Alaska Gold Company
A NovaGold Subsidiary

Rock Creek Mine Project

Groundwater Injection Well Permit Application

May, 2006

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Alaska Gold Company

A NovaGold Subsidiary

May 10, 2006

Luke Boles
Alaska Department of Environment Conservation
610 University Avenue
Fairbanks, AK 99709

Dear Mr. Boles:

Alaska Gold Company, a wholly owned subsidiary of NovaGold Resources Inc., is requesting an underground injection well permit in conjunction with the Rock Creek Project Waste Management Permit. The underground injection well portion of the waste management permit is requested in accordance with AS 46 and 18 AAC 72 and is intended for use in the disposal of water associated with the Rock Creek Mine Project.

Alaska Gold Company will intercept groundwater around the perimeter of the Rock Creek Pit and the Big Hurrah Pit and reinject the water into groundwater systems down gradient of the mine. Additional waters that may be injected include precipitation that collects in the pits and other stormwater runoff that accumulates at either of the sites. Injection wells will be established at both the Rock Creek Mine/Mill Complex and the Big Hurrah Mine site to handle their respective waters.

Details of the proposed underground injection well system are attached to this letter. Also attached in appendices are:

- The Rock Creek Water Management Report,
- The Big Hurrah Water Management Report,
- The Rock Creek Groundwater Database,
- The Big Hurrah Groundwater Database,
- Flow Chart for the Mill and Site, and
- the accompanying Water Rights Permit Application.

Forthcoming is the:

- Water Treatment Plant Design, and
- Detailed Engineering Plans for the Infiltration Gallery.

Pocketed placeholders for these last three items are inserted in the packet so that may be easily inserted as soon as they are available.

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If any additional information is required, please contact me at (907) 743-9366 or by e-mail at cmaccay@bristol-companies.com.

Sincerely,

Charlotte MacCay
Environmental Manager

cc: Pete McGee/ADEC
Tom Crafford/ADNR
Doug Nicholson/AGC
Ken Pohle/AGC

Alaska Gold Company

Rock Creek Mine Project

Groundwater Injection Well Permit Application

Prepared by

Bristol Environmental and Engineering Services Corporation

Anchorage, Alaska

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Appendix A Rock Creek Water Management Report

Appendix B Big Hurrah Water Management Report

Appendix C Rock Creek Groundwater Database

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Appendix E Water Rights Use Permit Application

Appendix F Water Treatment Plant Design

Appendix G Infiltration Gallery Design

1.0 PROJECT DESCRIPTION

The Rock Creek Mine Project (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 miles (10 kilometers (km)) north of Nome in the Snake River watershed, and the Big Hurrah Mine located about 42 miles (68 km) east of Nome in the Solomon River watershed (Figure 1).

1.1 ROCK CREEK

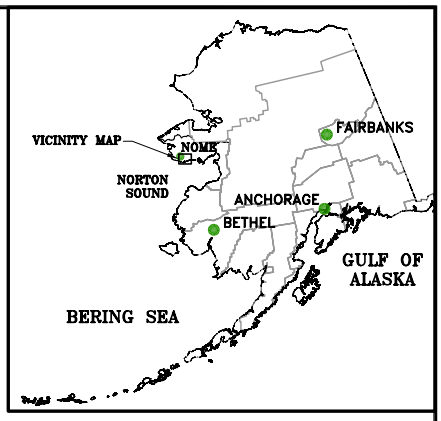
The Rock Creek Mine/Mill Complex will consist of an open pit gold mine, two non-acid generating development rock dumps, a gold recovery plant, and a paste tailings storage facility (TSF). The Rock Creek site layout is presented in Figure 2. Ore milling rates will be about 2.5 million tonnes (Mt) per year, while development rock stripping volumes will be in the range of 4 to 5 Mt 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.

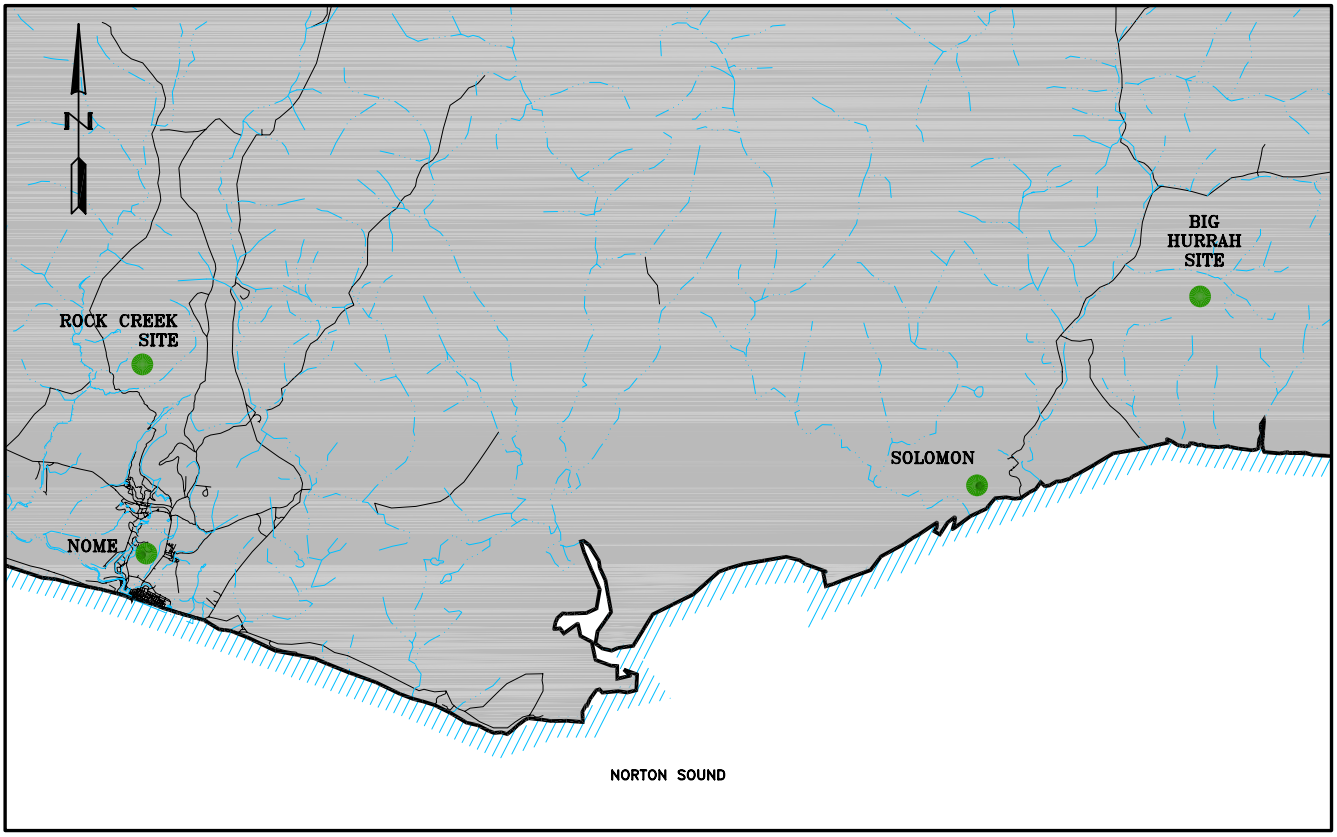
1.2 BIG HURRAH

The Big Hurrah Mine facilities will include: an open pit gold mine, a non-acid generating development rock dump, a temporary stockpile for backfill of potentially acid generating development rock in the pit, a run-of mine ore stockpile, a truck maintenance shop, a small administration building, explosive storage and diesel fuel storage. The Big Hurrah site layout is presented in Figure 3. The ore mining rate will be about 1,500 tonnes per day (tpd) and the stripping rate will be 5,000 tpd. Ore will be stockpiled and delivered to the Rock Creek Mill at an average rate of about 1000 tpd.

2.0 CLIMATE

The climate of the Nome region is maritime during the summer months (early June to mid-November) due to the open water of Norton Sound; however, near the end of November, Norton Sound begins to freeze causing a shift of the regions climate from maritime to continental (National Climate Data Center 2004). The project site is characterized by cool summers and cold winters. Temperatures in the summer average between 44 and 65 degrees, while winter average temperatures range between –3 and 11 degrees Fahrenheit (ADCED 2003). The area receives approximately 18 inches of precipitation annually, which includes 56 inches of annual snowfall (ADCED 2003)





