Hurrah Creek crosses one major river, 12 streams, and several smaller creeks. Of these, five, including Hastings Creek support anadromous fish. Nome River, Manila Creek, Solomon River and Shovel Creek provide spawning and rearing habitat for Dolly Varden and pink, chinook, coho, and chum salmon (ADFG, 1998).

Big Hurrah Creek

Big Hurrah Creek is an extensively mined floodplain. Prospectors with hand tools, hard rock mining and placer mining have all occurred within the area. Dredge tailing piles are present up and down the creek bed. The stream channel is poorly defined and there is no know over-wintering habitat in the area. Big Hurrah Creek supports Dolly varden (Salvelinus malma)and provides spawning habitat for pink salmon (Oncorhynchus gorbuscha)

8.2.6 Threatened and Endangered Species

The spectacled eider, listed in 1993 as a threatened species under the Endangered Species Act, is known to occur in the Safety Sound area. Spectacled eiders use the Safety Sound area as a stopover during migration. Spectacled eiders are not known to nest in the area and the habitat of this coastal barrier island is not typical of areas where nest sites have been previously found (AMNWR, 1995).

8.2.7 Subsistence

8.2.7.1 Affected Environment

Safety Sound provides important subsistence opportunities for local residents for wildlife, waterfowl, plants, and fish. Chinook, coho, chum, and pink salmon; Dolly Varden and whitefish species are harvested from the Flambeau River and Bonanza Creek. Clamming and tomcod fishing are also popular. A fish drying rack is available on refuge lands. Many households harvest hares, ptarmigan, fox, squirrel, otter, mink, and muskrat. Bears are occasionally hunted along the rivers. Safety Sound is a prime waterfowl hunting area for local residents because of the abundance of birds.

The road system allows local residents to harvest wild plant foods, particularly roots, blueberries, cranberries, willow leaves, sourdock, and Eskimo potato. Driftwood is also collected along the coastline for firewood and building materials (AMNRWR, 1995).

8.2.7.2 Consequences

Use of the existing road by trucks transporting ore from Big Hurrah Creek to Rock Creek is not anticipated to have any measurable impact on fish and wildlife resources. Bird species more sensitive to a slight increase in the frequency of road traffic will likely select areas more removed from the source of the disturbance.

Construction of the improved road up the Big Hurrah Creek valley will result in the removal of historic tailing piles that impede water passage in the floodplain. The project has also committed to excavation that will better define a stream channel through the floodplain, and the establishment of ponds that will provide over-wintering habitat for fish. Overall, the fishery in Big Hurrah Creek will be enhanced as a result of the transportation access improvements associated with the project.

Subsistence and mining have co-existed in the area for 100 years. Subsistence resources are abundant throughout the region. The project is not expected to adversely impact local resident's subsistence lifestyle.

8.2.8 Hazardous Wastes

8.2.8.1 Affected Environment

According to the ADEC, there are 20 known hazardous material sites in and around the city of Nome, including 13 leaking underground storage tanks (ADEC, 2005).

The Big Hurrah gold mine was investigated as a possible EPA Superfund site in 1981, in response an observation of 10 to 20 drums labeled sodium cyanide at the site.. In 1982, 20 drums of cyanide were removed from the site by Anaconda Company. Follow-up site assessments were conducted in 1982 and 1984, and soil samples were collected in 1992. There was no evidence of hazardous substances present at the site in 1982 and the 1992 soil samples indicated the soils were within compliance for total and TCLP metals, cyanide, and PCBs, the exception being elevated levels of arsenic. However, TCLP results indicated low leachability and that arsenic concentrations were consistent with regional background data.

8.2.8.2 Consequences

Ore transported on the Nome-Council Highway has an extremely low probability of becoming affected by hazardous materials based on location of these hazardous materials sites to the highway right-of-way.

8.2.9 ARCHEOLOGICAL AND CULTURAL RESOURCES

8.2.9.1 Affected Environment

In 1985, Buzzell et al., conducted a cultural resources survey of the Nome-Council Highway from Milepost 32 to Milepost 42 from the Bonanza River Bridge to south of the Big Hurrah Creek. A large number of historical features and sites were documented, including the Solomon Roadhouse (Milepost 33.5); Hercules gas engine and siphon tanks (Milepost 38.20); steam

engine (Milepost 38.9); steam winch (Milepost 38.7); and a gravesite (Milepost 39.8). Only the Solomon Roadhouse meets the criteria for the National Register of Historic Places. This site was placed on the National Register in 1979.

Settlements were first observed along the coast during both the summer and winter months by Europeans visiting the area. Ivan Kobelev's map of 1779 shows many of these Native villages proximate to caribou hunting and salmon fishing areas (Buzzell et al., 1986).

