PLAN OF OPERATIONS

WATER RESOURCES MANAGEMENT PLAN

Donlin Gold Project

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ACRONYMS

1D	one-dimensional
3D	three-dimensional
ABA	acid-base accounting
ADNR	Alaska Department of Natural Resources
AMEC	AMEC Americas Limited
ANCSA	Alaska Native Claims Settlement Act
AP	acid generating potential
APDES	Alaska Pollutant Discharge Elimination System
APMA	Application for Permits to Mine in Alaska
ARD	acid rock drainage
AWQS	Alaska water quality standards
BLM	Bureau of Land Management
BOD	biological oxygen demand
Calista	Calista Corporation
CCD	counter current decant
CDA	Canadian Dam Association
CFR	Code of Federal Regulations
CIL	carbon-in-leach
CIP	clean-in-place
COD	chemical oxygen demand
CWD	contact water dam
DI	deionized water
DO	dissolved oxygen
DOC	dissolved organic carbon
Eh	reduction-oxidation potential
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Administration
FWDD	fresh water diversion dam
GWB	Geochemist’s Workbench®
HDPE	high-density polyethylene
HDS	high density sludge
HRC	high rate clarifier
ICOLD	International Congress on Large Dams
IDF	inflow design flood
LLDPE	linear low density polyethylene
LOM	life of mine
Lorax	Lorax Environmental Services Ltd.
MCL	maximum contaminant level
ML	metal leaching
MSHA	U.S. Department of Labor Mine Safety and Health Administration
MWMP	meteoric water mobility procedure
NAG	non-acid generating
NOB	north overburden
NP	neutralization potential

NP_{CO3}	neutralization potential as carbonate
NRMS	normalized root mean square
PAG	potentially acid generating
PAX	potassium amyl xanthate
PMF	probable maximum flood
PMP	probable maximum precipitation
POX	pressure oxidation
ppb	parts per billion
QAPP	Quality Assurance Project Plan
RC	reverse circulation
redox	reduction-oxidation potential
RO	reverse osmosis
SAG	semi-autogenous grinding
SO_2/Air	sulfur dioxide cyanide destruction
SOB	south overburden
SRS	seepage recovery system
SWPPP	Stormwater Pollution Prevention Plan
STP	Sanitary Treatment Plant
TDS	total dissolved solids
TEU	twenty foot equivalent units
TKC	The Kuskokwim Corporation
TOC	total organic carbon
TRI	toxic release inventory
TSDF	treatment, storage, and disposal facility
TSF	tailings storage facility
TSS	total suspended solids
ULSD	ultra–low sulfur diesel
UNR	University of Nevada-Reno
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
VWP	vibrating wire piezometers
WAD	weak acid dissociable
WBM	water balance model
WRF	waste rock facility
WTP	water treatment plant

UNITS OF MEASURE

ºF	degree Fahrenheit
ºC	degree Celsius
ac	acre
acre-ft	acre-foot (43,560 cubic feet)
amsl	above mean sea level
cfs	cubic feet per second
cm	centimeter
ft	foot/feet
ft^3	cubic feet
gpm	U.S. gallons per minute
g/L	grams per liter
g/t	grams per tonne
h	hour
ha	hectares
hardness	generally the amount of calcium and magnesium dissolved in water
hp	horsepower
kg	kilogram
km	kilometer
km^2	square kilometers
km/h	kilometers per hour
kW	kilowatt
L	liter
lb	pound
m	meter
m^3	cubic meters
m^3/h	cubic meters per hour
m^3/s	cubic meters per second
mil	thousandth of an inch
µg/L	micrograms per liter
µm	micrometer (micron)
µS	microsiemen
µS/cm	microsiemens per centimeter
mL	milliliter
mm	millimeter
Mm^3	million cubic meters
MMCF	million cubic feet
Mst	million short tons
Msty	million short tons per year
Mt	million tonnes
Mt/a	million tonnes per year
mV	millivolt
MW	megawatt
Myd^3	million cubic yards

NP/AP	neutralizing potential to acid generating potential ratio
NRMS	normalized root mean square
NTU	Nephelometric Turbidity Units
pH	measure of the acidity or base acidity of an aqueous solution
ppb	parts per billion
oz/st	troy ounces per short ton
ppb	parts per billion
ppm	parts per million
st	short ton (2,000 pounds)
stpd	short tons per day
sq miles	square miles
s.u.	standard units
t	tonne (1,000 kg)
tpd	tonnes per day
yd^3	cubic yards
Z_r	relative depth

ELEMENTS AND COMPOUNDS

Ag	silver
Al	aluminum
As	arsenic
As/S	arsenic/sulfur ratio
B	boron
Ba	barium
Be	beryllium
Bi	bismuth
Ca	calcium
$CaCO_3$	calcium carbonate
Cd	cadmium
Ce	cerium
Cl	chloride
CN(F)	free cyanide
CN(T)	total cyanide
CNO	cyanate
CNS	thiocyanate
CN_{WAD}	cyanide Weak Acid Dissociable
Co	cobalt
CO_3	carbonate
Cr	chromium
Cs	cesium
Cu	copper
$CuSO_4$	copper sulfate
DO	dissolved oxygen
DOC	dissolved organic carbon
F	fluoride
Fe	iron
Fe/As	iron/arsenic ratio
Ga	gallium
Ge	germanium
HCO_3	bicarbonate
Hf	hafnium
Hg	mercury
HgS	mercuric sulfide
In	indium
K	potassium
$KMnO_4$	potassium permanganate
La	lanthanum
Li	lithium
Mg	magnesium
MIBC	methyl isobutyl carbinol
Mn	manganese

Mo	molybdenum
N	nitrogen
Na	sodium
Na_2CO_3	soda ash
NaOH	sodium hydroxide
$Na_2S_2O_5$	sodium metabisulfite
Nb	niobium
NH_3	ammonia
NH_4	ammonium
Ni	nickel
NO_2	nitrogen dioxide
NO_3	nitrate
NP_{co3}	neutralization potential as carbonate
OH	hydroxide
P	phosphorus
PAX	potassium amyl xanthate
Pb	lead
Rb	rubidium
Re	rhenium
S	sulfur
Sb	antimony
Se	selenium
Si	silicon
SiO_2	silica
Sn	tin
SO_2	sulfur dioxide
SO_2/Air	sulfur dioxide cyanide destruction
SO_4	sulfate
Sr	strontium
Ta	tantalum
Te	tellurium
Th	thorium
Tl	thallium
Ti	titanium
U	uranium
V	vanadium
W	tungsten
Y	yttrium
Zn	zinc
Zr	zirconium

1.0 INTRODUCTION

1.1 Plan Objective

The purpose of this Water Resources Management Plan (WRMP) is to describe how water will be managed during construction, operations, and closure of the proposed Donlin Gold Project. The Plan focuses on the mine site facilities. The Plan also provides a summary of the meteorological and hydrological characteristics, as well as geochemical parameters, essential to the development of water balance models. A full description of the project is available in the *Plan of Operations, Project Description, Volume I,* SRK 2016a.

The water management strategies are to meet the following objectives:

- Identify and characterize the various water streams potentially affecting water quality during construction, operations, and closure (Appendix A).
- Minimize contact of water to mined/disturbed materials to minimize the amount of water requiring treatment during construction, operations, and closure.
- Supply an adequate quantity and quality of makeup water to the plant during commissioning, startup, and operations.
- Water management and treatment to ensure compliance with AWQS.
- Achieve pit dewatering requirements.

1.2 Plan Revisions

This WRMP may be revised periodically during construction and operations as additional data or information becomes available based on operational observations and monitoring results. Revisions may also be warranted based on technological developments, changes to Integrated Waste Management Permit and/or Alaska Pollution Discharge Elimination System (APDES) Permit requirements or other information. Table 1-1 provides a record of these changes.

Table 1-1: Record of Changes and Amendments

Date	Section (s) Revised or Amended

1.3 Project Location and Climate

Donlin Gold LLC[1] (Donlin Gold) is proposing the development of an open pit, hardrock gold mine in southwestern Alaska, about 277 miles (446 km) west of Anchorage, 145 miles (233 km) northeast of Bethel, and 10 miles (16 km) north of the village of Crooked Creek, as shown on Figure 1-1.

The proposed project would be located in an area of low-lying, well rounded ridges on the western portion of the Kuskokwim Mountains, with elevations ranging from 500 to 2,100 ft (152 to 640 m). Area vegetation is typically hard shrubs and small trees. Hillsides are forested with black spruce, larch, alder, and birch. Soft muskeg and discontinuous permafrost can be found in poorly drained areas at lower elevations. The area has a relatively dry interior continental climate with typically about 19.6 inches (50 cm) total annual precipitation. Summer temperatures are relatively warm and may exceed 83°F (28°C) with an average temperature of 52°F (11°C). The average temperature in winter is 7°F (-14°C), although minimum temperatures may fall to -45°F (-43°C) (BGC 2011a).

1.4 Project Overview

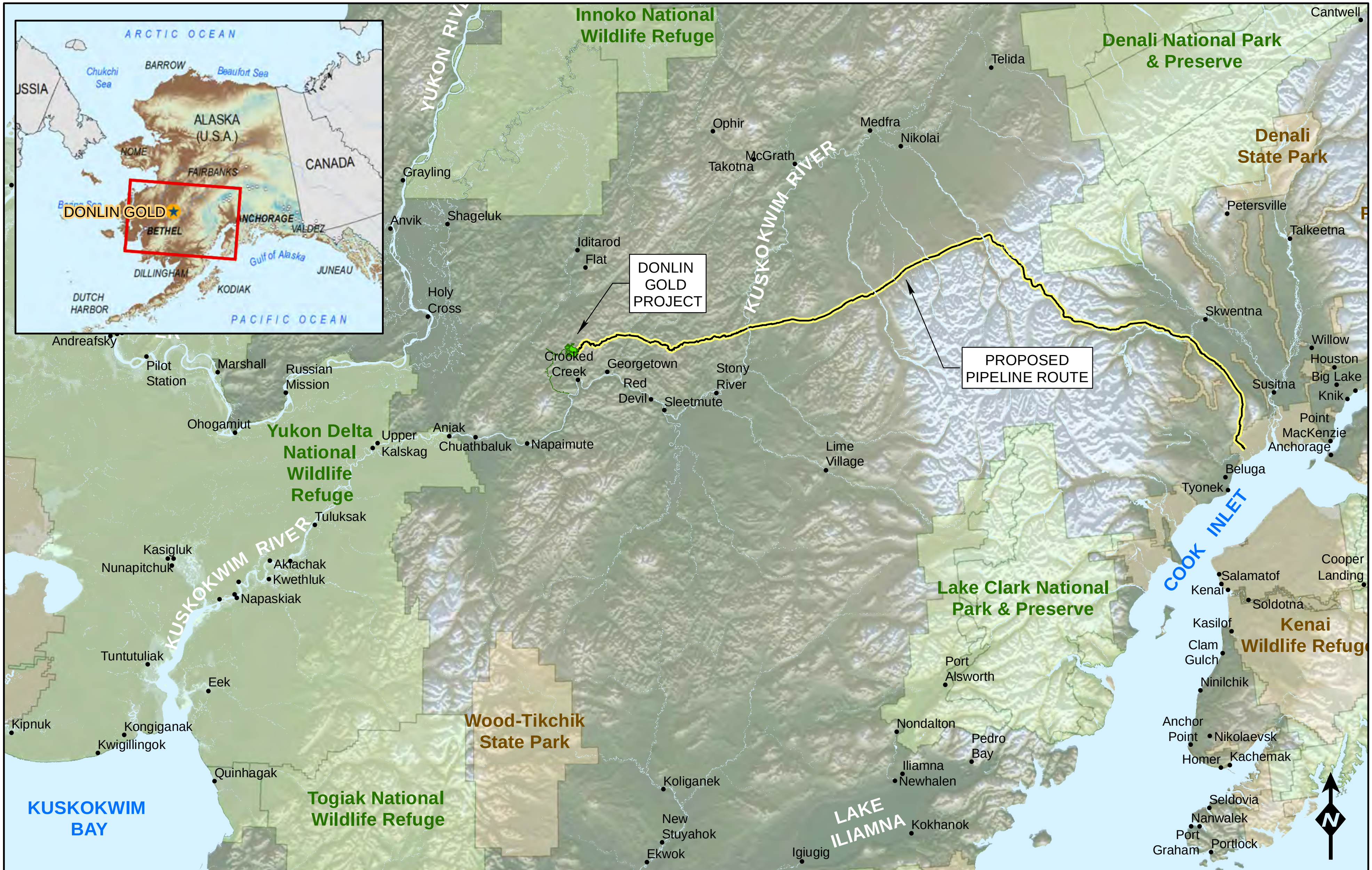
The proposed Donlin Gold project would require approximately three to four years to construct, with the mine life currently projected to be approximately 27 years. The mine is proposed to be a year-round, conventional “truck and shovel” operation using both bulk and selective mining methods. The proposed operation would have a projected average mining rate of 422,000 stpd[2] (383,000 tpd) or 154 Mst per year (140 Mt/a), and an average process production rate of 59,000 stpd (53,500 tpd). Processing components would include a gyratory crusher, semi-autogenous grinding (SAG) and ball mills, followed by flotation, pressure oxidation, and carbon-in-leach (CIL) circuits. Conventional carbon stripping and electrolytic gold recovery would produce an end product of gold doré bars, which would be shipped to a custom refinery for further processing. State of the art mercury abatement controls would be installed at each of the major thermal sources, including the autoclave, carbon kiln, gold furnaces, and retort. Figure 1-2 depicts proposed facility locations.