2500 0 2500 5000 METERS

CLASS V INJECTION WELL PERMIT APPLICATION

CLIENT: ALASKA GOLD COMPANY

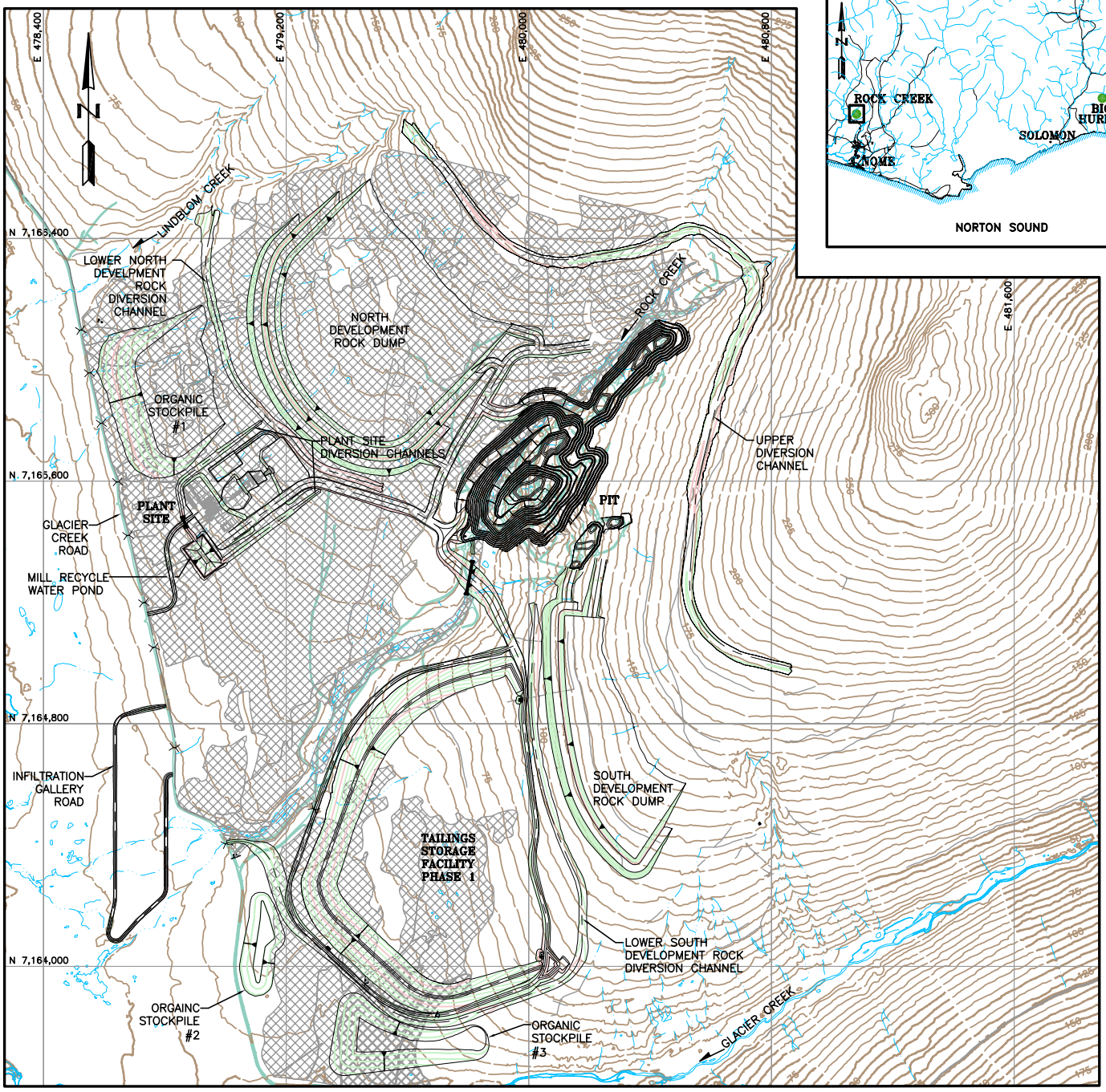
PROJECT: ROCK CREEK PROJECT

TITLE: VICINITY MAP

SMITH WILLIAMS CONSULTANTS, INC.
304 Inverness Way South, Suite 490, Englewood, Colorado 80112
Phone: 303-433-0262 Fax: 303-433-0362

DESIGNED BY	RTB	CHECKED BY	RTB	DATE
DRAWN BY	DS	APPROVED BY	RTB	2/24/06

FILENAME	FIGURE No.	REV.
1011F200	1	A



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LEGEND:

- PROPOSED GROUND SURFACE CONTOUR AND EL, METERS
- EXISTING GROUND SURFACE CONTOUR AND EL, METERS
- EXISTING ROAD
- EXISTING STREAM
- EXISTING DITCH
- EXISTING POND/WATER
- EXISTING CULVERT
- EXISTING TRAIL
- PROPOSED CULVERT
- WETLANDS

CLASS V INJECTION WELL PERMIT APPLICATION

CLIENT: ALASKA GOLD COMPANY

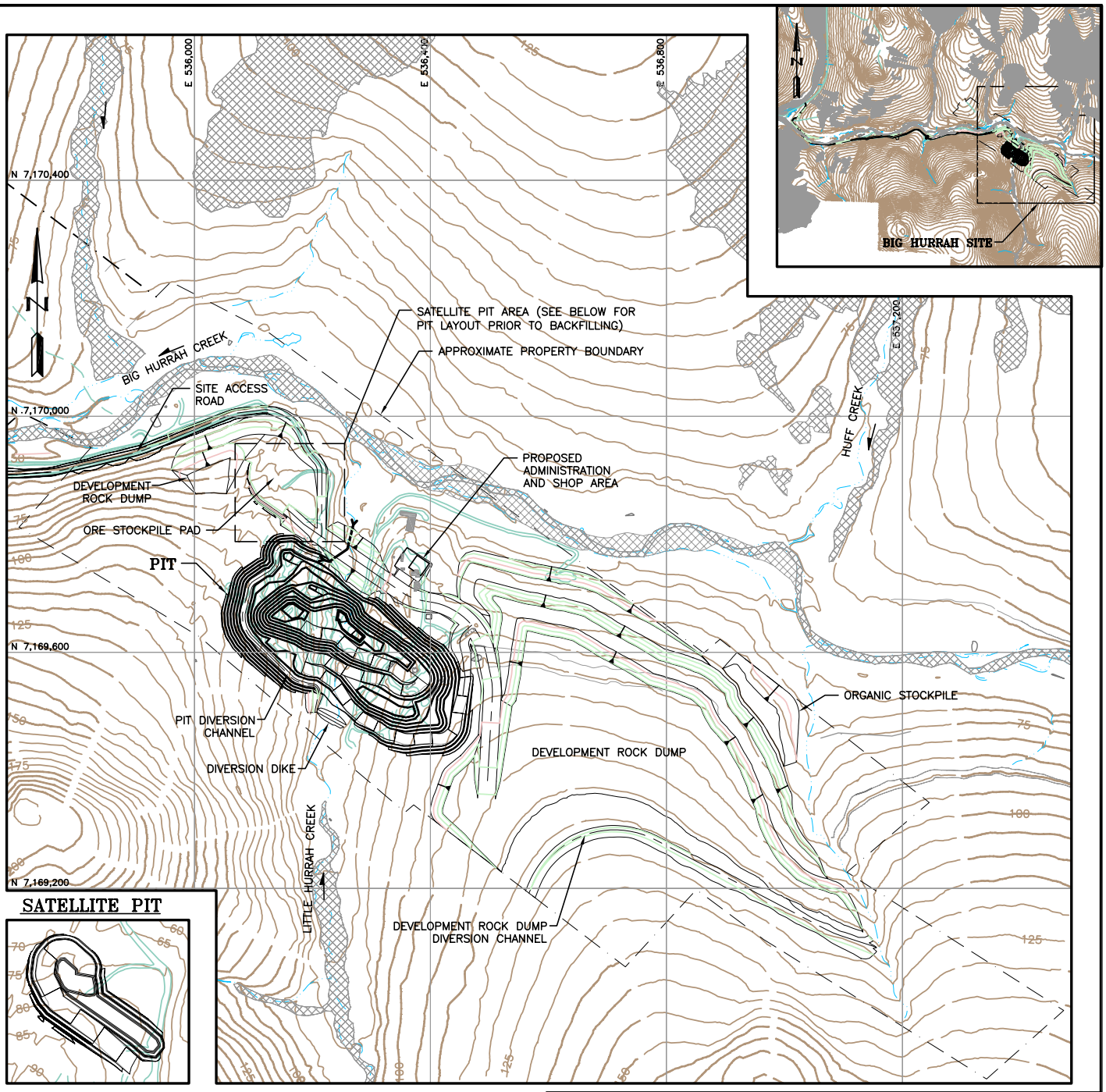
PROJECT: ROCK CREEK PROJECT

TITLE: ROCK CREEK MINE/MILL SITE PLAN

SMITH WILLIAMS CONSULTANTS, INC.
304 Inverness Way South, Suite 490, Englewood, Colorado 80112
Phone: 303-433-0262 Fax: 303-433-0362

DESIGNED BY	JNM	CHECKED BY	RTB	DATE
DRAWN BY	JNM	APPROVED BY	RTB	2/24/06

FILENAME	FIGURE No.	REV.
1011F197	2	A



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SCALE = 1:10,000

LEGEND:

- EXISTING GROUND SURFACE CONTOUR AND EL, METERS
- PROPOSED GROUND SURFACE CONTOUR AND EL, METERS
- EXISTING ROAD
- EXISTING STREAM
- EXISTING DITCH
- EXISTING POND/WATER
- EXISTING STRUCTURE
- WETLANDS
- PROPOSED CULVERT

CLASS V INJECTION WELL PERMIT APPLICATION

CLIENT: ALASKA GOLD COMPANY

PROJECT: ROCK CREEK PROJECT

TITLE: BIG HURRAH MINE SITE PLAN

SMITH WILLIAMS CONSULTANTS, INC.
304 Inverness Way South, Suite 490, Englewood, Colorado 80112
Phone: 303-433-0262 Fax: 303-433-0362

DESIGNED BY	JNM	CHECKED BY	RTB	DATE
DRAWN BY	JNM	APPROVED BY	RTB	2/24/06

FILENAME	FIGURE No.	REV.
1011F198	3	A

3.0 GEOLOGY

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).

3.1 ROCK CREEK LOCAL GEOLOGY

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 square miles (5 square km).

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). Glacial, alluvial, and tectonic processes shaped the eastern wall of the Snake River Valley, upon which this catchment lies.

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 feet (10.7 m) of sand and gravel overlying silt and clay, finally encountering bedrock at a depth of 61 feet (18.6 m).

3.2 BIG HURRAH LOCAL GEOLOGY

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.