Before the influx of white settlers during the gold rush, a small village existed at the mouth of the Solomon River. Buzzell speculates that the village may have been used seasonally as a fish camp and some of the inhabitants may have resided inland in the Casadepaga area.

The original Native village near present day Solomon was one of a number of small villages located along the coast of the southcentral Seward Peninsula; others included Cape Nome and Spruce Creek, located 8 miles east of Solomon.

Extensive prospecting and mining in the Solomon River Valley began in 1899. Construction of the Council to Solomon first standard gauge railroad started in 1903 but the line closed in 1907. The use of large scale-dredging dominated mining in the Solomon River drainage from 1905 to the 1930s. Solomon remained a vital town until mining activities declined in the 1950s.

Since the late 1950s, only four to six people have resided year-round in Solomon, depending upon a gold mining and subsistence lifestyle.

The Iditarod Trail was designated a National Historic Trail in 1978. This trail system was the primary route connecting Seward and Nome between 1880 and 1920. Today the trail is used in the winter to host the annual Iditarod Sled Dog Race from Anchorage to Nome.

8.2.9.2 Consequences

No impacts are anticipated on Archeological and Cultural Resources along the Nome-Council Highway from the operation of the trucks.

8.2.10 Noise

Noise for the transportation corridor is addressed in Section 7.9.7 Noise and Land Use Sensitivity

8.2.11 Visual

8.2.11.1 Affected Environment

The Nome-Council highway passes through tundra, coastal, and residential vistas along an established road corridor.

8.2.11.2 Consequences

The use of this transportation corridor is congruent with its present uses and should not impact the visual resources.

9.0 CUMULATIVE EFFECTS

9.1 OBJECTIVES OF CUMULATIVE EFFECTS ANALYSIS

Environmental effects may result not from the direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time; these are termed cumulative effects. Cumulative effects are defined in 40 CFR 1508.7 as effects on the environment which are expected to result, "…from the incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions…Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time."

The effects of human activity will accumulate when a second environmental perturbation occurs at a site before the ecosystem can fully rebound from the effect of the first perturbation. When an ecosystem has the opportunity to rebound from the effects of the first perturbation before a second perturbation occurs, there are no cumulative effects. Cumulative effects may be countervailing – where the net adverse cumulative impact is less than the sum of the individual effects, or synergistic – where the net adverse cumulative effect is greater than the sum of the individual effects.

The underlying objective of cumulative analyses is to better ensure resource sustainability, the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. Resource sustainability has also been defined as follows: "…provides a growing economy that provides equitable opportunities for satisfying livelihoods, and a safe, healthy, high quality of life for current and future generations" (Brundtland Commission).

The issues for consideration in a cumulative analysis are not meant to be a long laundry list, but a concise list of the most important issues to address. The resource values for the Snake River Valley are primarily subsistence, mineral resource development, and potential tourism. Issues related to these values include: economic development, subsistence, potential for water quality impacts, and general land disturbance.

An evaluation of cumulative effects requires an appropriate definition of time and geographical area to provide a meaningful analysis. Temporal definition is based on the life cycle of the effects. State of Alaska mine reclamation regulations require land, and related erosion, to be stabilized within one year of closure. The regulations also require that vegetation be established within 5 years of closure. The life cycle of the physical impacts should conclude with the revegetation and stabilization of the site, as required, within 1 to 5 years after closure of the mine. The cycle of effects for socioeconomic and transportation issues would extend as long as the mill was being used for mineral development in the area, 10 to 20 years after mine closure for the purpose of this analysis.

Geographically, the physical impacts of the projects are not likely to accumulate outside of the respective watersheds of the two mines, the Snake River Valley, and the Big Hurrah River Valley. Socioeconomic issues and transportation issues may extend throughout the known road system of the southern Seward Peninsula. It is reasonable to assume that it may be economically feasible to develop a mine that used the mill, if the mine could be accessed by the road system, or a minor extension of the system. However it is unlikely that mineral deposits on land away from the road system could be economically transported to the mill site for refinement.

9.2 PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE ACTIONS

9.2.1 Past Mining Activity

Mining has been a continuous intermittent activity on the Seward Peninsula for the past 100 years. In 1897, the first gold strike on the Seward Peninsula occurred on Melsing and Ophir creeks and the town of Council was founded. Discovery of gold in the Snake River Valley followed in 1898. The discovery of gold in the beach sands in 1899 established Nome as one of the largest and most corrupt towns of the Alaska Gold Rush. Between 1903 and 1934, 40 dredging operations were undertaken in the Nome district, with the major shift to dredging occurring in the 1920s. Dredges were still active in the area into the late 1980s, including an offshore gold dredge that operated between 1985 and 1990. Placer mining still occurs in the region today. There are few areas around the southern Seward Peninsula that have not been prospected or mined at some point and to some degree in the past 100 years.