The gold resource is hosted in intrusive and sedimentary rock in two main areas of the property, Lewis and ACMA. The proven and probable[3] reserves total 556.5 Mst (504.8 Mt), with an average grade of 0.061 oz/st (2.09 g/t). With process plant recovery at approximately 90%, the operation would produce an average of over one million ounces of gold annually. Tailings storage would encompass an area of 2,351 acres (951 ha), with a

[1] Donlin Gold LLC is a limited liability company, jointly owned by Barrick Gold U.S. Inc. and NovaGold Resources Alaska, Inc. on a 50/50 basis.

[2] Engineering design values are presented in metric units. Values presented in U.S. customary (standard) units may be rounded.

[3] Based on an assessment of qualitative, non-technical factors, Barrick Gold Corporation treats mineralization at Donlin Gold as measured and indicated resources, rather than proven and probable reserves for securities reporting, accounting, and other public disclosure purposes; NovaGold Resources Alaska, Inc. treats mineralization as reserves. Mineral reserves are those parts of mineral resources that, after the application of all mining factors, result in an estimated tonnage and grade which is the basis of an economically viable project after taking account of all relevant processing, metallurgical, economic, marketing, legal, environment, socio-economic, and government factors. Mineral reserves are inclusive of diluting material that will be mined in conjunction with the mineral reserves and delivered to the treatment plant or equivalent facility. The term ‘mineral reserve’ need not necessarily signify that extraction facilities are in place or operative, or that all governmental approvals have been received. It does signify there are reasonable expectations of such approvals.



- Populated Place
- Proposed Natural Gas Pipeline Alignment
- Proposed Infrastructure Layout
- Federal Administrative Boundaries
- State Administrative Boundaries

Seward Meridian, UTM Zone 5, NAD83

SCALE:

0 12.5 25 50 mi

0 20 40 80 km

DONLIN GOLD

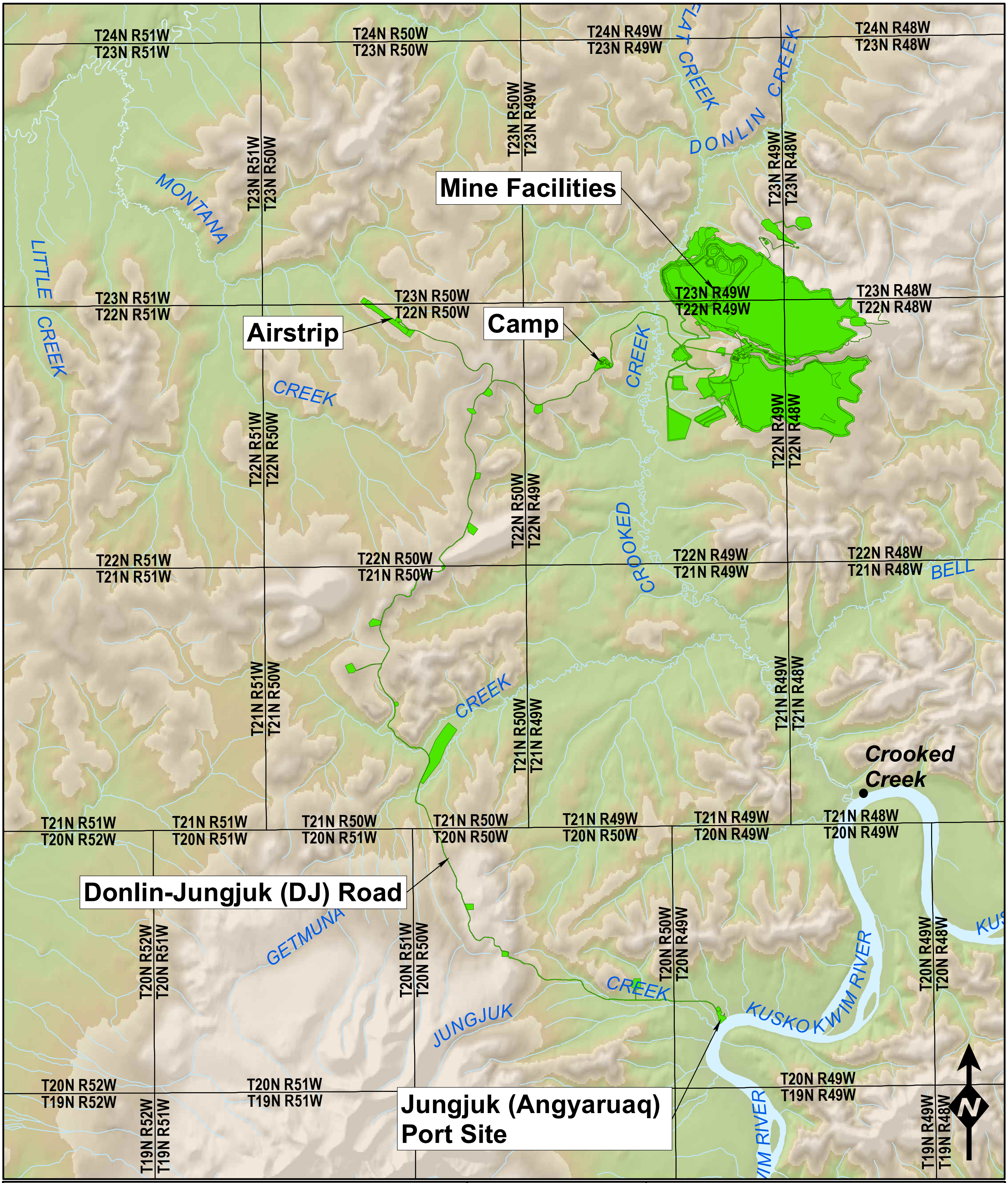
PROJECT LOCATION MAP

DONLIN GOLD PROJECT

FIGURE:

1-1

DG: PER540.mxd, 10/05/16, R01



Proposed Infrastructure Layout

Seward Meridian, UTM Zone 4, NAD83

DONLIN GOLD

LOCATION OF
MINE FOOTPRINT
AND OFFSITE FACILITIES

DONLIN GOLD PROJECT

SCALE:
0 1 2 4 mi
0 1.5 3 6 km

FIGURE:
1-2

DG: PER0323.mxd, 04/06/16, R03

total capacity of approximately 334,300 acre-ft (412.35 Mm^3) for tailings, reclaim water, and flood events. Total waste rock material is estimated at 3,145 Mst (2,853 Mt), with approximately 2,460 Mst (2,232 Mt) placed in a waste rock facility located outside the mine pit and the remaining waste rock backfilled in the pit or used in construction.

The proposed Donlin Gold project would be a camp operation accessible primarily by a 5,000 foot (1,542 m) gravel airstrip and include a camp capable of housing 638 workers. Other ancillary support facilities would be located within the project area.

1.4.1 Definitions

The following definitions were used to distinguish water type and associated management objectives/requirements in this Plan:

- *Contact water* – Contact water is surface water or groundwater that has contacted mining infrastructure. This includes "mine drainage" defined in Title 40, Code of Federal Regulations (CFR) at 40 CFR Part 440.132(h) as any water drained, pumped, or siphoned from a mine, as well as stormwater runoff and seepage from mining infrastructure. Examples of contact water include runoff and seepage from waste rock piles, runoff and seepage from stockpiles, and water from horizontal drains that accumulates in the pit.
- *Mine drainage* – Mine drainage has a specific regulatory definition as noted above and includes water drained, pumped, or siphoned from a mine, including pit wall runoff and drains internal to the pit. In the context of the WRMP, mine drainage is a type of contact water.
- *Process wastewater* – Process plant wastewater has a specific regulatory definition (40 CFR 122.2) and includes "…any water which during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product." Process wastewater includes water that comes into contact with tailings (Tailings Storage Facility [TSF] pond water and any component of Seepage Recovery System [SRS] water that could be attributable to TSF seepage) and ore, (runoff from the long-term ore stockpile).
- *Process water* - Process water is water that is fed to the processing plant. Sources of process water include water from the TSF reclaim, Contact Water Dams (CWDs), pit dewatering, SRS, and the Snow Gulch Reservoir.
- *Fresh water* – Fresh water is water that has not come into direct contact with mining or mine infrastructure. Examples include impounded fresh water (e.g. Snow Gulch Reservoir), surface water flows, and stormwater runoff diverted around mining infrastructure.
- *Pit dewatering water* – Pit dewatering water is groundwater from dewatering wells external and internal to the pit. This water may be directed to either the Lower CWD, in which case, it becomes co-mingled with contact water, or it may be treated and discharged.
- *Process plant makeup water* – Water required to make up for process plant losses.
- *Stormwater* – The regulatory definition of stormwater is "Stormwater runoff, snow melt runoff, and surface runoff and drainage" (40 CFR 122.26(b)(13)).
- *Domestic Wastewater* – Domestic wastewater is water from humans or household operations that is discharged to or otherwise enters a treatment works.

2.0 METEOROLOGICAL AND HYDROLOGICAL CHARACTERISTICS OF THE PROJECT SITE

This section provides information related to meteorological, groundwater, and surface water baseline data collected for the Project. This information was used as input to the water balance models and to develop the water management plan.

2.1 Meteorological Characteristics

2.1.1 Precipitation

Precipitation data are an important input to several aspects of the project design studies including site water balance, unsaturated flow modeling of the waste rock facility, groundwater modeling of pit dewatering, and Pit Lake hydrology following mine closure. Precipitation data have been gathered at the proposed Donlin Gold project site for the periods 1996-2000 and October 2004-June 2015. However, these datasets cannot be used on their own to generate a reliable long-term record of precipitation because they are too short to yield an accurate range of potential year-to-year variations in precipitation. Therefore, site precipitation was compared to precipitation measured at regional meteorological stations, Crooked Creek and McGrath. From this comparison, a synthetic precipitation dataset was developed for the period 1940-2010 (BGC 2011a). This synthetic precipitation dataset was used as input to the construction and operations, and closure water balance models (BGC 2011b, 2016b).

Average annual precipitation at the proposed Donlin Gold project site is estimated at 19.6 inches (50 cm), comprised of 13.6 inches (34.5 cm) rainfall (69%) and 6.1 inches (15.4 cm) snowfall (31%), as shown in Table 2-1 (BGC 2014a). Annual precipitation is variable, with a potential range of about 12.9 to 34.3 inches (33 to 87 cm). Annual potential evaporation/sublimation is about 13.4 inches (34 cm). Rainfall generally occurs from May through September and snowfall from November through March. October and April are transition months, with both rainfall and snowfall occurring. On average, snowmelt begins April 1st and ends May 4th.

2.1.2 Runoff

Runoff from undisturbed ground was calculated using an empirical water balance model developed by Vandewiele et al. (1992). This model divides runoff into slow and fast components that are roughly analogous to groundwater and surface water flows. Runoff calculations using the Vandewiele et al. empirical model were incorporated into the deterministic and probabilistic spreadsheet water balance models described in Appendix B. The runoff model was calibrated using site precipitation data and coincident stream flow measurements on American Creek for the period 1996-2000, and then it was validated for the period 2005-2009. Good calibration was obtained with the runoff model on a weekly basis for this period (BGC 2011a). A separate calibration and validation exercise was completed for Anaconda Creek (2005-2010).