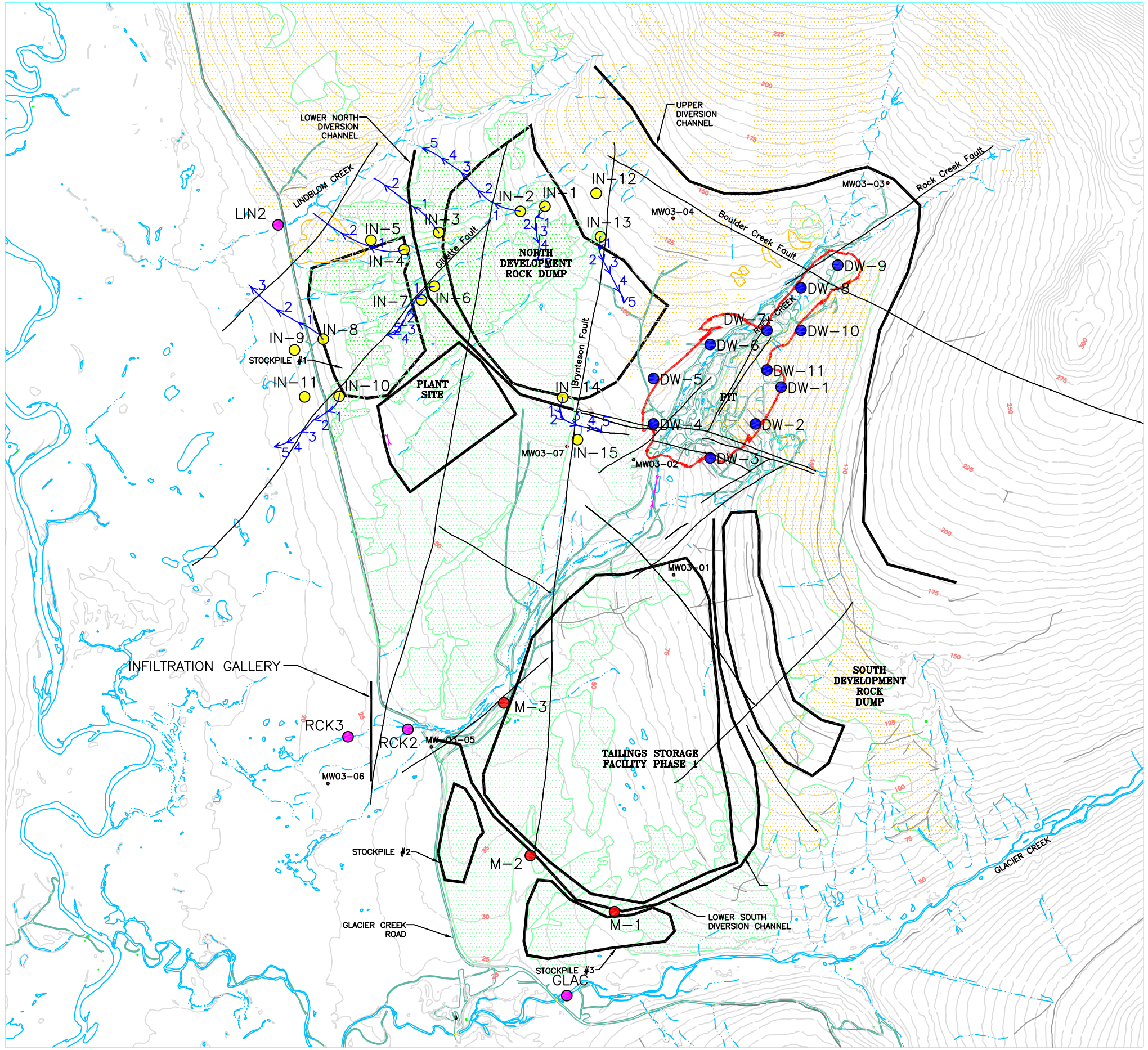
4.0 PERMAFROST

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.

4.1 ROCK CREEK

Six thermistors were placed near the TSF and Mill areas at the Rock Creek site. An additional two thermistors were installed in the vicinity of the open pit. Data available from four of the sites indicate an active layer that ranges from 3 to 38 feet (1 to 12 m), with a mean value of 19 feet (6 m). The approximate extent of permafrost at the Rock Creek site is shown on Figure 4.



N

LEGEND:

- EXISTING ROAD
- EXISTING STREAM
- GLAC — SURFACE WATER MONITORING SITE
- IN-5 — INJECTION WELL
- DW-5 — DEWATERING WELL
- M-1 — TSF MONITORING WELL
- MW-05 — EXISTING MONITORING WELL
- PATH LINE WITH TRAVEL TIME (YEARS)
- FROZEN GROUND
- FROZEN GROUND – INFERRED

REFERENCE:
TOPOGRAPHIC DATA DOWNLOADED FROM NORWEST CORPORATION FTP SITE.
SURVEY BY: KODIAK MAPPING SURVEY, FROM AERIAL PHOTOGRAPHY ACQUIRED ON 10-2-2004 FILENAME: S:\CAD\1011-rock creek\recv\20050203-Big Hurrah\big_hurrah_2004.dwg

150 0 150 300 METERS
SCALE = 1:15000

Original drawing (1011F35 – Preliminary Permafrost Frozen/Thawed Zone Delineation) provided by Smith Williams Consultants, Inc.

ALASKA GOLD

ROCK CREEK PROJECT
ROCK CREEK MINE/MILL COMPLEX
DEWATERING WELL AND INJECTION WELL LAYOUT

WATER MANAGEMENT CONSULTANTS

FIGURE 4

Project No.: 2509

4.2 BIG HURRAH

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 Big Hurrah site provide the following information about soils conditions:

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).

5.0 HYDROLOGY

5.1 ROCK CREEK

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 1.7 times the Nome Airport precipitation. This results in an average annual precipitation of approximately 30 inches (76.2 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.

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.

The water balance for the Rock Creek Mine/Mill Complex is attached in Appendix A Rock Creek Project Water Management Report.

5.2 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.

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. An estimate of 1.5 times the Nome precipitation average was used to estimate precipitation at Big Hurrah.

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.

The water balance for the Big Hurrah is attached in Appendix B Big Hurrah Water Management Report.

6.0 GROUNDWATER

6.1 ROCK CREEK

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.

Sources of groundwater recharge include snowmelt, rainfall.

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.

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 4). 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 1.05×10^{-5} feet per second (fps) (3.3×10^{-6} meters per second (m/s)).

6.1.1 Rock Creek Groundwater Monitoring Program

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. 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 in Table 1, were completed between 2003 and 2004 (Figure 4). 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 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 monitoring wells and was screened in all of the monitoring wells except MW03-06. The bedrock consists primarily of fractured, carbonate-rich schist that is highly weathered at the surface.

Two of the seven 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.

Three wells were installed to document groundwater conditions upgradient of the mine and mill facilities. MW03-01 is upgradient of the tailing facility, MW03-03 is upgradient of the mineralized zone, and MW03-04 is upgradient from the proposed waste rock facility.

One well, (MW03-07), monitors groundwater downgradient of the waste rock facility. One well, (MW03-02), monitors groundwater downgradient from the mineralized zone.

	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
MW03-01	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)
MW03-02	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)
MW03-03	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)
MW03-04	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)
MW03-05	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)
MW03-06	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)
MW03-07	479620	7165330	229.6 ft (70.0 m)	Monitors areas downgradient from the proposed waste rock facilities.	110.4 ft (33.54 m)	88.0 ft (26.83 m)	108.0 ft (32.93 m)	83.0 ft (25.30 m)	110.0 ft (33.54 m)	100.0 ft (30.49 m)

ft	=	feet
m	=	meters

Notes: *UTM coordintes using NAD 27 Zone 3.

Table 1 Baseline Monitoring Well Descriptions – Rock Creek Mine/Mill Complex

6.1.2 Rock Creek Groundwater Baseline Studies

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.

Metals concentrations are variable across the site, with elevated antimony, arsenic, iron, thallium, sulfate, 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 MW03-04 to 1,350 µg/L in MW03-02, adjacent to the proposed pit site.

Metals concentrations including (aluminum, arsenic, iron, cadmium, and copper), are also elevated with respect to ADEC water quality use criteria across the site, again with the exception of MW03-04.

Additional statistical information on groundwater at Rock Creek is attached in Appendix C Rock Creek Groundwater Database.

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 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 148 to 728 mg/L. Groundwater pH ranges from 6.9 to 7.8, although pH values.

Water levels were monitored in each well to measure the relative change in groundwater elevations from seasonal changes in precipitation. Since March 2005, groundwater elevation measurements have been collected (Table 2). Very little change in the groundwater elevation was observed at the Rock Creek site. Over an 18-month period from 2004 to 2005, groundwater elevations at the seven wells fluctuated an average of 6.0 feet (1.82 m). Records show Well MW03-05 exhibited the smallest change in seasonal water elevation (2.5 feet [0.77 m]) and Well MW03-01 had the largest change in elevation (10.5 feet [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.

Well ID	Collar Elevation(above mean sea level)	Potentiometric Elevation January 2004	Potentiometric Elevation April 2004	Potentiometric Elevation August 2004	Potentiometric Elevation November 2004	Potentiometric Elevation April 2005	Potentiometric Elevation July 2005
MW03-01	283.8 ft (86.49 m)	250.26 ft (76.28 m)	247.67 ft (75.49 m)	251.54 ft (76.67 m)	257.74 ft (78.56 m)	245.76 ft (74.91 m)	253.7 ft (77.33 m)
MW03-02	246.7 ft (75.2 m)	214.27 ft (65.31 m)	214.11 ft (65.26 m)	218.5 ft (66.6 m)	215.71 ft (65.75 m)	213.58 ft (65.1 m)	217.52 ft (66.3 m)
MW03-03	532.5 ft (162.3 m)	520.63 ft (158.69 m)	518.56 ft (158.06 m)	521.25 ft (158.88 m)	524.01 ft (159.72 m)	515.97 ft (157.27 m)	526.44 ft (160.46 m)
MW03-04	436.6 ft (133.08 m)	423.75 ft (129.16 m)	420.63 ft (128.21 m)	430.15 ft (131.11 m)	432.02 ft (131.68 m)	418.93 ft (127.69 m)	429.75 ft (130.99 m)
MW03-05	101.4 ft (30.9 m)	91.96 ft (28.03 m)	94.78 ft (28.89 m)	91.99 ft (28.04 m)	91.86 ft (28 m)	91.57 ft (27.91 m)	92.75 ft (28.27 m)
MW03-06	73.5 ft (22.39 m)	64.66 ft (19.71 m)	64.21 ft (19.57 m)	64.21 ft (19.57 m)	63.61 ft (19.39 m)	57.18 ft (17.43 m)	67.13 ft (20.46 m)
MW03-07	229.6 ft (70 m)	222.67 ft (67.87 m)	220.77 ft (67.29 m)	220.77 ft (67.29 m)	221.65 ft (67.56 m)	223.32 ft (68.07 m)	226.05 ft (68.9 m)

Table 2 Baseline Groundwater Elevation Data Summary – Rock Creek Mine/Mill Complex

The first category is upgradient groundwater dominated by snowmelt. This groundwater is represented by MW03-04 and generally did not exceed the primary or secondary drinking water standards, or aquatic life standards during the baseline sampling. The few incidental exceptions appear to be anomolies.

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 MW03-06.