The past mining activity produced 59.5 miles (95.8 km) of water conduits or ditches in the Nome area. The present day road system through the southern Seward Peninsula can all be traced back to pack train trails, roads, and railroads established during the gold rush. The present Nome port causeway infrastructure traces its original primary use as a docking facility for the offshore gold dredge, BIMA, owned by WestGold Exploration and Mining Company and its support vessels.

9.2.2 Present Mining Activity

At present there are 16 listed onshore APMAs for the Nome District, and 14 listed offshore APMA applicants. The mining lands manager at BSRC stated that 11 of the onshore applicants were known to have actively placer mined during 2005, two onshore applicants were actively conducting exploration work, and two onshore applicants did not conduct their permitted operations. It was unknown if the 16th applicant had conducted any mining or exploration activities in 2005. BSNC does not track the offshore miners, but was aware of many offshore operations being conducted off the Nome coast during 2005, and they were aware of an additional offshore operation offshore of Bluff, further east down the coast.

State of Alaska, Department of Commerce, Annual Minerals Industry Report production records for the Western District show four gold producers from the Nome District. These producers, along with five other gold producers in the Western Region, produced 12,446 ounces (352,838 grams) of gold. It is likely that not all miners are willing to submit production records to the Department of Commerce.

Present land use no longer uses railroads or water ditches as was done historically. Gold placer concentrates are typically low in bulk and can be transported by air. Supplies are still often

shipped by barge to Nome, but shipment is also augmented by air cargo. There are no gold ore mills currently in operation in Nome. Historical mills still remain in the area, including at Big Hurrah, but they are generally not up to modern standards.

9.2.3 Reasonably Foreseeable Actions

The mine has an expected life of 4 to 5 years based on core drilling. Reverse circulation drilling has produced samples that indicate the ore deposit may be larger than represented by the core drilling. If the reverse circulation drilling data are accurate, the life of the project could reasonably be expected to extend to 7 to 10 years before closure.

After closure, the capital costs of the mill are anticipated to have been recovered. The presence and availability of an already existing gold recovery mill could open up the potential to develop additional gold deposits that would otherwise not economically support the construction of an independent mill. Alaska Gold holds approximately 15,000 acres (6,100 ha) of patented mining claims in the Nome district and it is reasonable to predict that additional deposits may be discovered and developed for processing through the mill. Exploration is currently occurring, or has occurred in the recent past, for the lands adjacent to Rock Creek, Big Hurrah, and at the Saddle Bonanza deposit. These as well as other mineral deposits on the southern Seward Peninsula are all potential mines that could utilize the Rock Creek mill in the future.

It is also possible that other miners may work out an arrangement with the company to use the mill for their deposits. This would enable additional hard rock mining for gold in the general area.

The amount of growth associated with the availability of a mill would be limited by the maximum throughput rate for the mill (5,000 to 8,000 tons (4,500 to 7,250 tonnes] per day). The mill is set up to produce gold doré bars and would not likely result in bulk volumes of product for transportation or export. Cumulative impacts to transportation or shipping requirements are not anticipated to be significant.

The availability of the Rock Creek mill facility has the potential to extend the impacts associated with the Rock Creek Project over a longer period of time. The physical limitations of the mill, however, would not allow for an expansion in magnitude of the impacts. As potential new mines were opened, existing mines would be undergoing reclamation.

9.3 CUMULATIVE EFFECTS TO THE ENVIRONMENT

9.3.1 Cumulative Effects to the Physical Environment

9.3.1.1 Affected Environment

Geology

The Nome Schist Belt that extends across the southern Seward Peninsula is typically characterized by a substantial presence of carbonate. The presence of carbonate buffers the potential for acid generation related to any sulfides in the rock.

Much of the southern Seward Peninsula has been previously placer mined. At one time, 40 dredges were in operation, mostly operating in the creek bottoms.

Air Quality

Diesel generation and increased use of the power grid have contributed to industrial emissions in the area. By regulatory standards, this cumulative effect is not significant, because the area complies with all National Ambient Air Quality Standards and the State of Alaska Ambient Air Quality Standards. The Rock Creek mill is connected to the Nome electrical grid.

Water Quality

9.3.1.2 Environmental Consequences Geology

The development of additional mines in the area is not likely to result in acid-generating or metal-leaching geochemical impacts to the environment because of the general presence of carbonate in the rock.