Table 2-1: Estimated Monthly Precipitation

Month	Total Precipitation			Snowfall*			Rainfall	
	(inches)	(mm)		(inches)	(mm)		(inches)	(mm)
January	1.16	29.5		1.16	29.5		0.00	0.0
February	0.89	22.5		0.89	22.5		0.00	0.0
March	0.80	20.2		0.64	16.2		0.16	4.0
April	0.40	10.1		0.04	1.1		0.35	8.9
May	1.05	26.7		0.00	0.0		1.05	26.7
June	2.16	54.8		0.00	0.0		2.16	54.8
July	2.61	66.4		0.00	0.0		2.61	66.4
August	3.69	93.8		0.00	0.0		3.69	93.8
September	2.65	67.4		0.00	0.0		2.65	67.4
October	1.74	44.3		0.85	21.7		0.89	22.6
November	1.17	29.8		1.17	29.8		0.00	0.0
December	1.30	33.1		1.30	33.1		0.00	0.0
Annual	**19.63**	**498.7**		**6.06**	**154.0**		**13.57**	**344.7**

*Snow Water Equivalent

2.1.3 Evaporation/Sublimation

Table 2-2 presents the monthly potential evaporation/sublimation and mean temperature in the proposed project area. Annual average potential evaporation/sublimation for the project area is estimated to be 14.56 inches (37 cm). Annual average runoff for the project area is 13.4 inches (34 cm) indicating that actual evaporation/sublimation is 6.26 inches (159 mm) or approximately 43% of the potential evaporation.

Table 2-2: Potential Evaporation/Sublimation and Mean Temperature

Month	Potential Evaporation/Sublimation			Mean Temperature	
	(inches)	(mm)		(ºF)	(ºC)
January	0.09	2.3		-7.4	-22
February	0.11	2.8		0.7	-17
March	0.19	4.8		10.4	-12
April	0.55	14		27.9	-2.3
May	2.84	72		45.3	7.4
June	3.58	91		56.5	13.6
July	3.31	84		59.2	15
August	2.09	53		54.5	12.5
September	1.50	38		44.2	6.8
October	0.12	3		25.5	-3.6
November	0.11	2.8		5.9	-14.5
December	0.07	2		-6.0	-21
Total	**14.56**	**369**			

2.1.4 Storm Frequency Analysis

A 100-year synthetic precipitation dataset was used to create storm frequency data. A frequency analysis of annual precipitation was completed using this dataset. The dataset has maximum and minimum annual values of 34.3 inches (871 mm) and 12.7 inches (322 mm), respectively, and a standard deviation of 4.25 inches (107 mm). Table 2-3 summarizes the results of the frequency analysis.

A frequency analysis was also completed for 24-hour storm events based on the 100-year synthetic precipitation dataset. Peak rainfall events are most likely to occur during the summer and to be associated with convective storm cells. Results are summarized in Table 2-3. The largest 24-hour storm event on record occurred on July 8, 1998 when 2 inches (50 mm) of rain was recorded at the American Ridge climate station.

Table 2-3: Total Annual Precipitation/Maximum Daily Rainfall - Frequency Analysis

Return Period (yrs.)	Annual Precipitation			24-hour Rainfall	
	(inches)	(mm)		(inches)	(mm)
Average	19.6	499		-	-
2-year wet	-	-		1.2	30
5-year wet	23.4	595		1.6	41
10-year wet	25.9	658		1.9	49
20-year wet	28.2	716		2.3	59
50-year wet	31.1	789		2.6	67
100-year wet	33.2	843		3.0	76
200-year wet	35.3	896		3.3	84

Source: BGC 2011a, Hydro-Meteorological Data: Synthesis and Analysis Final Report, Tables 7-1 and *7-2.*

2.1.5 Snowmelt and Concurrent Rainfall Frequency Analysis

Some of the dam structures considered at the proposed Donlin Gold project require storage for snowmelt of various return periods. The synthetic precipitation dataset for Donlin Gold (1940-2010) includes a record of snow accumulation and snowmelt start/end dates. These data allow snowmelt volumes to be defined on an annual basis (sublimation is accounted for in these data). The snowmelt data are based on climate records at McGrath (1940-present).

Snowmelt depths and concurrent rainfall for various return periods are summarized in Table 2-4. The precipitation excess (i.e., expected runoff) of the snowmelt and concurrent rainfall was also evaluated using the calibrated Vandewiele et al. (1992) water balance model (BGC 2011b, 2016b). These results are summarized in Table 2-4.

Table 2-4: Snowmelt and Concurrent Rainfall – Frequency Analysis

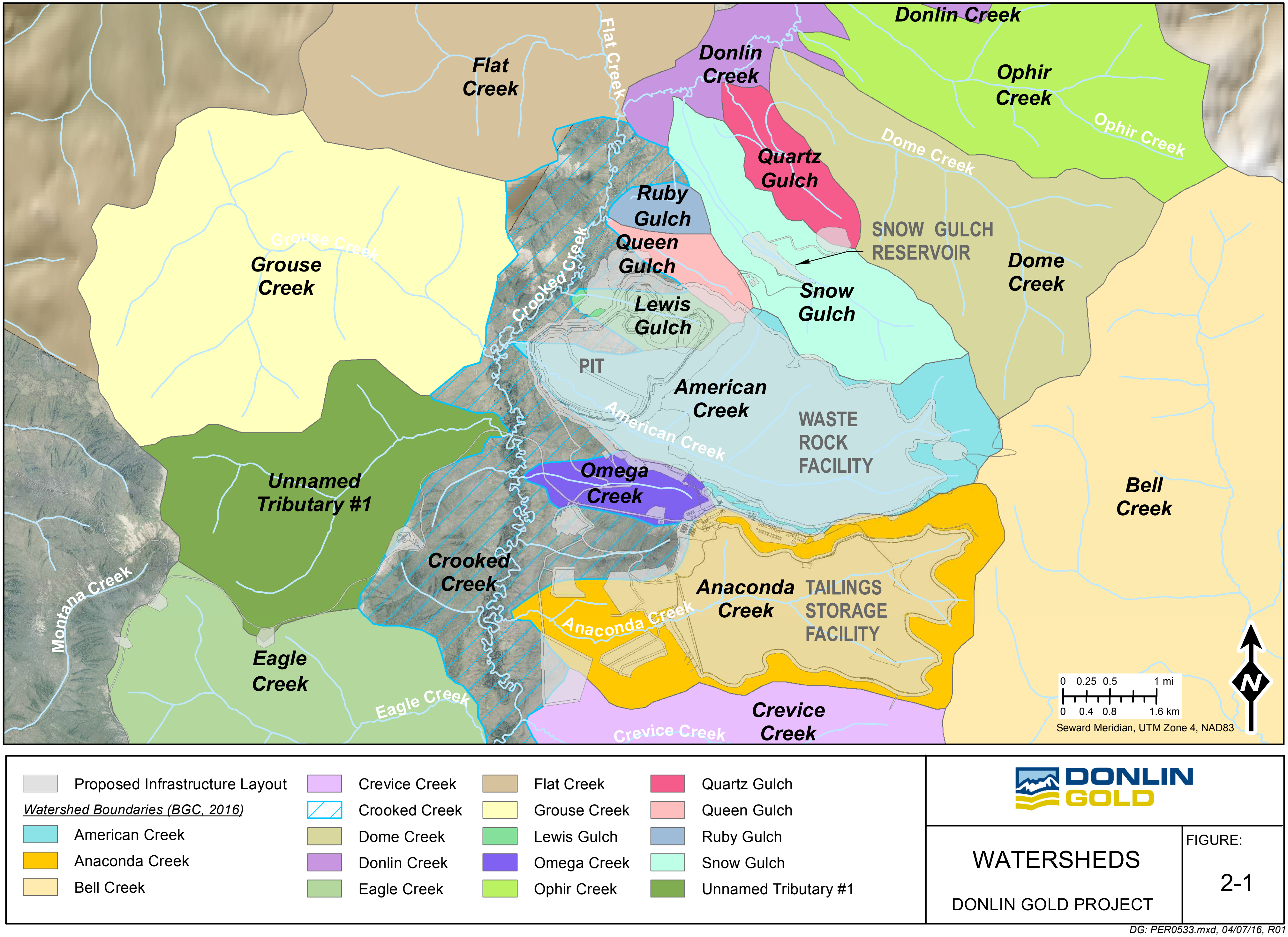
Return Period (yrs.)	Snowmelt and Concurrent Rainfall (inches)	Snowmelt and Concurrent Rainfall (mm)	Modeled Runoff (inches)	Modeled Runoff (mm)
Average	5.8	147	3.1	78
5-year	7.1	180	4.0	101
10-year	8.0	202	4.6	118
20-year	8.8	223	5.2	132
50-year	9.8	248	5.9	151
100-year	10.5	266	6.5	164
200-year	11.2	284	7.0	177

Source: BGC 2011a. Hydro-Meteorological Data: Synthesis and Analysis Final Report, Tables 7-3 and 7-4.

2.2 Surface Water Hydrology

The ore body is located between American Creek on the south and Snow Gulch to the north. The TSF would be located south and east of the ore body; Anaconda Creek bisects the TSF along the east-west axis. Crooked Creek is the main drainage course of the area. The mine area, which has been investigated for geologic, geotechnical, hydrologic, and hydrogeological characteristics, lies to the east of Crooked Creek. Figure 2-1 shows the surface water resources in the mine area which consist of the following watersheds:

- Crooked Creek along stretch adjacent to the project area; Donlin Creek above
- Dome Creek
- Quartz Gulch
- Snow Gulch
- Queen Gulch
- Lewis Gulch
- American Creek
- Omega Gulch
- Anaconda Creek
- Grouse Creek
- Unnamed Tributary #1
- Crevice Creek
- Eagle Creek
- Ruby Gulch
- Ophir Creek
- Flat Creek



Donlin Creek
Flat Creek
Donlin Creek
Ophir Creek
Ophir Creek
Dome Creek
Quartz Gulch
Ruby Gulch
Queen Gulch
SNOW GULCH RESERVOIR
Grouse Creek
Grouse Creek
Crooked Creek
Lewis Gulch
Snow Gulch
Dome Creek
PIT
American Creek
American Creek
WASTE ROCK FACILITY
Omega Creek
Unnamed Tributary #1
Bell Creek
Crooked Creek
Anaconda Creek
TAILINGS STORAGE FACILITY
Anaconda Creek
Montana Creek
Eagle Creek
Eagle Creek
Crevice Creek
Crevice Creek
0 0.25 0.5 1 mi
0 0.4 0.8 1.6 km
Seward Meridian, UTM Zone 4, NAD83
N
Proposed Infrastructure Layout
Watershed Boundaries (BGC, 2016)
American Creek
Anaconda Creek
Bell Creek
Crevice Creek
Crooked Creek
Dome Creek
Donlin Creek
Eagle Creek
Flat Creek
Grouse Creek
Lewis Gulch
Omega Creek
Ophir Creek
Quartz Gulch
Queen Gulch
Ruby Gulch
Snow Gulch
Unnamed Tributary #1
DONLIN GOLD
WATERSHEDS
DONLIN GOLD PROJECT
FIGURE:
2-1
DG: PER0533.mxd, 04/07/16, R01

The surface water monitoring plan at the proposed Donlin Gold project was first established in 1996. The initial plan included 13 monitoring stations that were scattered throughout the upper portions of the project area; these stations were concentrated along Crooked Creek and on its tributaries immediately upstream of their confluence with Crooked Creek. The original monitoring stations were located to gather water quality and surface flow data for entire drainage basins. As the proposed project progressed, and the understanding of both flow and loading of metals from the respective basins increased, the sampling program was revised during 2005 to include the addition of new surface water sampling stations and to remove others. The sampling plan was then expanded in 2006 to include the Crevice Creek drainage, and again in 2013 to include Getmuna and Bell Creeks.

The locations of the surface water monitoring stations are shown on Figure 2-2 (within facilities footprint) and Figure 2-3 (outside of facilities footprint). Table 2-5 provides a description of each surface water monitoring station,

2.2.1 Stream Flow Data

The period of record and the type of stream flow monitoring for each station is summarized in Table 2-6. Most stations have only manual stage-discharge data; however, automatic recording stations were established for periods of time at several stations within the proposed project site (AMER, ANDA, DCBO, CCBA, CCAC, and CRDN). Continuous flow data are available for these locations only during open-water seasons, typically June through October. Figures 2-4 and 2-5 present the discharge hydrographs and precipitation for data available at these stations from 1996 through 2013.