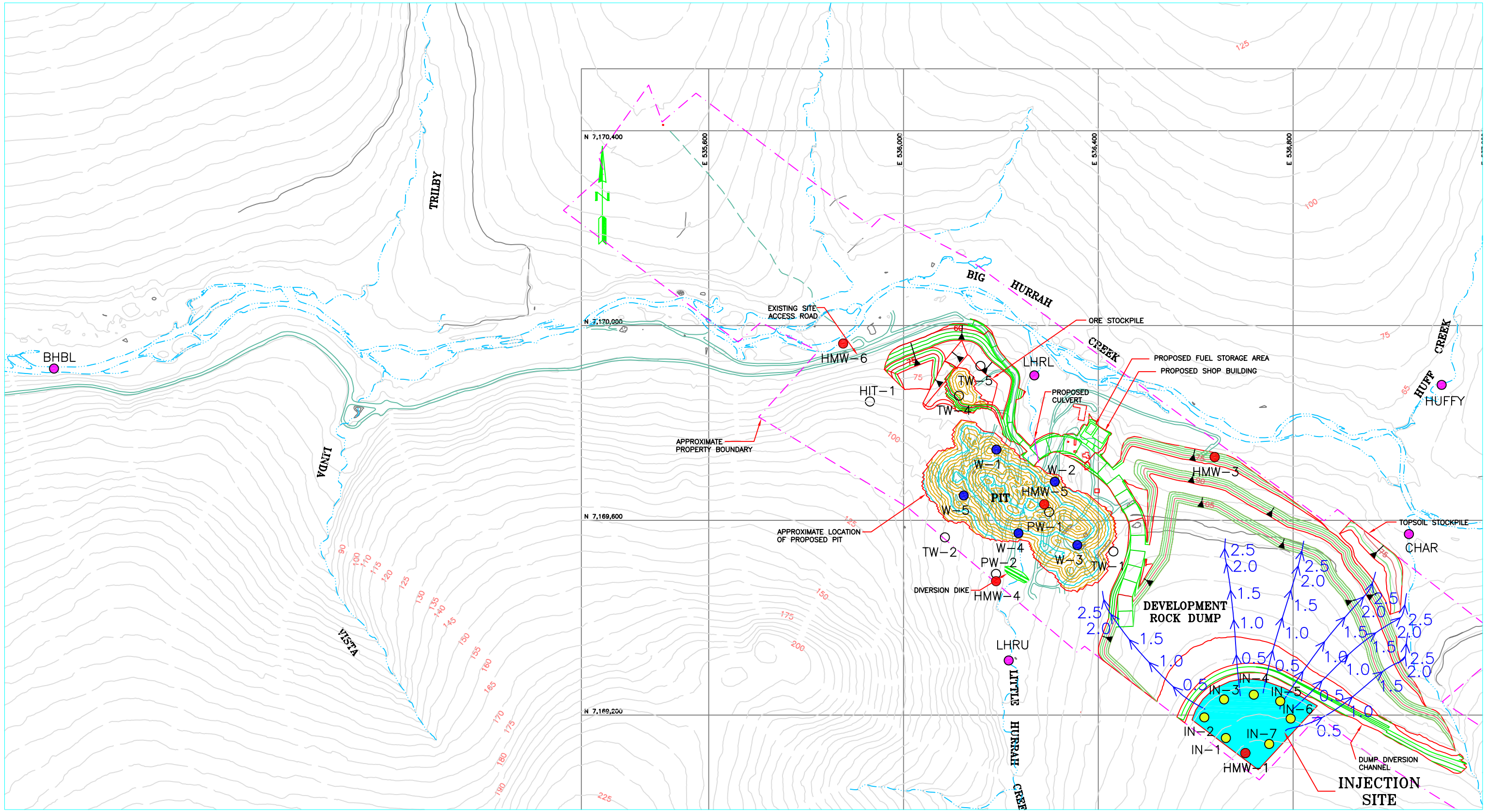
Trends in the groundwater flow regime were identified in the data from recovery tests and observations made during drilling of the monitoring wells. Response testing conducted at every monitoring well provided the data to estimate hydraulic conductivity. Monitoring Well MW03-06, within the alluvium of the Snake River Valley, recovered too quickly to obtain sufficient data for analysis. We hypothesize that 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 and MW03-04) 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.

6.2 BIG HURRAH

6.2.1 Rock Creek Groundwater Baseline Studies

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 and development rock stockpiles are the two mine facilities that will have the greatest effect 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 seven monitoring wells (HWM-1A, HWM-3A, HWM-3B, HWM-4A, HWM-4B, HWM-6B, HWM-6C) distributed over four locations designed to collect baseline groundwater chemistry and water level data upgradient and downgradient of the proposed mining facilities in the surficial and deep hydrostratigraphies (Figure 5). The description of the monitoring wells is found in Table 3.



LEGEND:

- EXISTING GROUND SURFACE CONTOUR AND EL, METERS
- PROPOSED GROUND SURFACE CONTOUR AND EL, METERS
- PROPOSED PIT SURFACE CONTOUR AND EL, METERS
- EXISTING DRAINAGES
- EXISTING ROAD
- EXISTING TRAIL
- EXISTING TRENCH

HMW-4 EXISTING MONITORING WELL

IN-1 INJECTION WELL – PROPOSED

BHRU SURFACE WATER SAMPLING SITE

W-1 PROPOSED DEWATERING WELL

INVESTIGATION WELL

PATH LINE WITH TRAVEL TIME (YEARS)

80 0 80 160 METERS

SCALE = 1:40,000

REFERENCE:
TOPOGRAPHIC DATA DOWNLOADED FROM NORWEST CORPORATION FTP SITE.
SURVEY BY: KODIAK MAPPING SURVEY, FROM AERIAL PHOTOGRAPHY ACQUIRED ON 10-2-2004 FILENAME: S:\CAD\1011-rock creek\recv\20050203-Big Hurrah\big_hurrah_2004.dwg

ALASKA GOLD

ROCK CREEK PROJECT
BIG HURRAH DEWATERING WELL
AND INJECTION WELL LAYOUT

WATER MANAGEMENT CONSULTANTS

FIGURE 5

Project No.: 2509

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
MW03-01	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)
MW03-02	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)
MW03-03	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)
MW03-04	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)
MW03-05	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)
MW03-06	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)
MW03-07	479620	7165330	229.6 ft (70.0 m)	Monitors areas downgradient from the proposed waste rock facilities.	110.4 ft (33.54 m)	88.0 ft (26.83 m)	108.0 ft (32.93 m)	83.0 ft (25.30 m)	110.0 ft (33.54 m)	100.0 ft (30.49 m)

ft	=	feet
m	=	meters

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

Table 3 Baseline Monitoring Well Descriptions – Big Hurrah Mine Site

Since March 2005, groundwater elevation measurements have been collected (Table 4). 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.

6.2.2 Big Hurrah Water Quality

Mineralization in the groundwater from the four wells at Big Hurrah consists primarily of calcium bicarbonate and magnesium. Groundwater with higher levels of calcium magnesium bicarbonate sulfate have been in contact with or immediately downgradient of mineralized zones. Metals concentrations are highly variable across the site.

Elevated iron and manganese are present at all sampling sites, lead and aluminum are present at some, but not all sites. Elevated antimony occurs above the pit area at HMW-1 and in the Big Hurrah alluvium at HMW-6 but is not elevated above drinking water standards at any other site.

Arsenic values range from 1.5 µg/L at HMW-3B to 86 µg/L at Camp Well 1. The arsenic levels exceed the EPA 10 ug/L drinking water standards at HMW 6 (the alluvium in Big Hurrah Creek), at HMW 5 (in the proposed pit area) and at the Camp Well (to the northeast of the pit), but are below 10 ug/L at all other sites. Arsenic at all sites is well below standards for 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.

Nickel, cadmium, copper and zinc are elevated above standards in the Big Hurrah alluvium at HMW6, but are below standards throughout the project footprint and at all other monitoring sites. The presence of elevated metals at HMW-6 may be related to the historic mill tailings that were deposited just upstream of this vicinity.

Additional groundwater information is attached in Appendix D under Big Hurrah Groundwater Database.

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.

Well ID	Measuring Point Elevation (above sea level)	Measuring Date	Potentiometric Elevation (above sea level)
HMW-3B	210.0 ft (64.02 m)	October-04	195.5 ft (59.60 m)
HMW-4A	Not Available	June-05	186.2 ft (56.75 m)
HMW-4B	Not Available	Not Available	Not Available
HMW-6B	156.4 ft (47.68 m)	October-04	164.7 ft (50.20 m)
HMW-6C	164.3 ft (50.08 m)	October-04	161.4 ft (49.20 m)

ft	=	feet
m	=	meters

Notes: *Potentiometric elevations for HMW-1A and HMW-4A are calculated from estimated collar elevations.

Table 4 Baseline Groundwater Elevation Data Summary – Big Hurrah Mine Site

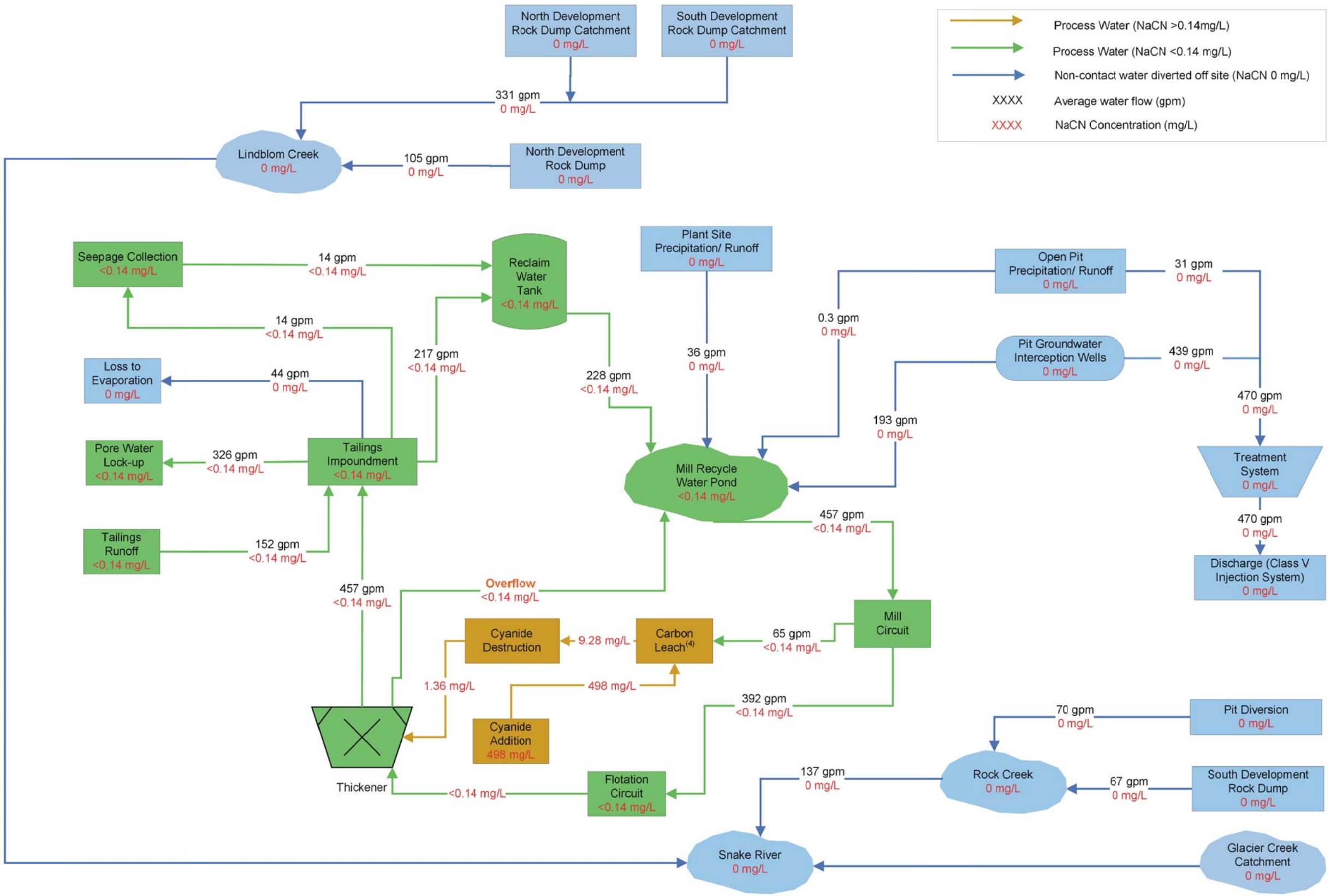
7.0 PROPOSED WATER INJECTION PLAN

7.1 ROCK CREEK

Groundwater from perimeter well pumping around the pit and runoff water from other mine facilities not used in mill processing will be appropriately treated and injected in to the subsurface during periods of excess water. A schematic of the overall water flow at the Rock Creek Mine/Mill complex diagram is shown in Figure 6.