As new mines are developed on previously disturbed lands, it is likely that reclamation efforts will encompass recontouring of those lands that were previously unstable. Tailings piles in creeks provide good fill material. The removal of tailings from creek beds for fill purposes and associated stream enhancement projects is being modeled in the Rock Creek Project and will likely be encouraged by local regulators in the future, leading to increased stream enhancement within the region.

Excavation, fill, and development of mine pits all have the potential to affect surface drainage patterns and modify the soils thermal regime. This can result in minor changes to drainage patterns or permafrost, and may cause an expansion of the affected area beyond the original disturbance. Modern practices have resulted in the development of successful approaches to help minimize these impacts. These include diversion ditches and the use of thermo-siphons. As mines close out and others open, re-establishment of stream channels and freeze-back of permafrost should balance over time.

Air Quality

Use of the mill could be extended to process additional deposits. Power would continue to be supplied through the local power grid with the same rate/quality of emissions. The amount of diesel generation required to support a satellite mine facility would likely be small and within compliance.

Water Quality

The development of additional satellite mines will likely result in the need to discharge pit water, as the satellite mine water would not be available for recycling in the mill. The NPDES program would manage these discharges.

Water withdrawal from groundwater sources or the Snake River will likely be required to run the mill.

9.3.2 Cumulative Effects to the Biological Environment

9.3.2.1 Affected Environment

Throughout the southern Seward Peninsula there are extensive undisturbed wetlands and wildlife habitat. Habitat types are similar throughout the Peninsula. Bird and mammal species observed at the Rock Creek site coincide with species observed at Big Hurrah 50 miles (80 km)to the east.

9.3.2.2 Consequences

Because the throughput of the mill is limited, the most likely scenario is that one mine will close before another is opened. There may be a slight overlap in mine operations as volumes diminish at the end of mine life, or there may be dormant periods until another discovery is brought into production. Reclamation regulations require that revegetation be significant within 5 years of closure. Overall disturbance and reclamation should balance out over time, creating little net cumulative impact on wildlife and wildlife habitat. There will be some wetlands loss due to filling activity; however, there will also be wetlands being generated in the form of pit lakes and wetlands mitigation occurring in conjunction with mine development.

9.3.3 Cumulative Effects to the Human Environment

9.3.3.1 Affected Environment

Subsistence activity is the main land use, along with mining in these areas. Subsistence use and mining have co-existed in this region for the past 100 years. Subsistence use occurs near both mine sites, especially moose hunting in the Snake River Valley. There are extensive opportunities for subsistence use in other areas throughout the southern Seward Peninsula.

Visual resources in the area are primarily natural scenery mixed in with abandoned and relic mining equipment. This is especially true at the Big Hurrah site where there are visible remains of an old stamp mill, residence, power house, and other related mining support buildings.

Noise level potential would be similar from one mine site to the next as the landforms and vegetation are fairly similar throughout the region.

Socioeconomic conditions in the region include a 39.4% unemployment rate. Housing is limited and usually substandard with more than half the houses more than 40 years old.

9.3.3.2 Consequences

Ongoing mining activity is congruent with past and present land use. The net balance of disturbance and reclamation over time will minimize impacts on subsistence use. There will be some impact on hunter knowledge and success rates due to changes in wildlife use patterns as wildlife adjusts to lands being developed and lands being reclaimed. The abundance of subsistence use resource areas will mitigate much of this impact.

Visual resource impacts will also shift over time and place as mines are developed and closed. The mill, if it remains in place and in use, will be a more permanent industrial structure than

typical of most present day mines in the area, although not incongruent with historical use of the area, i.e., the stamp mill at Big Hurrah which is still standing. However, the mine is a portable unit that can be removed when it is of no further use to the owners.

Ongoing use of the mill facility could extend the socio-economic benefits of the Rock Creek Project over time, bringing a stabilizing effect to the Nome economy. The potential for steady mining activity over time would improve the economic feasibility of developing more local support services.

Noise – The noise levels would not likely increase over time. New mines would likely have similar mining and transportation rates because of mill capacity limitations.

9.4 SUMMARY CONCLUSIONS

The cumulative effects of the Rock Creek project are primarily tied to the possible extended use of the mill. The limited mill capacity creates a balance between new impacts and reclamation that generally leads to no net increase in cumulative effects. The potential for mitigation of historical mine disturbance associated with ongoing new mine development, based on the examples set by the Rock Creek Project, could lead to an overall countervailing cumulative effect from the project. As either a project that leads to no net increase in cumulative effects, or a facility with countervailing cumulative effects, the project fulfills the goal of sustainable development.

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