2.2.2 Surface Water Quality

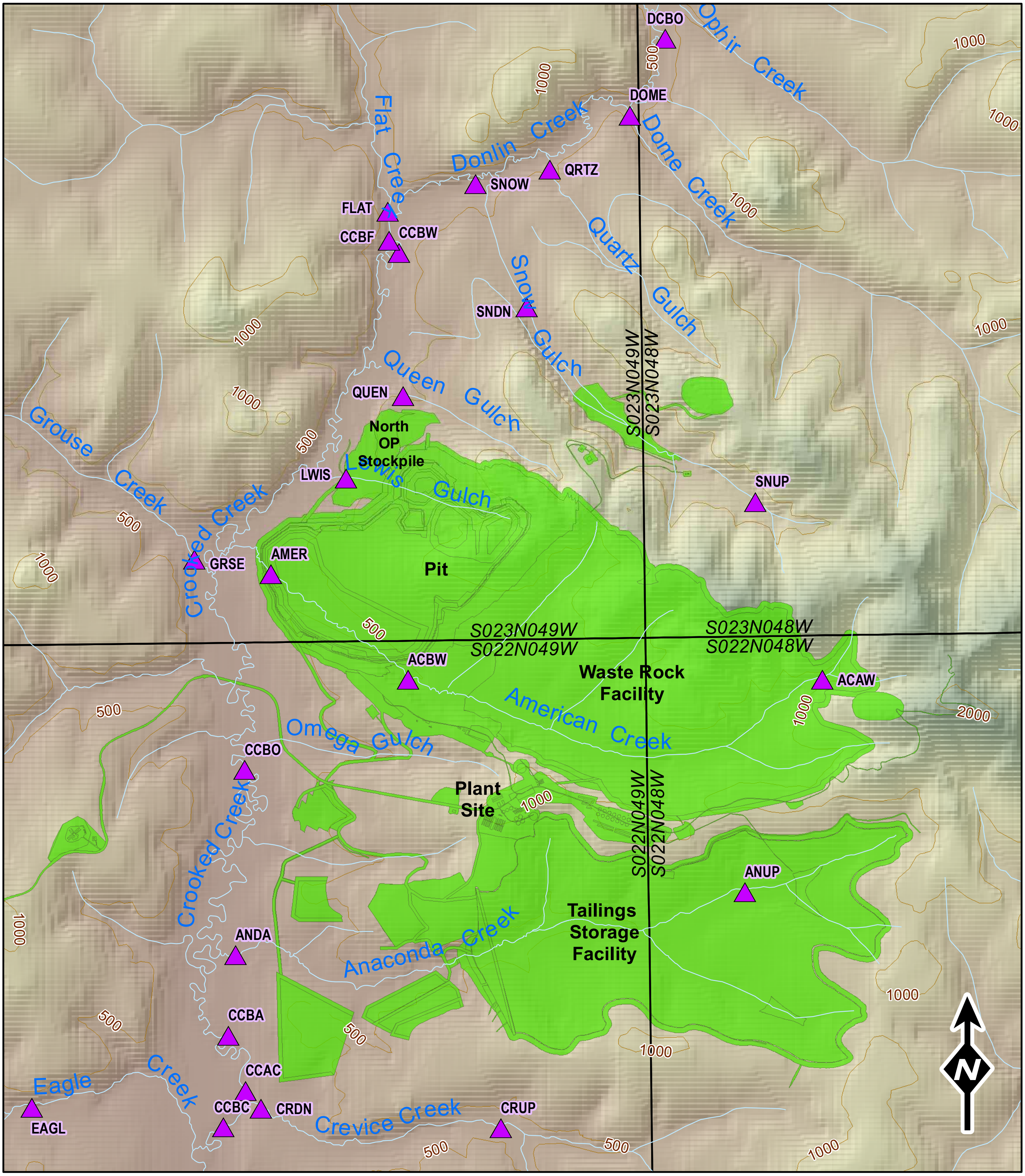
The primary components of the surface water characterization program at the proposed Donlin Gold project are collection of surface water samples for laboratory chemical analysis, acquisition of water quality field parameters, and measurement of stream flow and stream stage.

Alaska Water Quality Standards

Table 2-7 presents the AWQS for drinking water, acute and chronic aquatic life, and human health for constituents of concern at the proposed Donlin Gold project. Water quality standards in Table 2-7 are applicable for conditions observed at monitoring station CCBO, which is at the proposed operations water treatment plant (WTP) outfall location.

Project Area Water Quality Monitoring

Water quality data collected are maintained in accordance with the *Quality Assurance Project Plan (QAPP) Water Quality Monitoring, Sampling and Analyses Activities* (AES Lynx 2005), updated through January 2015 (Donlin Gold 2015). In this section, surface water quality data are summarized for the period starting in the second quarter of 2005 through the second quarter of 2015. The QAPP procedures were used to collect, record, and maintain data during this time period; it is, therefore, the most comprehensive data set of highest quality and serves as the best data set in order to provide a summary of baseline water quality.



▲	Surface Water Monitoring Site
(green)	Proposed Infrastructure Layout
(line)	Contour (500-ft)

Seward Meridian, UTM Zone 4, NAD83

DONLIN GOLD

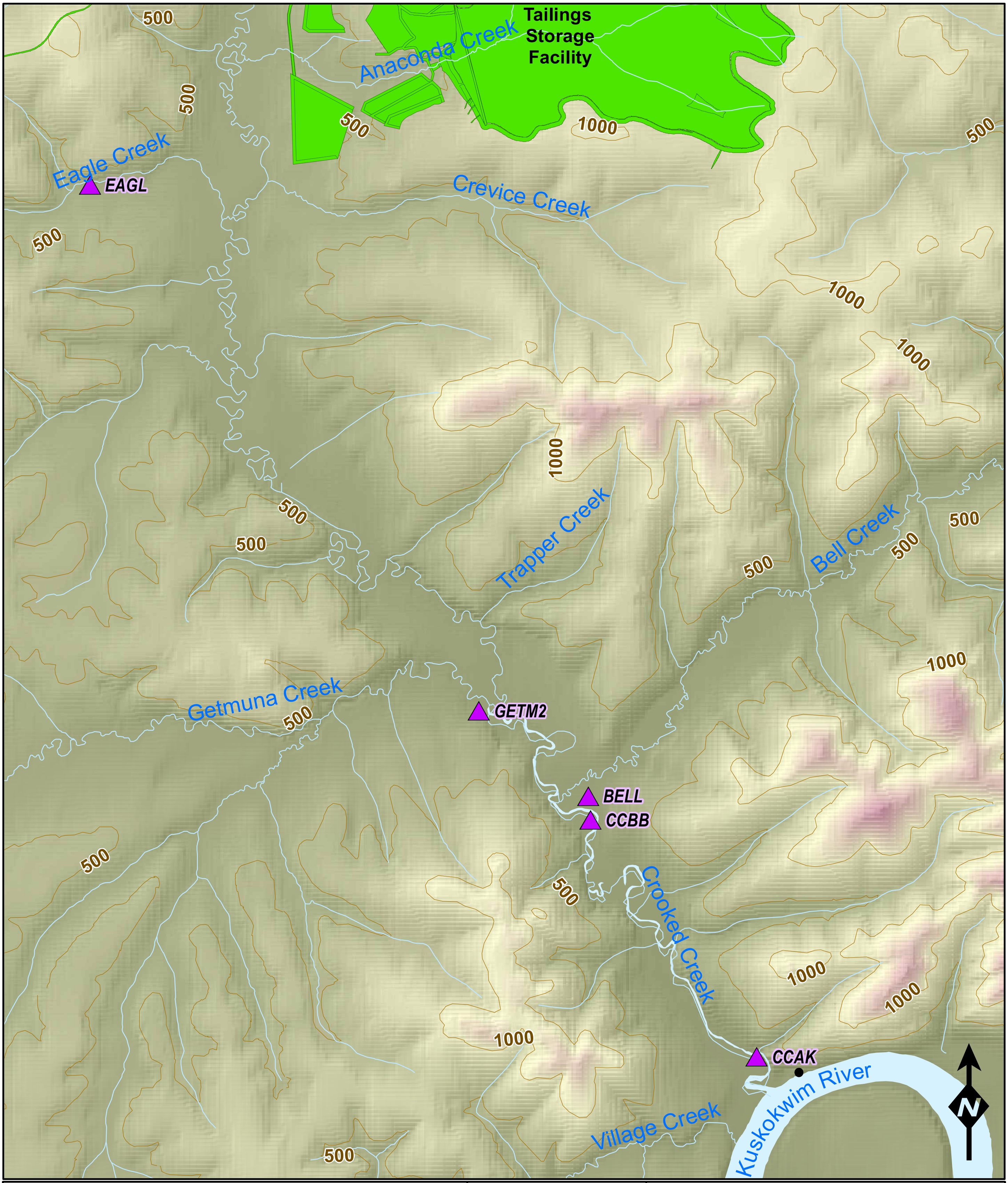
SURFACE WATER MONITORING SITES WITHIN FACILITIES FOOTPRINT

DONLIN GOLD PROJECT

SCALE: 0 0.25 0.5 1 mi / 0 0.375 0.75 1.5 km

FIGURE: 2-2

DG: PER0088.mxd, 04/06/16, R14



Surface Water Monitoring Locations Outside of Mine Area Proposed Infrastructure Layout Contour (500-ft) Seward Meridian, UTM Zone 4 NAD83	DONLIN GOLD	SURFACE WATER MONITORING SITES OUTSIDE OF FACILITIES FOOTPRINT DONLIN GOLD PROJECT
		SCALE: 0 0.25 0.5 1 mi / 0 0.4 0.8 1.6 km — FIGURE: 2-3

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Table 2-5: Surface Water Monitoring Stations

Station ID	Station Name and Description	Catchment Area		Rationale and Purpose	Category
		sq miles	km^2		
Locations within Mine Facilities Footprint					
ACAW	American Creek above Waste Rock Facility	-	-	American Creek upstream of proposed waste rock placement near upstream diversion of water. Also upstream of mineralization in American Creek. Placed to determine quality of diversion water that would be directed to Crooked Creek as non-mine water.	1 (background)
ACBW	American Creek below Waste Rock Facility	-	-	American Creek Below waste rock and downstream of SRS pond. Designed as long-term monitoring station through reclamation and closure.	2 (background)
AMER	American Creek upstream of Bridge Crossing	6.7	17	American Creek below all planned facilities and disturbance and above confluence with Crooked Creek.	2 (background)
ANDA	Anaconda Creek above the confluence with Crooked Creek	7.9	21	Below all proposed facilities in Anaconda Creek and above Crooked Creek.	1 (background)
ANUP	Upper Anaconda Creek	-	-	Anaconda Creek above any potential influence from diversions or other physical disturbance.	1 (background)
CCAC	Crooked Creek above Crevice Creek	116	300	Below all proposed facilities and potential impacts to Crooked Creek. This site replaces CCBA.	3 (baseline)
CCBC	Crooked Creek below Crevice Creek	-	-	Below all proposed facilities and potential impacts to Crevice Creek.	3 (baseline)
CCBO	Crooked Creek below the confluence with Omega Creek	104	269	Downstream of Ophir Creek, which drains from the camp area and airstrip.	3 (baseline)
CCBW	Crooked Creek below Lyman's Wash Plant	-	-	Crooked Creek below influence of placer mining operation.	3 (baseline)
CRDN	Lower Crevice Creek	-	-	Crevice Creek below any potential influence from Anaconda facilities.	1 (background)
CRUP	Upper Crevice Creek	-	-	Crevice Creek above any potential influence from Anaconda facilities.	1 (background)