A single layer groundwater model (MODFLOW) was used to provide an estimate of perimeter well pumping requirements. The model hydraulic conductivity was calibrated to the estimated groundwater recharge rate (7.9 inches) by matching modeled groundwater levels with field measured groundwater levels. The following perimeter well pumping estimates were developed in order to maintain a dry pit floor.

- Approximately 600 gpm (38 L/s) from the perimeter wells for year 1 and 2.
- Approximately 620 gpm (39 L/s) for year 3 and 635 gpm (40 L/s) for year 4.



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.

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: JC/BJ
DATE: APRIL 2006		FIGURE: 1	

P:\2509 - ROCK CREEK\WATER BALANCE\FIGURE-1.DWG

7.1.1 Water Quality from the Interception Wells

The majority of the water to be injected comes from the pit perimeter dewatering wells. The water quality parameters from monitoring well MW03-02 best represent untreated pit water. The pit perimeter dewatering water will require treatment prior to injection into the groundwater system. Water quality at MW03-02 exceeds drinking water quality standards for sulfate, TDS, antimony, arsenic, iron and manganese. Water quality at MW03-02 also exceeds the chronic aquatic life criterion for iron and aluminum. No seasonal trending was apparent in the baseline data. Water quality parameters at MW03-02 that exceeded the drinking water standard are summarized in Table 5 below and additional parameters that exceeded the chronic aquatic life standards are summarized in Table 6 below. The complete groundwater database with statistical analyses is attached in Appendix C.

MW03-04, which lies further upgradient of the pit, generally shows no exceedences of drinking water or aquatic life standards with the exception of a few anomalous samples that exceeded aluminum, iron and manganese. If pit dewatering is extended this far to the north, the water being extracted will be of much higher quality than is expected at the pit perimeter wells.

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Table 5 Parameters that exceed Drinking Water Criteria at well MW03-02

Date	Sulfate	TDS	Antimony	Arsenic	Iron	Manganese
1/29/04	244	**614**	**12**	**1450**	**7.61**	**1840**
4/22/04	219	**616**	**10.3**	**1380**	**2.88**	**1360**
7/15/04	247	**650**	**19.4**	**1560**	**3.38**	**1740**
10/14/04	205	**650**	**14.6**	**1290**	**1.56**	**738**
1/18/05	**319**	**592**	**20.2**	**1820**	**5.08**	**1960**
4/19/05	218	**600**	**36**	**2440**	**4.29**	**1700**
11/2/05	**323**	**597**	**10.6**	**1050**	**1.77**	**1070**
Mean	**253.57**	**617**	**17.59**	**1570**	**3.80**	**1487**
St. Deviation	48.4	24.16	9.05	450.70	2.10	448.84
#of values	7	7	7	7	7	7
Minimum	205	**592**	**10.3**	**1050**	**1.56**	**738**
Maximum	**323**	**650**	**36**	**2440**	**7.61**	**1960**
Lowest 5th Percentile	208.9	**593.5**	**10.39**	**1122**	**1.62**	**837.6**
Chronic Aquatic Life Standard	**----**	**-----**	**------**	**------**	1	**-----**
Drinking Water Standard	250	500	6	10	0.3	50

Note:

- All values are ug/L except sulfate and TDS which are in mg/L
- All metal values represent total metals analyses
- Bold values exceed the drinking water standard

The only additional parameter that exceeds the aquatic life standard is aluminum. These readings are highly variable with no seasonal trending.

Table 6 Additional Parameters at Well MW03-02 above the Aquatic Life Standard

Date	Aluminum (total) (ug/L)
1/29/04	**2550**
4/22/04	**165**
7/15/04	**460**
10/14/04	46.6
1/18/05	19.3
4/19/05	**640**
11/2/05	6.6

Mean:	55.6
St Deviation:	912.37
# of values:	7
Minimum:	6.6
Maximum	**2550**
Lowest 5th Percentile:	10.41
Chronic Aquatic Life Standard:	87

7.1.2 Water Treatment

Excess water from the perimeter wells and runoff from the mine site will be appropriately treated and then discharged to a Class V underground injection system. Groundwater treatment will consist of a ferric chloride treatment system or other appropriate treatment. Arsenic is responsive to ferric chloride treatment and antimony will follow arsenic in the precipitation chemistry. Manganese is also anticipated to respond to ferric chloride treatment. Precipitation of manganese in the ferric chloride treatment however, will require a second phase for ph adjustment though lime adjustment, and filtration. The addition of lime to adjust the pH will also precipitate the sulfate and iron out of solution. If water from well MW03-04 is also injected, then the mixing of the relatively clean water from MW03-04 with MW03-02 will likely result in lower levels of TDS and metals.

Injection water will meet drinking water quality standards as required by EPA Class V injection well regulations. Prior to discharge, the injection water will meet applicable ADEC water quality use criteria or be at concentrations that will not cause a statistically significant increase in background values per 18 AAC 60.830j.

Background water quality and the option of using natural background site specific criteria would differ for each of the injections sites. Estimation of background water quality at the point of injection is addressed at the end of the Section 7.1.3.1 Infiltration Gallery and Section 7.1.3.2 Bedrock Injection Wells.

7.1.3 Injection Systems

Two separate systems are proposed to dispose of appropriately treated water pumped from perimeter wells and other excess water from the Rock Creek Mine/Mill Complex:

- Infiltration gallery located on Rock Creek alluvial fan;
- Bedrock injection wells placed in an area west and northwest of the pit.

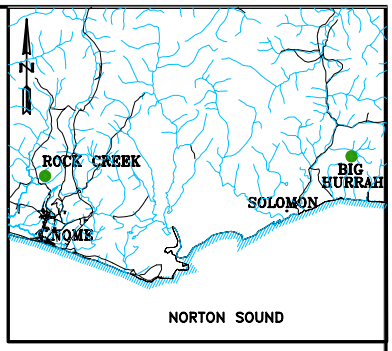
7.1.3.1 Infiltration gallery

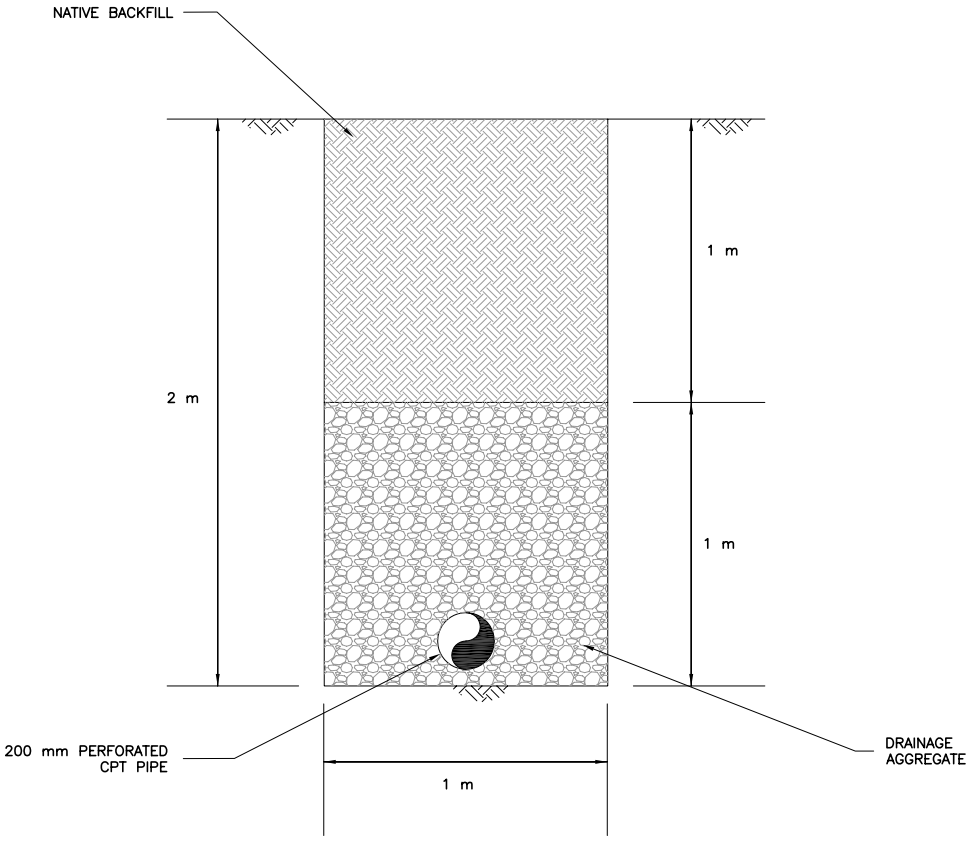
Design

Following appropriate treatment, discharge water would be fed to a head tank for re-injection. The water would be piped to the infiltration gallery. The infiltration gallery consists of a network of perforated pipes buried within the Rock Creek alluvial fan. Water injected into this fan would migrate through the fan deposits towards the toe of the fan where it would discharge into the alluvium and into the side channels at the toe of the fan. Drilling and testing indicated that the upper half of the fan is underlain by suitably permeable material. A schematic cross section of the gallery is shown in Figure 7 (forthcoming). The alluvial fan of Rock Creek is located on the east side of Snake River alluvial plain, with its apex approximately 3,000 feet (900 m) south of the proposed plant site. The injection system will cross the upper part of the fan in a north south direction, about 200 m downslope of the fan apex. (see Figure 4).

Infiltration Capacity and Travel Time

The thickness of the alluvial material varies from 15 feet (4.5 m) to more than 20 feet (6 m). The following material was encountered in boreholes and test pits: peat, sand and gravel, silty sand, silty gravel, and silty clay. The groundwater level was observed at a depth of 3.3 to 6.6 feet (1 to 2 m) below ground surface. There is significant variability in the water level seasonally with water levels at the seven wells varying an average of 6.0 feet (1.82 m). The average groundwater gradient is 2%.





CLASS V INJECTION WELL PERMIT APPLICATION

CLIENT: ALASKA GOLD COMPANY

PROJECT: ROCK CREEK PROJECT

TITLE: CROSS SECTION OF A TYPICAL CLASS V INJECTION SYSTEM

SWC
SMITH WILLIAMS CONSULTANTS, INC.
304 Inverness Way South, Suite 490, Englewood, Colorado 80112
Phone: 303-433-0262 Fax: 303-433-0362

DESIGNED BY	MJR	CHECKED BY	RTB	DATE
DRAWN BY	MJR	APPROVED BY	RTB	2/24/06

FILENAME	FIGURE No.	REV.
1011F199	7	A

As mine construction will result in diversion of Rock Creek water to Lindblom Creek, the diverted water would likely result in an increase in infiltration capacity for a Class V System (lower groundwater level). The capacity of this gallery is estimated at approximately 100 gpm – as a result of moderately permeable material, relatively thin aquifer and limited (available) extra head in the gallery. The velocity from the injection system to discharge points downstream will be:

v = ki/n, where

k (hydraulic conductivity) = $5x10^{-5}$ m/s and

i (gradient) = 0.02 and

n (porosity) = 0.25; so

v (velocity) = $4x10^{-6}$ m/s or 0.3 m/day (1ft/day)

The distance to the toe of the fan is approximately 2300 feet (700 m), so the travel time to the fan toe is approximately 2,000 days or 5.5 years.

Background Water Quality for the Rock Creek Infiltration Gallery

Background water quality for the Infiltration Gallery is best represented by the data collected at well MW03-06. MW03-06 shows elevated levels of aluminum, arsenic, copper, iron, and manganese. Because EPA Class V injection well standards require compliance with the drinking water standards regardless of background conditions, the elevated levels of arsenic, iron, and manganese are irrelevant for permitting effluent limits. However, it should be noted they naturally exist when evaluating downgradient water quality as a monitoring practice.

Copper is not known to be elevated in the interception well water and therefore the option for a natural background site-specific criterion for this parameter is not likely necessary.

Aluminum is elevated above the chronic aquatic life criterion at this receiving site and is known to be elevated in the interception well water as well. It should be noted that the aluminum concentrations at the receiving site, MW03-06, are much higher than the aluminum concentrations in the pit dewatering water from MW03-02. Aluminum could be considered for a natural background site-specific criterion option. Statistics for total aluminum in ug/L at well MW03-06 are summarized in Table 7 below:

Table 7 Statistics for Total Aluminum in ug/L at Well MW03-06 and MW03-02

Site	MW03-06	MW03-02
Mean:	**3415**	55.6
St Deviation:	2072.15	912.37
# of values	6	7
Minimum:	**608**	6.6
Maximum	**6300**	**2550**
Lowest 5th Percentile:	**965.50**	10.41
Chronic Aquatic Life Standard:	87	87

Note: bold values exceed the chronic aquatic life standard

The water quality data for all parameters at well MW03-06 are presented in their entirety with statistical analyses in the appendices.

7.1.3.2 Bedrock Injection Wells

Design

Bedrock injection wells are proposed as the key component for disposal of treated water. The design is based on the following data obtained during exploration and investigation works at the mine/mill site:

- Character of local bedrock – well foliated schist with joint (fracture) systems parallel and perpendicular to the foliation.
- Existence of several fault zones with higher permeability.
- Low, moderate and high groundwater inflow into drill holes ranging from a few gpm to 150 gpm.
- Estimated bulk hydraulic conductivity from a numerical model and pumping test of 3.82×10^{-7} m/s. Locally, pump testing indicates hydraulic conductivities of $4\text{-}8 \times 10^{-6}$ m/s and more. This indicates a compartmentalized groundwater system.

Up to 15 injection wells may be located in 3 areas west of the pit and processing plant and one area between the pit and plant site as shown in Figure 4. Table 8 presents a summary of the Rock Creek dewatering and injections wells. If additional wells are required to meet the anticipated maximum injection rate, these wells would be located to the north near Lindblom Creek. The sites were selected at locations with confirmed or "expected" fault zones that are anticipated to exhibit higher permeability. The well depths may vary from 300 to 400 ft (90

to 120 m). The installation details will be determined based on the borehole geology and groundwater inflows during drilling. Wells will be constructed with a 150 to 260 ft (50-80 m) long screened interval and a 100 to 150 ft (30 to 50 m) seal up to surface. The injection capacity of the wells should exceed 50 gpm (3 L/s).

Infiltration Capacity and Travel Time

The injection wells will be operated primarily in the summer. The injection requirement for the bedrock wells, considering the injection of 100 gpm (6 L/s) throughout the year into the Rock Creek fan by the infiltrations gallery, is estimated to be a maximum of 975 gpm (62 L/s) for 8 months of the year and significantly reduced during the winter months.

Travel time of groundwater flowing from the injection wells to the Snake River alluvium was calculated with the same numerical model used to estimate perimeter well pumping rates. Travel path-lines with travel times (in years) are shown on Figure 4. The travel path-lines accounts for the seasonal frequency of the injection with minimal injection during the winter months. Due to the injection interruption in the winter season, the groundwater flow velocity will reach a maximum of 100-200 m per year.

Typically up to 10 wells will be in operation during the injection. Figure 8 shows a schematic cross-section along proposed injection wells with estimated pre-mine groundwater flow. The expected flow direction of injected water is also shown.

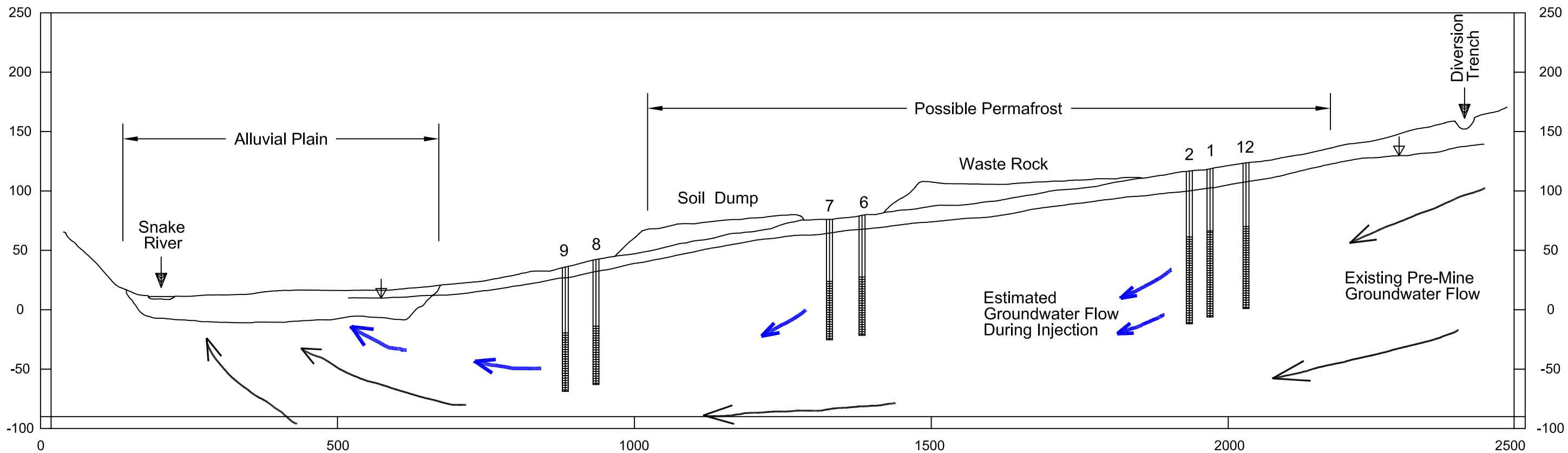
Table 8 Summary of Rock Creek Proposed Dewatering and Injection Wells

Proposed Dewatering Wells

No.	Site description	Eastings	Northings	Elevation	Distance to river	Distance to pit	Structural feature	Available data	Estimated depth	Screened interval	Outflow pumping rate
		m	m	ft	ft	ft			ft	ft	gpm
1	near E1	480250	7165650	400 (120 m)				E1	400 (120 m)	300 (90 m)	50 to 60 (3 to 4 L/s)
2	E side	480160	7165520	310 (95 m)				n/a	330 (100 m)	230 (70 m)	50 (3 l/s)
3	S side	480000	7165400	280 (85 m)				n/a	330 (100 m)	230 (70 m)	50 (3 l/s)
4	S side	479800	7165520	260 (80 m)				E2	330 (100 m)	230 (70 m)	50 (3 l/s)
5	near E2	479800	7165680	280 (85 m)			Rock Cr Fault	E2	330 (100 m)	230 (70 m)	60 (4 l/s)
6	W side	480000	7165800	300 (90 m)			Rock Cr Fault	n/a	330 (100 m)	230 (70 m)	60 to 80 (4 to 5 l/s)
7	upper W side	480200	7165850	300 (90 m)			Rock Cr Fault	n/a	400 (120 m)	260 (80 m)	50 (3 l/s)
8	upper W side	480320	7166000	330 (100 m)			Rock Cr Fault	E3	330 (100 m)	230 (70 m)	50 to 80 (3 to 5 l/s)
9	near E3	480450	7166080	410 (125 m)			Rock Cr Fault	E3	330 (100 m)	230 (70 m)	50 to 80 (3 to 5 l/s)
10	upper E side	480320	7165850	400 (120 m)			Boulder ck Fault	n/a	400 (120 m)	260 (80 m)	50 to 60 (3 to 4 l/s)
11	upper E side	480200	7165710	380 (115 m)				n/a	400 (120 m)	260 (80 m)	50 to 60 (3 to 4 l/s)