DCBO	Donlin Creek below Ophir Creek	37	96	Upstream of all proposed activity and above any disturbance from historic placer mining. Project Control.	1 (background)
SNDN	Lower Snow Creek	-		Snow Gulch below the mineralized trend and above historic placer tails.	2 (background)
SNOW	Snow Gulch above the confluence with Donlin Creek	3.4	8.8	Snow Gulch below mineralization and historic placer tails and above confluence with Crooked Creek.	3 (baseline)
SNUP	Upper Snow Creek	-	-	Snow Gulch crosses both the mineralized trend and historic placer mining. This site is above both the mineralization trend and placer mining.	1 (background)
Locations Outside Mine Facilities Footprint					
BELL	Bell Creek above confluence with Crooked Creek	-	-	Bell Creek upstream of potential mine influence on Crooked Creek.	1 (background)
CCAK	Crooked Creek above confluence with Kuskokwim River	347	899	Crooked Creek about 8 miles downstream of all proposed mine facilities and potential impacts to Crooked Creek, and upstream of historical mine influences on Kuskokwim River.	3 (baseline)
CCBB	Crooked Creek below Bell Creek	-	-	Crooked Creek about 6 miles (10 km) downstream of all proposed mine facilities and potential impacts to Crooked Creek.	3 (baseline)
DOME	Dome Creek above confluence with Donlin Creek	7.1	18	Dome Creek downstream of potential exploration activities.	1 (background)
EAGL	Eagle Creek above confluence with Crooked Creek	-		Eagle Creek downstream of potential domestic wastewater outfall facilities.	3 (baseline)
GETM1	Getmuna Creek above confluence with Crooked Creek	-	-	Getmuna Creek adjacent to the planned Jungjuk Road material site.	1 (background)
GETM2	Getmuna Creek above confluence with Crooked Creek	-	-	Getmuna Creek below any potential influence from Jungjuk Road material site.	1 (background)
KUSK	Kuskokwim River above Crooked Creek confluence	-	-	Characterize Kuskokwim River water quality above Crooked Creek confluence	1 (background)
KWIM	Kuskokwim River below Crooked Creek confluence	-	-	Characterize Kuskokwim River water quality below Crooked Creek confluence	1 (background)
QRTZ	Quartz Gulch above the confluence with Donlin Creek	1.2	3.1	Quartz Gulch downstream of potential exploration activities.	1 (background)

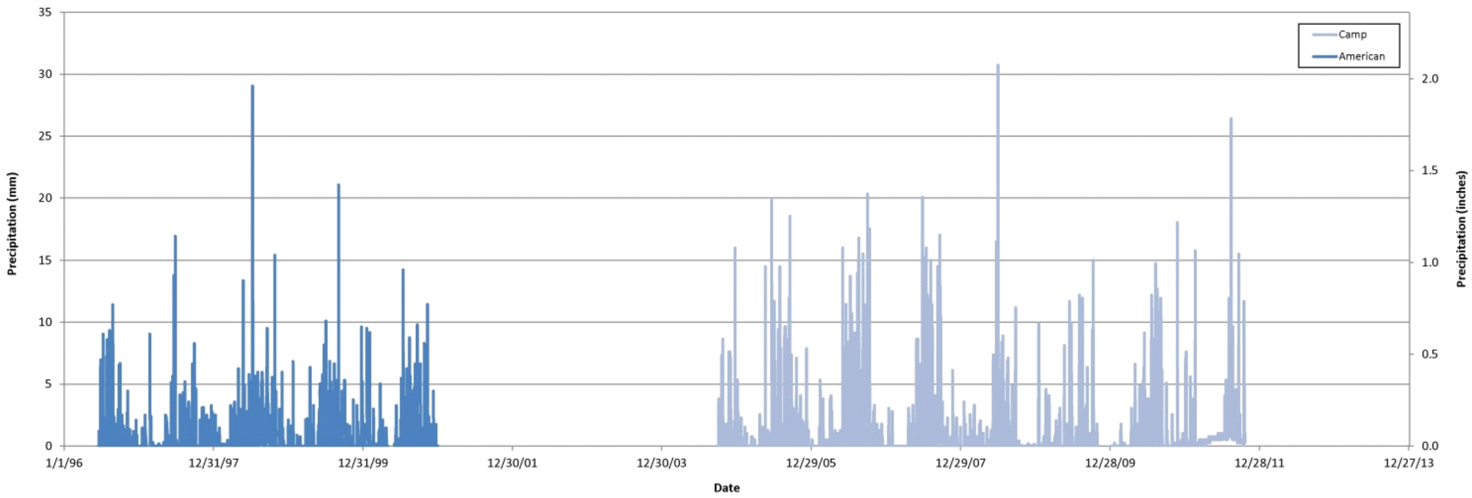
Historically-Monitored Locations Obsolete for Current Mine Plan					
FLAT	Flat Creek above the confluence with Crooked Creek	20.7	53.6	Obsolete location for current mine plan	Not applicable
CCBA	Crooked Creek below the confluence with Anaconda Creek	112	290	Obsolete location for current mine plan	Not applicable
CCBF	Crooked Creek below the confluence with Flat Creek	71.0	184	Obsolete location for current mine plan	Not applicable
GRSE	Grouse Creek above the confluence with Crooked Creek	12.5	32.4	Obsolete location for current mine plan	Not applicable
LWIS	Lewis Gulch above the confluence with Crooked Creek	0.9	2.3	Obsolete location for current mine plan	Not applicable
QUEN	Queen Gulch above the confluence with Crooked Creek	0.9	2.3	Obsolete location for current mine plan	Not applicable

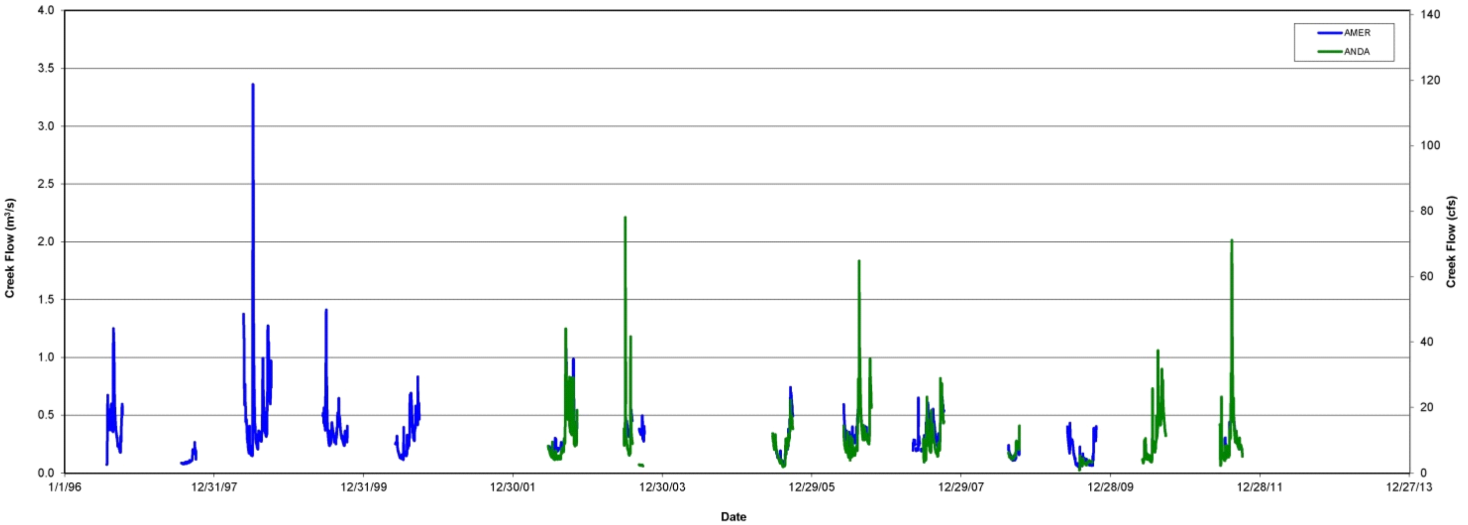
Table 2-6: Period of Record for Surface Water Monitoring Stations

Station	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Locations within Mine Facilities Footprint																				
ACAW						Field Sampling Program Suspended				M	M	M	M	M	M	M	M	M		M
ACBW										M	M	M	M	M	M	M	M	M		
AMER	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A
ANDA	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A
ANUP										M	M	M	M	M	M	M	M	M		
CCAC										A	A	A	A	A	A	A	A	A	A	A
CCBC										M	M	M	M	M	M	M	M	M		
CCBO	A	A	A	A	A		A			M	M	M	M	M	M	M	M	M	M	M
CCBW										M	M	M	M	M	M	M	M	M	M	
CRDN										M	M	M	M	M	A	A	A	A	A	A
CRUP										M	M	M	M	M	M	M	M			
DCBO	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A
SNDN										M	M	M	M	M	M	M	M			
SNOW	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M	M	M		M
SNUP										M	M	M	M	M	M	M	M	M		M
Locations Outside Mine Facilities Footprint																				
BELL						Field Sampling Program Suspended												M	M	M
CCAK	M	M	M	M	M		M	M	M	M	M	M	M	M	M			M	M	M
CCBB																		M	M	M
DOME	M	M	M	M	M		M	M	M				M	M	M					
EAGL														M	M	M				
GETM1																	M			
GETM2																		M	M	M
KUSK	W	W	W	W	W		W	W	W											
KWIM			W	W	W		W	W	W											
QRTZ	M	M	M	M	M		M	M	M				M	M	M					
Historically-monitored Locations Obsolete for Current Mine Plan																				
FLAT	M	M	M	M	M	Field Sampling Program Suspended	M	M	M	M										
CCBA							M	M	M											
CCBF	M	M	M	M	M															
GRSE	M	M	M	M	M		M	M	M				M	M						
LWIS	M	M	M	M	M		M	M	M											
QUEN	M	M	M	M	M		M	M	M											

Notes:

A - Automatic Recording during this year with periodic manual readings (pressure transducer + stream gauging)
M - Manual Readings Only
W – Water Quality Sampling Only





SCALE:		MEASURED DAILY STREAM DISCHARGE AT AMERICAN AND ANACONDA STATION AND PRECIPITATION AT AMERICAN CAMP STATIONS	FIGURE:
N/A	DONLIN GOLD	DONLIN GOLD PROJECT	2-4

SOURCE:BGC, 2014, Conceptual Hydrogeological Model-Report (DWG No. 13)

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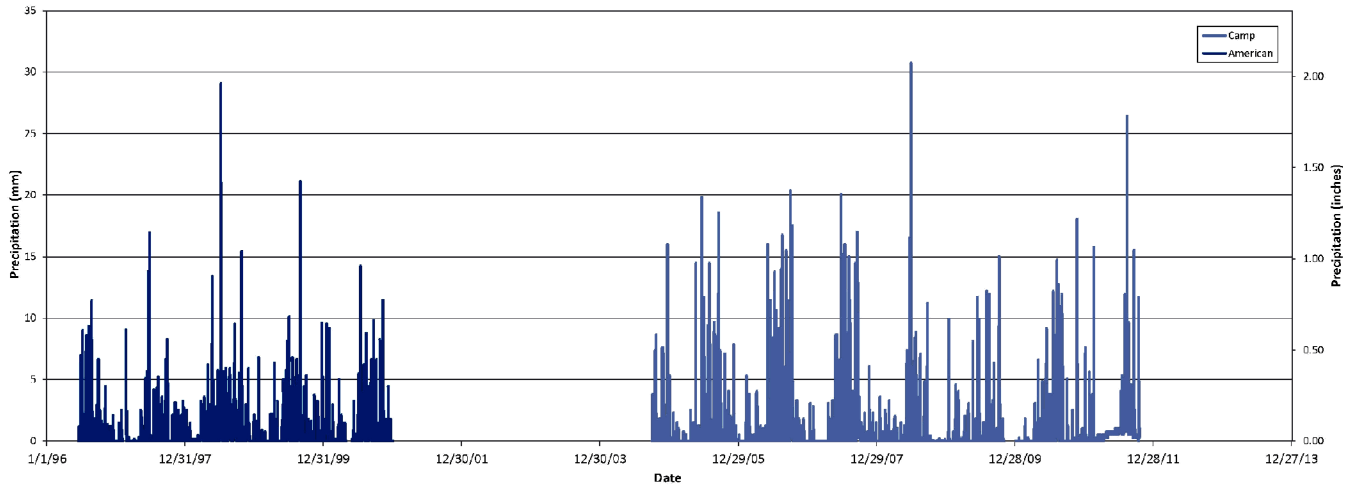
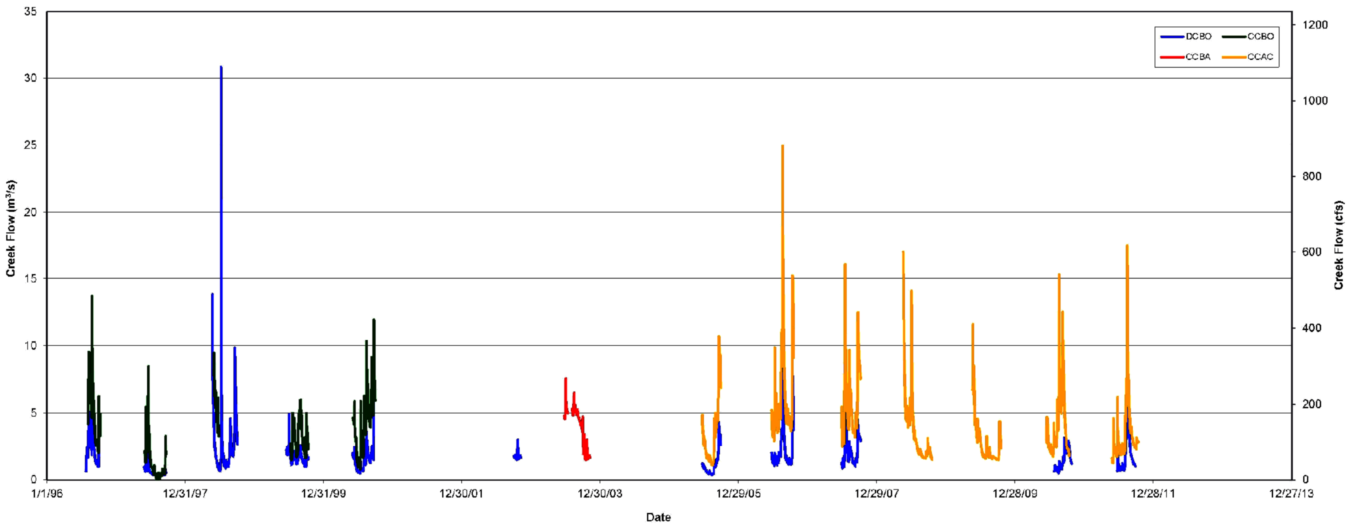