Proposed Injection Wells

No.	Site description	Eastings	Northings	Elevation	Distance to river	Distance to pit	Structural feature	Available data	Estimated depth	Screened interval	Inflow rate
		m	m	ft	ft	ft			ft	ft	gpm
1	above N development rock dump	479418	7166287	370.64 (113 m)	5772.8 (1760 m)	2197.6 (670 m)	Brynt_F x Boulder F x WSW feature	MW03-4	400 (120 m)	260 (80 m)	50 (3 l/s)
2	above N development rock dump	479332	7166267	354.24 (108 m)	5559.6 (1695 m)	2361.6 (720 m)	Brynt_F x Boulder F x WSW feature	MW03-4	400 (120 m)	260 (80 m)	30 to 50 (2 to 3 l/s)
3	below N development rock dump	479044	7166194	246 (75 m)	3985.2 (1215 m)	2952 (900 m)	WSW x WNW features	n/a	330 (100 m)	160 (50 m)	30 to 50 (2 to 3 l/s)
4	below N development rock dump	479005	7166144	239.44 (73 m)	3837.6 (1170 m)	3148.8 (960 m)	WSW x WNW features	n/a	330 (100 m)	160 (50 m)	15 to 50 (1 to 3 l/s)
5	N side of soil dump	478805	7166166	213.2 (65 m)	3886.8 (1185 m)	3575.2 (1090 m)	WNW feature	n/a	330 (100 m)	160 (50 m)	resting
6	below N development rock dump	479070	7165977	246 (75 m)	4624.8 (1410 m)	2722.4 (830 m)	WSW x SWS features	n/a	330 (100 m)	160 (50 m)	50 (3 l/s)
7	below N development rock dump	478983	7165955	229.6 (70 m)	4296.8 (1310 m)	3411.2 (1040 m)	WSW x SWS features	n/a	330 (100 m)	160 (50 m)	30 to 50 (2 to 3 l/s)
8	below soil dump	478612	7165809	131.2 (40 m)	3050.4 (930 m)	3837.6 (1170 m)	WSW feature	n/a	260 (80 m)	130 (40 m)	30 to 50 (2 to 3 l/s)
9	below soil dump	478534	7165780	108.24 (33 m)	2886.4 (880 m)	4100 (1250 m)	WSW feature	n/a	260 (80 m)	130 (40 m)	30 (2 l/s)
10	below soil dump	478666	7165615	131.2 (40 m)	3148.8 (960 m)	3673.6 (1120 m)	SWS feature	n/a	260 (80 m)	130 (40 m)	30 to 50 (2 to 3 l/s)
11	below soil dump	478573	7165615	108.24 (33 m)	2886.4 (880 m)	3936 (1200 m)	SWS feature	n/a	260 (80 m)	130 (40 m)	30 (2 l/s)
12	above N development rock dump	479599	7166334	377.2 (115 m)	6199.2 (1890 m)	1968 (600 m)	Brynt_F x Boulder F	MW03-4	400 (120 m)	260 (80 m)	50 (3 l/s)
13	above N development rock dump	479599	7166128	360.8 (110 m)	6133.6 (1870 m)	1705.6 (520 m)	Brynt_F x Boulder F	MW03-4	400 (120 m)	260 (80 m)	30 (2 l/s)
14	SE corner of N development rock dump	479540	7165592	246 (75 m)	6297.6 (1920 m)	951.2 (290 m)	Brynt_F	MW03-7	330 (100 m)	160 (50 m)	30 (2 l/s)
15	SE corner of N development rock dump	479532	7165465	229.6 (70 m)	5871.2 (1790 m)	951.2 (290 m)	Brynt_F	MW03-7	330 (100 m)	160 (50 m)	30 (2 l/s)



ALASKA GOLD

ROCK CREEK PROJECT
INJECTION WELLS – SECTION

WATER MANAGEMENT CONSULTANTS

FIGURE 8

Project No.: 2509

Background Water Quality for the Rock Creek Interception Wells

The water quality at the various injection well locations is unknown and variable across the site. This variability is due to the complex nature of the bedrock in the area. The compartmentalization of the groundwater flow observed during well installation and pump testing supports the variable nature of the groundwater quality depending on the mineralogy of the bedrock that the groundwater has moved through. MW03-04, MW03-07, and MW03-02 represent the variability of the groundwater quality in the areas of the proposed injection wells. A summary of parameters of interest, those parameter that exceed either drinking water or chronic aquatic life standards at one or more of the sites, is presented below in Table 9. The water quality data in its entirety and a summary of water quality statistics from MW03-02, MW03-04, MW03-07, MW03-02 is in Appendix C Rock Creek Groundwater Database.

To best determine background water quality at the proposed bedrock injection well sites, background ground water quality will be monitored in each of the four injection well clusters proposed for Rock Creek Mine/Mill Complex. A selected well in each cluster will be monitored bi-monthly over a 6 month period prior to that injection well cluster becoming operational. The collected data will provide necessary information on natural water quality within the lithologic intervals into which injection will occur. The clusters, shown on Figure 4 are:

- RCIN-8, RCIN-9,RCIN-10 and RCIN-11;
- RCIN-3, RCIN-4, RCIN-5, RCIN-6and RCIN-7;
- RCIN-1, RCIN-2, RCIN-12 and RCIN-13; and
- RCIN-14 and RCIN-15.

Alaska Gold intends only to inject water that is of equal or better quality than naturally occurring ground water, or applicable state water quality standards, whichever is appropriate. Background quality will be established by monitoring the selected well from each cluster four times during a six month period prior to implementing injection operations at that cluster. For each monitored well, the measured values for each parameter will be averaged to establish the background quality for the represented cluster. For parameters where the average background quality exceeds applicable state water standards, the background average will be applied to determine the suitability of water for injection.

Site	Statistic	Sulfate mg/l	TDS mg/l	Aluminum total ug/l	Antimony total ug/l	Arsenic total ug/l	Iron total ug/l	Manganese total ug/l
MW03-02	Mean	**253.57**	**617**	**555.36**	**17.59**	**1570**	**3.80**	**1486.86**
	St Deviation	48.40	24.16	912.37	9.05	450.70	2.10	448.84
	# of samples	7	7	7	7	7	7	7
	Minimum	205	592	6.6	10.3	1050	1.56	738
	Maximum	323	650	2550	36	2440	7.61	1960
	Lowest 5th %	208.90	593.50	10.41	10.39	1122.001.62	837.60	
	Aquatic life			87				
	Drinking Std	250	500		6	10	0.3	50
MW03-04	Mean	33.94	244.71	**220.23**	0.86	2.66	0.28	24.79
	St Deviation	2.04	15.92	551.13	0.19	0.77	0.62	26.83
	# of samples	7	7	7	7	7	7	7
	Minimum	31.1	221	6.44	0.541	1.5	0.019	4.65
	Maximum	36.7	268	**1470**	1.08	4.05	**1.67**	**71.6**
	Lowest 5th %	31.46	224.6	7.51	0.60	1.80	0.02	5.39
	Aquatic life			87				
	Drinking Std	250	500		6	10	0.3	50
MW03-07	Mean	20.13	244.50	**92.28**	3.68	**506**	**0.86**	**61.75**
	St Deviation	1.27	19.58	133.98	1.24	39.03	0.14	9.51
	# of samples	6	6	6	6	6	6	6
	Minimum	18.8	208	10	1.99	**452**	**0.721**	**51.1**
	Maximum	21.6	265	**355**	5.22	**541**	**1.03**	**76.3**
	Lowest 5th %	18.80	216.25	11.35	2.20	**454.25**	**0.73**	**51.43**
	Aquatic life			87				
	Drinking Std	250	500		6	10	0.3	50

Table 9 **Parameters of Interest at Wells MW03-02, MW03-04, and MW03-07**

7.1.4 Monitoring

7.1.4.1 Infiltration Gallery Monitoring

Monitoring of the Infiltration Gallery will include the following:

- Water quality of treated water prior to discharge will be monitored weekly for two months and monthly thereafter, assuming consistency has been demonstrated, to demonstrate that the water meets the applicable water quality concentrations (to monitor that water meets injection permit water quality standards).

- Water quality downgradient of the injection systems (to monitor for no statistically significant decrease in water quality per 18 AAC 60.830j.
    - **MW03-06.** This existing well, used during baseline data collection, is located within the area of potential impacts from the Infiltration Gallery at the Rock Creek Mine/Mill Complex. This well will provide groundwater data on operational impacts from that gallery.
    - **RCK3**. This surface water station will be located on Rock Creek, approximately 300 feet (100 m) downstream from the Infiltration Gallery. This station will provide data on potential impacts from use of that system.

- Depth to groundwater near the Infiltration Gallery to monitor for groundwater mounding. The depth to groundwater will be monitored quarterly during injection activities in MW03-06.

7.1.4.2 Injection Well System Monitoring

Monitoring of the injection well system will include the following:

- Water quality of treated water prior to discharge will be monitored weekly for two months and monthly thereafter, assuming consistency has been demonstrated, to demonstrate that the water meets the applicable water quality concentrations (to monitor that water meets injection permit water quality standards).

- Background ground water quality will be monitored in one well from each of the four injection well areas (RCIN-1, 2,12,13, RCIN- 3-7, RCIN- 8 -11, and RCIN- 14-15; See Figure 4) at the Rock Creek Mine/Mill Complex prior to the injection well system becoming operational. The collected data will provide necessary information on natural water quality within the lithologic intervals into which injection will occur. Background groundwater quality will be established by monitoring one injection well in that area once every two months for at least six months prior to implementing the injection system. The averaged value from the four sampling events will be used to establish the background water quality for that parameter for that injection well area. For parameters where the average background quality exceeds applicable state water

use criteria, the background average will be applied to determine the suitability of water for injection.

- Water quality downgradient of the injection systems.
    - **LIN2**. This station will be located approximately 500 feet downstream from the LIND station that was utilized during baseline monitoring. This station will provide data on the potential operational impacts to Lindblom Creek water quality. The station is to be re-located downstream of the baseline monitoring location to provide for monitoring impacts from the operation of proposed injection wells. Surface water samples will be collected monthly from May through September of each year during operations at the Rock Creek Mine/Mill Complex to represent the seasonal hydrologic conditions. During the winter season (October through April), it is expected that the streams will be frozen and sufficient flow will not be available for sample collection.
    - Water quality will not be monitored in groundwater downgradient of the injection wells because of the distance to the Snake River alluvium and the travel times to reach the alluvium being greater than the mine operating life. The travel times to downgradient alluvium monitoring wells is sufficiently long enough that monitoring there would not allow for operational changes to be protective of the environment. The proposed monitoring approach allows the discharge water to be closely monitored and provides, in a timely manner, a check on discharge water quality to ensure protection of groundwater and surface water quality.
- Depth to groundwater near injection points to monitor for groundwater mounding.
    - Depth to groundwater will be monitored in any injection wells not currently being used for injection of water. Groundwater mounding will be monitored quarterly during injection activities.

7.2 BIG HURRAH

There is no processing plant at the Big Hurrah site, so all water pumped from the perimeter wells and runoff from the open pit will be disposed of in injection wells. The small pit at Big Hurrah is proposed as a storage site for runoff water prior to treatment and injection. The proposed injection area is located along the south property boundary near the SE corner of the property (see Figure 5).