SOURCE:BGC, 2014, Conceptual Hydrogeological Model-Report (DWG No. 14)

SCALE:

N/A

DONLIN GOLD

MEASURED DAILY STREAM DISCHARGE AT CROOKED CREEK STATIONS AND ANACONDA AND CAMP PRECIPITATION

DONLIN GOLD PROJECT

FIGURE:

2-5

DG: PER0108.mxd, 04/06/16, R04

Table 2-7: Alaska Water Quality Standards at Operations WTP Discharge Location

Parameter	Unit	Most Stringent Applicable Alaska Standard*	Notes
pH	pH units	6.5-8.5	
Alkalinity**, Total	mg/L as $CaCO_3$	20[1]	
TDS	mg/L	500[2]	
Sulfate (SO_4)	mg/L	250[2]	
Fluoride (F)	mg/L	1[5]	
Chloride	mg/L	230[1]	
Nitrite + Nitrate	mg/L as nitrogen (N)	10[2]	
Ammonia***	mg/L as N	2.16***	
Aluminum (Al)	mg/L	0.75[1]	
Antimony (Sb)	mg/L	0.006[2]	
Arsenic (As)	mg/L	0.01[2]	
Barium (Ba)	mg/L	2[2]	
Beryllium (Be)	mg/L	0.004[2]	
Boron (B)	mg/L	0.750[5]	
Cadmium (Cd)	mg/L	0.00023[1]	
Calcium (Ca)	mg/L	500[2]	based on TDS
Chloride (Cl)	mg/L	230[1]	
Chromium (Cr), Total	mg/L	0.10[1]	
Chromium (Cr) III	mg/L	0.072[1]	
Chromium (Cr) VI	mg/L	0.011[1]	dissolved
Cobalt (Co)	mg/L	0.050[5]	
Copper (Cu)	mg/L	0.00775[1]	
Cyanide (CN)	mg/L	0.0052[1]	weak acid dissociable (WAD)
Fluoride (F)	mg/L	1[5]	
Iron (Fe)	mg/L	1[1]	
Lead (Pb)	mg/L	0.00242[1]	
Lithium	mg/L	2.5[5]	
Manganese (Mn)	mg/L	0.050[4]	
Mercury (Hg)	mg/L	0.000012[4]	1994 WQS approved by EPA
Molybdenum (Mo)	mg/L	0.010[5]	
Nickel (Ni)	mg/L	0.0434[2]	
Potassium (K)	mg/L	500[2]	based on TDS
Selenium (Se)	mg/L	0.005[1]	
Silica (Si)	mg/L	500[2]	based on TDS
Sodium (Na)	mg/L	500[2]	based on TDS
Strontium (Sr)	mg/L	8 picocuries per liter Sr-90[2]	
Silver (Ag)	mg/L	0.0026[3]	
Thallium (Tl)	mg/L	0.0017[4]	
Vanadium (V)	mg/L	0.1[5]	
Zinc (Zn)	mg/L	0.119*[1]	

*Hardness-based standards for metals were derived using a hardness of 80.55 mg/L, which represents the 15th percentile measurements at Monitoring Station CCBO, Crooked Creek immediately below Omega Gulch. The 15th percentile was derived from data collected from Q1-1996 through Q2-2015. Monitoring Station CCBO represents the receiving waters at the proposed outfall location.

**(minimum) as $CaCO_3$ except where natural alkalinity is lower

***The ammonia standard was derived as specified in Alaska Water Quality Criteria Manual - Appendix D using the 85th percentile temperature and pH at CCBO, 6.83^{0}C and 7.85 pH units respectively.

[1]Chronic Alaska Aquatic for Fresh Water equivalent to the acute Aquatic Criteria for Fresh Water at this discharge location as the average pH at monitoring station CCBO is greater than 7.0 and the average hardness is greater than or equal to 50 parts per million as $CaCO_3$.

[2]Alaska Drinking Water

[3]Acute Alaska Aquatic for Fresh Water

[4]Human Health Criteria

[5]Irigation Water

Surface water quality in the vicinity of the proposed project can be segregated into three basic categories of influence:

- Category 1: waters draining undisturbed areas and areas outside of the mineralized area of interest (background sites)
- Category 2: waters draining the area of defined mineralized zone only, with no placer mining activities (background sites)
- Category 3: waters draining from areas of both placer mining and the mineralized zone of the proposed Donlin Gold project (baseline sites)[4].

The surface water sampling plan was designed to characterize these three areas and to establish control sites. The surface water hydrologic data collection sites vary from the water quality sites because they are located to achieve different goals. Additional grab samples and collection of field parameters are collected when practical.

Results of surface water quality monitoring are provided in Appendix A, Tables A-1 (Category 1), A-2 (Category 2), A-3 (Category 3), and A-4 (organics). A general summary of the surface water quality data for locations within the mine facilities footprint is presented in the following sections. This data includes all field data for the period of record, and laboratory analyses data from samples collected 2005 and later. Results of analysis for field samples prior to 2005 was not included as data from this period was found to have outliers associated with differences in method and reporting limits between laboratories (Arcadis 2012), and the samples were not collected and analyzed under the procedures established in the 2005 QAPP.

General Water Quality Parameters

The average concentration of total dissolved solids (TDS) was as follows: 125 mg/L (Category 1); 141 mg/L (Category 2); and 145 mg/L (Category 3). Suspended solids are highest for Category 1 water (average of 42.6 mg/L vs. 15.9 mg/L, and 20.2 mg/L for Categories 2 and 3, respectively). Total alkalinity was highest for Category 3 water due to sample location SNOW, although the highest single reading was at station CCBO. It is likely water at SNOW drains from an area rich in carbonate minerals that contribute to the bicarbonate alkalinity of the water.

Field Parameters

The average pH of Category 1, Category 2 and Category 3 waters were all 7.4. The average turbidity levels were as follows: 13.5 Nephelometric Turbidity Units (NTU) (Category 1); 9.41 NTU (Category 2); and 8.91 NTU (Category 3).

Organic Analyses

Analysis for total organic carbon (TOC, biological oxygen demand (BOD), and chemical oxygen demand (COD) were performed for samples collected from select surface water locations during two sampling events, one in 2012 and the second in 2014. Samples were collected from stations in Snow Gulch (SNOW), on Crooked Creek (CCBW and CCBO),

[4] Background sites are those that would not be affected by potential mining operations; baseline sites represent those sites that could conceivably be affected. Impacts to surface water quality would be determined by comparing data collected at baseline sites before operations (characterization data) and during operations.

American Creek (AMER and ACAW), and Anaconda Creek (ANUP and ANDN). The highest TOC concentration, 5.81 mg/L, was detected in a sample from monitoring station CCBO. The highest dissolved TOC concentration, 5.01 mg/L, was detected in a sample from monitoring station ANDA. BOD was not detected at any of the monitoring stations sampled. The highest COD concentration, 13.9 mg/L, was detected in a sample from monitoring station AMER. Baseline water samples were not routinely analyzed for petroleum range organics within the project area.

2.3 Groundwater Hydrology

Available hydrogeologic data presented here includes results from packer tests, slug tests, pumping tests, water quality sampling, and ground water elevation data that have been collected east of Crooked Creek in the proposed project area from 1999 through 2013 (BGC 2014b, 2014c). The data are briefly summarized below.

The elevation of the mine area ranges from approximately 330 to 2,100 ft (100 to 640 m amsl). The average depth to groundwater in the mine area is approximately 33 ft (10 m); however, the depth to water table ranges from 0 to 230 ft (0 to 70 m) below ground surface. Surface topography in the mine area generally slopes west toward Crooked Creek. The water table generally mimics surface topography. Groundwater enters the system as recharge from rainfall and snowmelt and leaves the system at zones of discharge (i.e., creeks and low-lying areas) and through evapotranspiration (BGC 2014a). The water table is near or above ground surface (i.e., artesian conditions) in low-lying areas and is found at greater depths along ridges and ridge tops. Individual groundwater monitoring wells are further identified in the Monitoring Plan, Volume VIIA, (SRK 2016b).

2.3.1 Groundwater Elevation

Groundwater elevation data are available for 206 locations in the mine area. The locations are comprised of monitoring wells, pumping wells, standpipe piezometers, and vibrating wire piezometers (VWPs), as presented in Table 2-8 and shown on Figure 2-6.

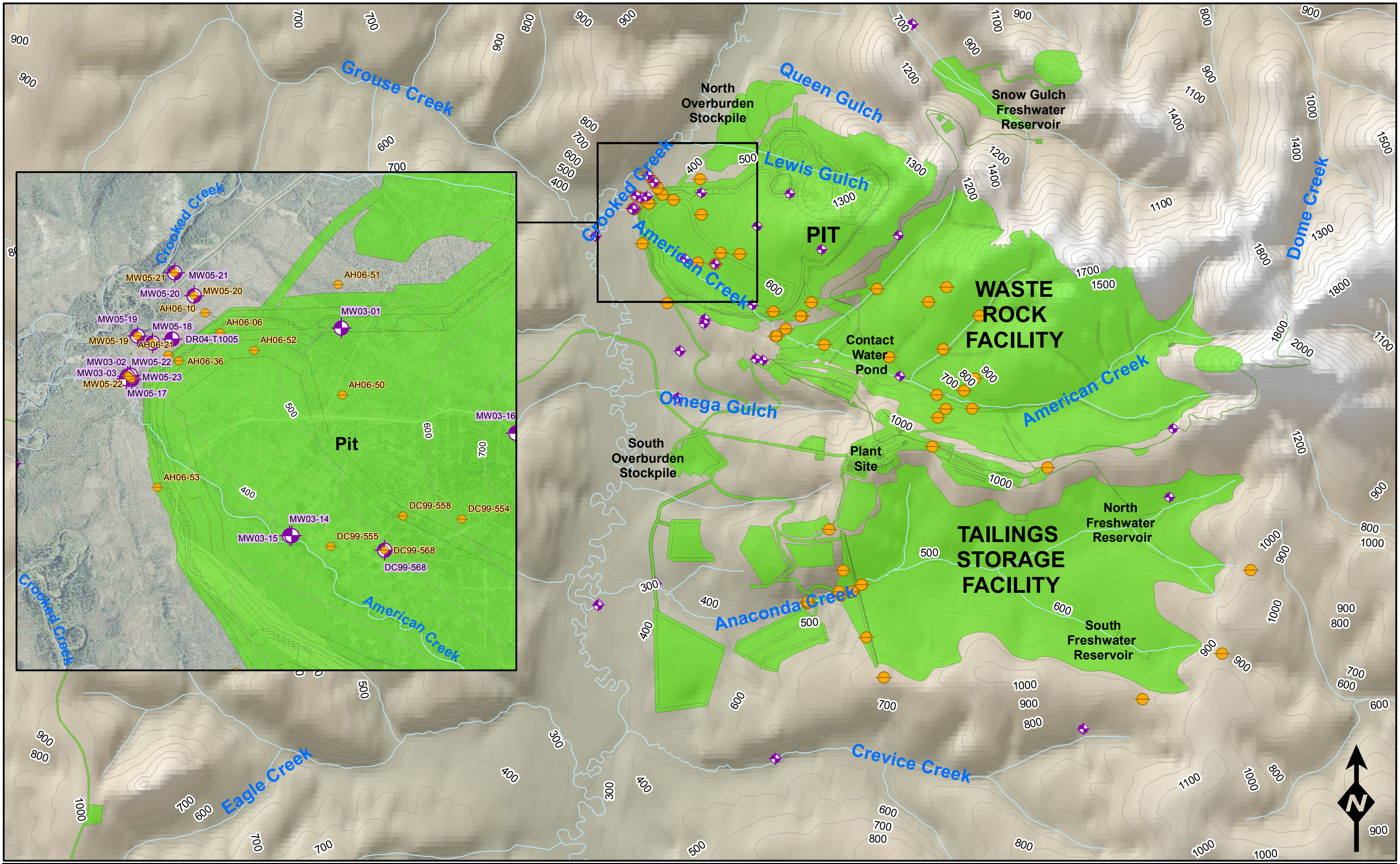
Figure 2-7 presents the groundwater potentiometric surface based on water-level data collected at monitoring points during the summer/fall of 2010. The measured values indicate that seasonal fluctuations in groundwater elevation range from less than 16 ft (5 m) near creeks, gullies, and low ridges, and vary up to 33 to 66 ft (10 to 20 m) in higher elevation ridges.