7.2.1 Water Quality from the Big Hurrah Interception Wells

The water to be injected primarily comes from the pit perimeter dewatering wells. The water quality from monitoring well HMW-5 represents untreated pit water. Water at this location

shows elevated levels of arsenic, iron, and manganese, above the drinking water standards. Data for these parameters are provided in Table 10 below.

Table 10 Parameters at Well HMW – 5 that Exceed the Drinking Water Standards

	Date	Arsenic	Iron	Manganese
	10/26/05	**47.2**	**1.01**	**104**
	11/27/05	**44.7**	**1.04**	**87.8**
Mean		**45.95**	**1.03**	**95.9**
St. Deviation		1.77	0.02	11.46
#of values		2	2	2
Minimum		**44.7**	**1.01**	**87.8**
Maximum		**47.2**	**1.04**	**104**
Lowest 5th Percentile		**44.83**	**1.01**	**88.61**
Chronic Aquatic Life Standard		-----	1	
Drinking Water Standard		10	.03	50

Note:

- All values are ug/L
- All metal values represent total metals analyses
- Bold values exceed the drinking water standard

7.2.2 Water Treatment

Excess water from the perimeter wells and runoff from the mine site will be appropriately treated and then discharged to a Class V underground injection system. Groundwater treatment will consist of a ferric chloride treatment system or other appropriate treatment similar to what is developed for Rock Creek.

Injection water will meet drinking water quality standards as required by EPA Class V injection well regulations. The injection water prior to discharge will meet applicable ADEC water quality use criteria or be at concentrations that will not cause a statistically significant increase in background values per 18 AAC 60.830j.

7.2.3 Injection System

Design

Bedrock injection wells are proposed for disposal of the groundwater from the perimeter wells and runoff from the pit. The water will be treated as necessary. Their design results from following data obtained during exploration and investigation works done at the mine site:

- Character of local bedrock – well foliated schist with joint (fracture) systems parallel and perpendicular to the foliation.
- Existence of several fault zones with higher permeability

- Low, moderate and high groundwater inflow into drill holes ranging from few gpm to 100-150 gpm.
- Estimated bulk hydraulic conductivity: $K=5x10^{-7}$ to $5x10^{-5}$ m/s.
- Interpretation of injection test on one well (HIT-1, Figure 4), where the injection rate reached approximately 80 gpm.
- Groundwater level monitoring.
- Large scale compartmentalization due to existing boundary conditions.

The pumping rate of the open pit perimeter wells was estimated based on an interpretation of pumping tests and a numerical model (Modflow). The model was calibrated to expected groundwater recharge and discharge rates and measured groundwater levels and to the reported pumping rate from the underground workings. The pumping rate to keep the former underground mine dry, with the deepest working at an elevation of approximately 15 ft (5 m) was 150 to 200 gpm. The proposed open pit will reach an elevation of 50 to 65 ft (15 to 20 m). The model perimeter wells were then pumped to achieve the groundwater level required for a dry pit floor in each year of mining. To keep the piezometric level below the pit floor, 5 perimeter wells are proposed. They will be pumped more or less constantly during the last phases of the pit for about two years. Dewatering of the pit through interception wells will start when the bottom of the pit reaches an elevation of 210 ft (65 m). The required pumping rate from the pit was estimated to be approximately 200 to 250 gpm (13 to 15 L/s).

It is estimated that pit area runoff with surge storage in the small pit would averages 30 gpm (166 m^3/day) over six months, with a requirement to manage up to 130 gpm (8 L/s) in wet months. There will be no runoff in winter months. Total water management requirements are therefore an average of 230 gpm (14 L/s) in summer months and 200 gpm (13 L/s) in winter months. These numbers were used to estimate travel times. However, in order to meet possible maximum runoff in the summer months, the capacity for treatment and injection will need to be 470 gpm (30 L/s).

Up to fifteen injection wells (seven to ten online and five backup) are proposed for the injection area near monitoring well HWM-1 (see Figure 5). Table 11 presents a summary of the Big Hurrah dewatering and injections wells. The ten injection wells are located close to a fault zone along Huff Ck (opposite side of Big Hurrah Ck valley) and Charlotte Ck (south side of Big Hurrah Ck). This area is covered by permafrost and underlain by brittle graphite-carbonate schist. Also the area is probably separated from the mine site by a mapped north south trending fault. The groundwater elevation in HWM-1 was approximately 394 feet (120 m) and the groundwater inflow encountered was 10 gpm at the final depth of 128 feet (42 m), only about 49 feet (15 m) below permafrost. The proposed injection wells may be 330 to 400 ft (100 to 120 m) deep. The installation details will be determined based on the borehole geology and groundwater inflows during drilling. Screened intervals of 150 to 260 ft (50-80 m) and 100 to 150 ft (30 to 50 m) seals up to surface are anticipated. The injection capacity of the wells are expected to exceed 50 gpm (3 L/s) per well. Ten wells are required to meet the maximum anticipated injection rate of 470 gpm (30 L/s). Up to five additional wells are proposed to provide additional wells to meet the maximum injection rate and provide the ability to rest some injection wells and minimize mounding. The wells would be located along the property boundary to the south east of the ten injection wells.

Table 11 Summary of Big Hurrah Proposed Dewatering and Injection Wells

Proposed Dewatering Wells

No.	Site description	Eastings	Northings	Elevation	Available data	Estimated depth	Screened interval	Expected rate
		m	m	ft		ft	ft	gpm
1	pit, bench 65 m	536200	7169720	213 (65 m)	PW-1, PW-2	260 (80m)	200 (60 m)	30 to 50 (2 to 3 l/s)
2		536300	7169650	312 (95 m)		260 (80m)	200 (60 m)	30 to 50 (2 to 3 l/s)
3		536300	7169550	279 (85 m)		260 (80m)	200 (60 m)	30 to 50 (2 to 3 l/s)
4		536200	7169600	262 (80 m)		260 (80m)	200 (60 m)	30 to 50 (2 to 3 l/s)
5		536100	7169660	279 (85 m)		260 (80m)	200 (60 m)	30 to 50 (2 to 3 l/s)

Note: Dewatering wells should intersect old underground workings at 250 ft (5 m el.)

Proposed Injection Wells

No.	Site description	Eastings	Northings	Elevation	Available data	Estimated depth	Screened interval	Inflow rate
		m	m	ft		ft	ft	gpm
1	above waste rock dump, close to HMW-1	536600 to 536900	7169100 to 7169300	394 to 443 (120 to 135 m)	HMW-1 TW-1 HMW-3	300 to 400 (100 to 120 m)	160 to 260 (50 to 80 m)	30 to 50 gpm (2 to 3 L/s)
2								
3								
4								
5								
6								
7								

Note: Number of injection wells depends on bedrock permeability in proposed "injection area".

The travel time of groundwater flowing from the injection wells to the Big Hurrah Creek alluvium was calculated with the same numerical model used to estimate pumping rates from the perimeter wells. The injection wells were operated simultaneously with the perimeter wells for two years. Travel path-lines with travel times (in years) are shown on Figure 5. Travel times of over two years were estimated.

Background Water Quality at Big Hurrah Injection Site

The water quality at the various injection well locations is most likely similar to HMW-1. Water Quality at HMW-1 meets all water quality standards with the exception of both the drinking water and chronic aquatic life standards for iron and the drinking water standard for manganese. Since EPA Class V requirements for injection of groundwater requires treatment to meet all drinking water standards, the option to develop a natural background site-specific criterion for iron and/or manganese is not relevant.

7.2.4 Monitoring

Monitoring of the injection system will include the following:

- Water quality of treated water prior to discharge will be monitored weekly for two months and monthly thereafter, assuming consistency has been demonstrated, to demonstrate that the water meets the applicable water quality concentrations (to monitor that water meets injection permit water quality standards).

- Background ground water quality will be monitored in one of the proposed injection wells (BHIN-1-7; See Figure 5) at the Big Hurrah mine site prior to the injection well system becoming operational. The collected data will provide necessary information on natural water quality within the lithologic intervals into which injection will occur. Background groundwater quality will be established by monitoring one injection well in that area once every two months for at least six months prior to implementing the injection system. The averaged value from the four sampling events will be used to establish the background water quality for that parameter for the injection well area. For parameters where the average background quality exceeds applicable state water use criteria, the background average will be applied to determine the suitability of water for injection.

- Water quality downgradient of the injection systems.
    - **BHBL**. This station, used during baseline data collection, is located on Big Hurrah Creek, downstream from potential impacts from operations at the Big Hurrah Mine. This station will provide data on operational impacts and from the operation of proposed injection wells impact on Big Hurrah Creek water quality.

- **LHRL.** This station, used during baseline data collection, is located on Little Hurrah Creek, downstream from the mine pit, downstream from where diverted flow re-enters the natural stream course, and upstream of the confluence with Big Hurrah Creek. This station will provide data for operational impacts and from the operation of proposed injection wells on Little Hurrah Creek water quality.
- **CHAR**. This station will be located on an unnamed creek east of, and down-gradient from, the location of the proposed development rock stockpile (the stream is informally known as Charlotte's Creek). Flow at this station may be intermittent. This station will provide data on operational impacts and from the operation of proposed injection wells on the water quality of this stream.
- Water quality will not be monitored in groundwater downgradient of the injection wells due to land ownership restricting placement of an alluvial monitoring well outside of the property boundary. This is compensated for through frequent influent sampling and surface water sampling.

- Depth to groundwater near injection points to monitor for groundwater mounding.
  - Depth to groundwater will be monitored in any injection wells not currently being used for injection of water. Groundwater mounding will be monitored quarterly during injection activities.

APPENDIX A

Rock Creek Water Management Report

This appendix has not been included in this packet due to volume. It may be located in the Rock Creek Project Plan of Operations Volume 3 Water Management Reports.

APPENDIX B

Big Hurrah Water Management Report

This appendix has not been included in this packet due to volume. It may be located in the Rock Creek Project Plan of Operations Volume 3 Water Management Reports.

APPENDIX C

Rock Creek Groundwater Database

This appendix has not been included in this packet due to volume. It may be located in the Rock Creek Project Plan of Operations Volume 2 EID/Appendices/Hydrology/Groundwater.

APPENDIX D

Big Hurrah Groundwater Database

This appendix has not been included in this packet due to volume. It may be located in the Rock Creek Project Plan of Operations Volume 2 EID/Appendices/Hydrology/Groundwater.

APPENDIX E

Temporary Water Use Permit Applications

APPENDIX F

Water Treatment Plant Design

APPENDIX G

Infiltration Gallery Design