Groundwater elevations are generally lowest during the winter and spring quarter (i.e., December to March) and highest during the summer and fall quarter (i.e., June to September). The trend is more pronounced in wells located away from the creeks. The seasonal variation in groundwater levels is consistent with the seasonal precipitation and temperature trends.

Table 2-8: Summary of Groundwater Monitoring Wells and Vibrating Wire Piezometers

Year	Series	No. Monitoring Wells/Standpipe Piezometers	No. VWP*	Comments
1999	DC99	2	2	Converted exploration drillholes, standpipe in drillholes 554 and 558, VWP in drillholes DC99-555 and DC99-568.
2002	-	5	2	Temporary piezometer installations in drillholes DR02-828 (WW-1), DR02-829 (WW-2), and DR02-831 (WW-4) used as observation wells; DR02-830 (WW-3) and DR02-832 (WW-5) were used as production wells.
2003	MW03	16	0	Groundwater measurements were taken quarterly at most of MW03- series monitoring wells through 2013.
2005	MW05, DGT05, AH05	20	0	Monitored during the summer and fall quarter since installation in 2005 through 2013.
2006	DGT06, AH06	33	12	Generally have been monitored during the summer and fall quarters since installation through 2013. Continuous daily data was collected at VWPs DGT06-1168, DGT06-1177a, DGT06-1177b, DGT06-1179a, and DGT06-1179b from June 1, 2007 through June 2015.
2007	DGT07, AH07	54	15	One 5-inch (127 mm) prototype pumping well 660-ft (200 m) deep; and ten standpipe monitoring wells and six nested VWPs in two 6-inch (152 mm) boreholes were installed as part of the 13 hole RC drilling program. Groundwater elevation data is limited to three or four observations at the majority of the DGT07 and AH07 holes; daily data are available from June 2007 through Sept. 2011 for two of VWPs nested in MW07-13 and until March 2014 for MW07-13c
2008	DGT08, AH08, AH10	10	11	Data at these locations were generally observed and downloaded quarterly through June 2015.
2009	DGT09	3	4	Data at these locations were generally observed and downloaded quarterly through June 2015.
2010	AH10, DGT10	0	21	Data at these locations were generally observed and downloaded quarterly through June 2015.
2013	MW13	7		Seven additional monitoring wells (MW13-series were installed to monitor pumping tests conducted in 2013 (BGC 2014a)
Total		150	67	Some installations were temporary or have been abandoned.

Source: BGC (2014a). Conceptual Hydrogeologic Model
*Vibrating wire piezometer (VWP)



Contour (100-ft)

Proposed Infrastructure Layout

Piezometer/Water Level

Groundwater Monitoring Well

Seward Meridian, UTM Zone 4, NAD83

SCALE:

0 0.25 0.5 1 mi

0 0.4 0.8 1.6 km

DONLIN GOLD

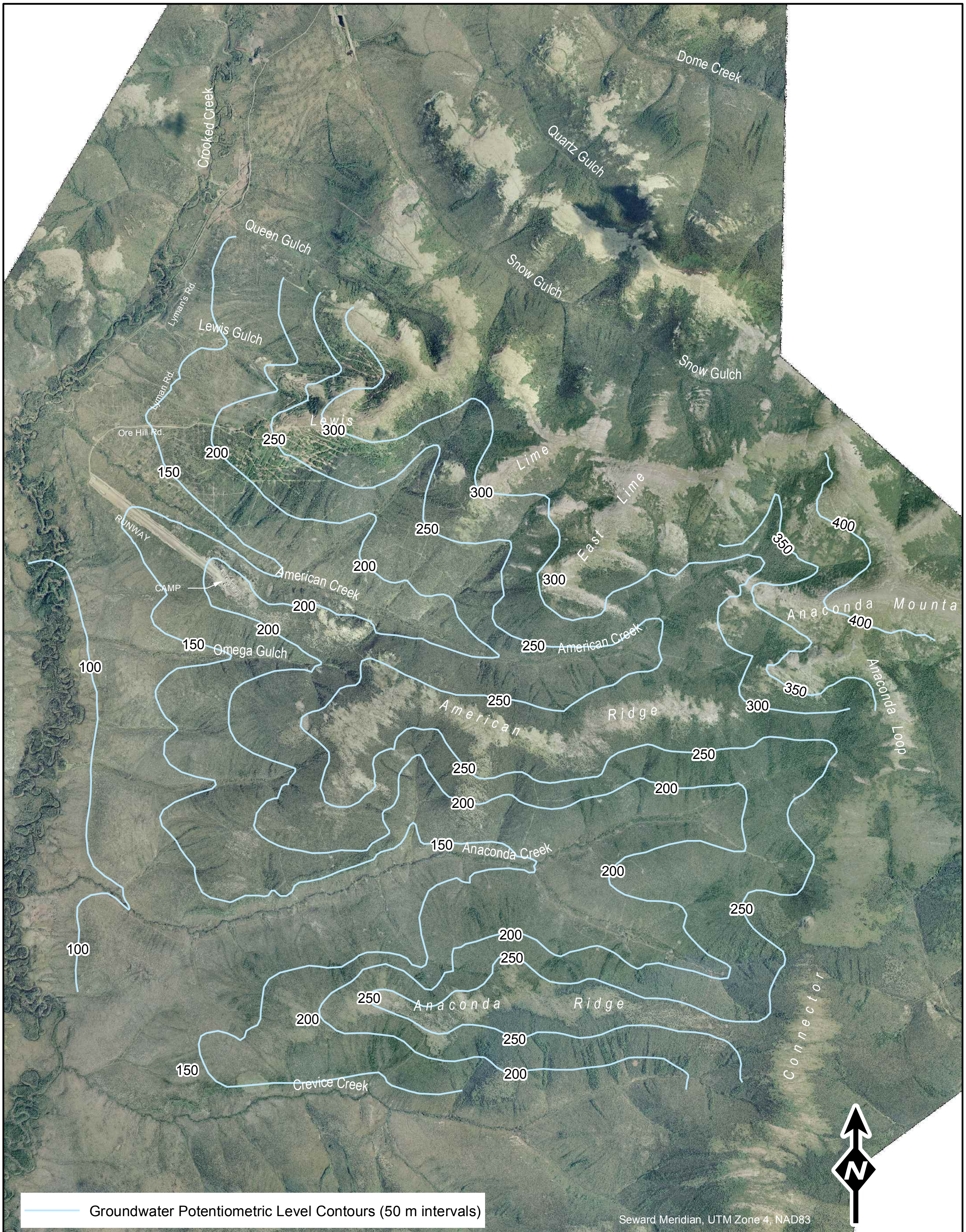
GROUNDWATER MONITORING SITES

DONLIN GOLD PROJECT

FIGURE:

2-6

DG: PER0089.mxd, 04/06/16, R12



SCALE:

0 1,000 2,000 4,000 ft

0 250 500 1,000 m

DONLIN GOLD

SUMMER/FALL GROUNDWATER POTENTIOMETRIC SURFACE

DONLIN GOLD PROJECT

FIGURE: 2-7

DG: PER0286.mxd, 04/06/16, R02

2.3.2 Vertical Hydraulic Gradient

Data from 29 monitoring well and piezometer nests were reviewed to evaluate vertical gradients at the site (BGC 2014a). Many well pairs are installed near creeks where discharge zones have upward gradients. Several of these well pairs indicate artesian conditions and have strong upward gradients. In the remaining piezometer pairs near creeks, gradients are typically near zero (i.e., essentially there is no vertical gradient).

2.3.3 Hydraulic Conductivity

Hydraulic conductivity data available for the mine area is comprised of findings from a total of 40 tests conducted in the overburden and 931 tests conducted in bedrock. The majority of the hydraulic conductivity tests were small scale or "point scale" tests (i.e., packer and slug tests), with larger scale tests (i.e., pumping tests) conducted at thirteen locations (BGC 2014a).

Overburden

A total of twenty estimates of hydraulic conductivity (fifteen from slug tests and five from observation wells used during three pumping tests) are available to characterize the alluvial deposits. The geometric mean hydraulic conductivity for all tests not affected by permafrost is 11 ft/d ($4x10^{-5}$ m/s), and ranges from 0.009 to 900 ft/d ($3x10^{-8}$ to $3x10^{-3}$ m/s). However, results of tests at a larger scale (i.e., the pumping tests) are considered to be more representative for these materials. The geometric mean of hydraulic conductivity values obtained from pumping tests at alluvium wells MW03-13, MW03-05, and MW13-07 is 113 ft/d ($4x10^{-4}$ m/s). The estimate of hydraulic conductivity obtained from the long-term pumping test at MW13-07, located between Crooked Creek and the proposed open pit, was 384 ft/d ($1x10^{-3}$ m/s).

Sixteen estimates of hydraulic conductivity of the colluvium are available from slug tests. Five of these tests were conducted in monitoring wells partially screened in permafrost. The geometric mean hydraulic conductivity for tests not affected by permafrost for the colluvium is 0.07 ft/d ($2x10^{-7}$m/s), and ranges from 0.003 to 1 ft/d ($1x10^{-8}$ to $5x10^{-6}$ m/s).

Two slug tests were conducted in the loess and terrace gravel. One test in each hydrogeologic unit was performed in monitoring wells partially screened in permafrost. Based on the test results, the estimated hydraulic conductivities for the loess and terrace gravel are 0.06 ft/d ($2x10^{-7}$ m/s) and 0.1 ft/d ($5x10^{-7}$ m/s), respectively (BGC 2014c).

Bedrock

Hydraulic conductivity estimates typically vary over approximately three orders of magnitude at any given depth below ground surface (bgs), but tend to decrease with depth. The hydraulic conductivity estimated from testing data for the upper 330 ft (100 m) of bedrock typically ranges from 0.006 to 14 ft/d ($2x10^{-8}$ to $5x10^{-5}$ m/s), with a geometric mean of 0.3 ft/d ($1x10^{-6}$ m/s); while from 330 ft (100 m) bgs to 660 ft (200 m) bgs, it typically ranges from 0.0009 to 0.9 ft/d ($3x10^{-9}$ to $3x10^{-6}$ m/s), with a geometric mean of 0.03 ft/d ($9x10^{-8}$ m/s).

Below a depth of 660 ft (200 m), the hydraulic conductivity of the bedrock ranges from 0.0003 to 0.2 ft/d ($1x10^{-9}$ to $6x10^{-7}$ m/s), with a geometric mean of 0.006 ft/d ($2x10^{-8}$ m/s).

Geometric mean hydraulic conductivity values for depth intervals of 0 to 330 ft (0 to 100 m) bgs, 330 to 660 ft (100 to 200 m) bgs, and greater than 660 ft (200 m) bgs show an approximate one order of magnitude decrease with depth (BGC 2014c).

Specific Yield and Specific Storage Data

Aquifer storage properties are import to predict the behavior of the hydrogeological system to seasonal changes in groundwater and during pumping and dewatering. The rate at which water can be removed from or can be added to an aquifer is dependent upon the magnitude of the change in hydraulic head and the aquifer storage parameters. Specific yield describes the storage behavior of an aquifer when it is desaturated (or re-saturated) while specific storage describes the storage behavior when water is removed from or added to an aquifer while it remains fully saturated (BGC 2014c).

<u>Overburden</u>

Based on the 2013 pumping tests near Crooked Creek (BGC 2014c), the specific yield of the alluvium is estimated to be 0.03 and the specific storage of the alluvium is estimated to be $6x10^{-4}$ ft^{-1} ($2x10^{-3}$ m^{-1}).

<u>Bedrock</u>

Based on pumping tests at MW07-11 and MW12-03, the specific storage of the bedrock is estimated to range from $1x10^{-7}$ to $6x10^{-5}$ ft^{-1} ($4x10^{-7}$ m^{-1} to $2x10^{-4}$ m^{-1}).

2.3.4 Groundwater Quality

Groundwater samples collected quarterly from the second quarter of 2005 through the third quarter of 2013 were used to characterize groundwater at the site. This included the MW03-series groundwater monitoring wells (except MW03-06 and MW03-11, which were historically dry wells) and MW07-series wells (except MW07-08 and MW07-11). Groundwater samples collected at MW05-23, MW07-11, and MW13-02 and MW13-07 during pumping tests conducted during the 2006, 2007 and 2013 hydrogeologic investigations, respectively, are also included in this analysis.

Average water ionic composition for each well is presented in Figure 2-8, while average water quality for a full suite of analytes at each location during this same period is summarized in Tables A-5 (in-pit area bedrock groundwater) A-6 (ex-pit area bedrock groundwater), and A-7 (alluvial groundwater) of Appendix A. Organics analyses are summarized on Table A-4. All water quality parameters discussed here, unless specified otherwise, are mean dissolved concentrations. Dissolved concentrations typically have been found to reflect the total concentrations found in wells at the project site.

Bedrock Groundwater Quality in the Vicinity of the Pit

Six MW03-series monitoring wells (i.e., MW03-01, MW03-02, MW03-04, MW03-14, MW03-15, MW03-16) and three additional wells (MW-05-23, MW07-11, and MW13-03) installed for pumping tests and sampled only during the tests are completed in bedrock in the pit vicinity. The groundwater composition for each well ranges from calcium-sodium-bicarbonate to calcium-magnesium-bicarbonate type. Reduction-oxidation potential or redox is typically low within these bedrock wells, ranging from an average of 24 millivolt (mV) (MW03-02) to -65 mV (MW07-11).

Average TDS concentrations ranged from 152 mg/L at MW03-15, to 584 mg/L at MW03-14. With the exception of the deep groundwater wells in the pit area, MW03-14 and MW05-23, average TDS values are less than the most stringent AWQS of 500 mg/L (drinking water standard).

Groundwater samples collected in shallow bedrock monitoring wells MW03-01, MW03-04, MW03-15 contained average dissolved Fe concentrations greater than the most stringent AWQS of 1 mg/L (i.e., chronic aquatic life standard). Groundwater in all wells, with the exception of MW07-11, contained average dissolved concentrations of As greater than the most stringent AWQS of 0.01 mg/L (i.e., drinking water standard). Average dissolved As concentrations appear to be somewhat higher in the deeper wells (0.207 mg/L, 1.87 mg/L, and 0.236 mg/L at MW03-14, MW03-16, and MW05-23, respectively) than the shallow wells, where average concentrations range from 0.0108 mg/L at MW03-02, to 0.223 mg/L at MW03-01.

Average dissolved Mn concentrations were greater than the most stringent AWQS of 0.05 mg/L (i.e., human health criteria) in many of the wells, including MW03-01, MW03-04, MW03-15, MW03-16, and MW13-03. Average dissolved concentrations of trace metals are also greater than the most stringent AWQS in well MW05-23 for Sb, Hg and Zn; and MW07-11 and MW13-03 for Zn.

Analyses for TOC, BOD, and COD were performed for samples collected from select groundwater locations during 2012. Unfiltered groundwater samples were collected for organics analyses from bedrock wells within the footprint of the proposed open pit (MW03-01, 02, 04, 14, 15 and 16). The highest groundwater TOC concentration, 3.23 mg/L, was detected in a sample from monitoring well MW03-16. The highest BOD concentration, 10.2 mg/L, was detected in a sample from monitoring well MW03-04. The highest COD concentration, 10.6 mg/L, was detected in a sample from monitoring well MW03-01. Baseline water samples were not routinely analyzed for petroleum range organics within the project area.

Bedrock Groundwater Quality outside the Vicinity of the Pit

Groundwater quality data are available for MW03-series groundwater monitoring wells MW03-07 and MW03-08, which were completed within the bedrock upgradient from the proposed open pit (i.e., the upper American Creek catchment) and for MW03-series groundwater monitoring wells MW03-09, MW03-10 and MW03-12, which were completed in the bedrock in the Anaconda Creek catchment. Additionally, monitoring wells installed in 2007 provide groundwater quality information for Snow Creek (MW07-01 and MW07-02), Omega Gulch (MW07-03, MW07-04, MW07-05, and MW07-06), and Crevice Creek (MW07-07, MW07-09, and MW07-10). The groundwater composition for these wells ranges from calcium-sodium-bicarbonate to calcium-magnesium-bicarbonate type shown in Figure 2-8.

Average TDS concentrations measured in the laboratory ranged from 65.6 mg/L at MW07-10, to 345 mg/L at MW03-12. The average dissolved concentrations for analyzed parameters in these bedrock wells are typically less than the most stringent AWQS. The exceptions are for Al (MW07-10), Sb (MW07-01 and MW07-02), As (MW03-07, MW03-12, MW07-01, and MW07-02), Ba (MW03-12 and MW07-07), Fe (MW03-12, MW07-01, MW07-02, MW07-03, and MW07-10), Mn (MW03-07, MW03-12, MW07-01, MW07-02, MW07-03, MW07-05, MW07-07, and MW07-10), and Hg (MW07-01, MW07-03, and MW07-10), with average values that exceed the most stringent AWQS.

Alluvium Groundwater Quality

Groundwater monitoring wells MW03-03, MW03-05, and MW03-13 were completed in the alluvium along Crooked Creek in 2003. One additional well, MW13-07, was installed for pumping tests in 2013 and was only sampled during the testing program. The groundwater composition for each well is calcium-sodium-bicarbonate type. The average pH ranges from 6.6 at MW03-13, to 7.2 at MW03-05. The average TDS concentrations range from 160 mg/L at MW03-05, to 171 mg/L at MW03-13.

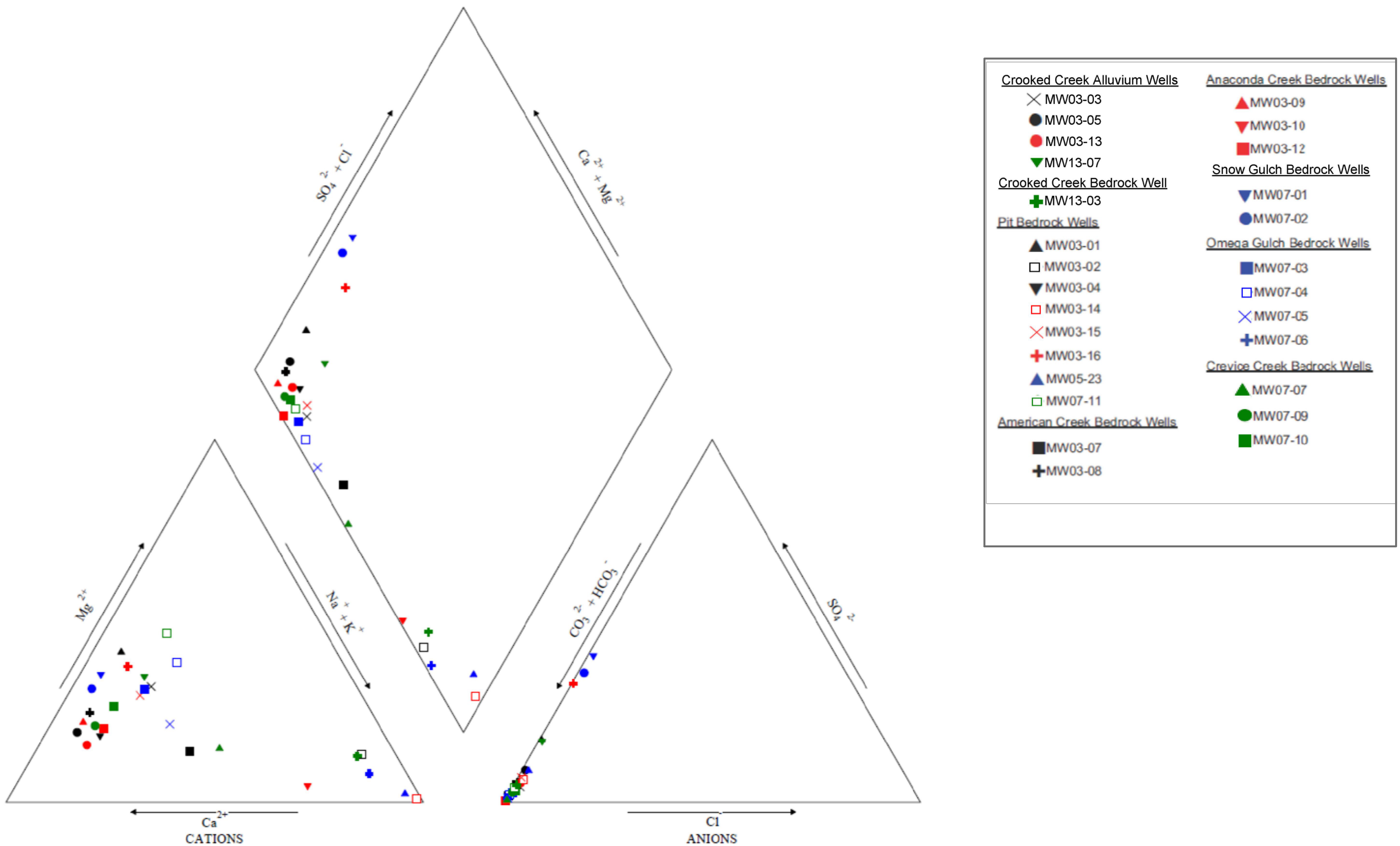
Average dissolved concentrations of the trace metals As, Fe, and Mn are greater than the most stringent AWQS in these wells. The As concentrations range from 0.0168 mg/L at MW03-05, to 0.218 mg/L at MW03-03, and are greater than the drinking water standard of 0.01 mg/L. The Fe concentrations range from 6.01 mg/L at MW03-05, to 40.4 mg/L at MW03-03, and are greater than the chronic aquatic life standard of 1 mg/L, while the Mn concentrations range from 1.32 mg/L at MW03-03, to 1.83 mg/L at MW13-07, and are greater than the human health criteria of 0.05 mg/L.

Dissolved oxygen (DO) and redox parameters were measured quarterly in the field for wells completed in alluvium. DO measurements tend to vary significantly at each well, and these data were, therefore, considered suspect. Redox is typically low in these wells, ranging on average from -59 mV at MW03-03, to -36 mV at MW03-05. The consistently low redox value, together with the high Fe and Mn concentrations, suggests reduced groundwater conditions. Strongly reducing conditions in groundwater, which appear to be present at the site, can cause Fe and Mn to be dissolved from solid-phase hydroxides commonly found in sediment.

2.3.5 Permafrost

The proposed Donlin Gold project site is located in the discontinuous permafrost zone of Alaska. Permafrost is rock or soil that remains at or below 32°F (0°C) for at least two years. Discontinuous permafrost, characterized by isolated or interconnected non-frozen zones, is expected at the proposed project site as the mean annual air temperature for the proposed project area is 26.5°F (-3.0°C).

Ground temperatures were determined from thermistor cables installed throughout the study area. The average measured temperature of permafrost is 31.6°F (-0.2°C), which is considered to be warm permafrost. The minimum recorded temperature is 31ºF (-0.5°C). A map showing the observed extent of permafrost at the site is shown for the American Creek area in Figure 2-9, for the Anaconda Creek area in Figure 2-10, and for the Snow Gulch Area in Figure 2-11. These figures are derived from direct observations of ground ice in auger cores, test pits, rock cores, documented ice occurrences, and ground temperature readings from thermistors. Based on visual observations from the auger holes and test pits, ice-rich permafrost appears to be largely confined to the overburden soils. Visible ice crystals were detected predominantly in gravelly soils, and the greatest amount of segregated ice was measured in silty soils. The depth of the active layer observed in the valley bottoms and mid-slope thermistors averages about 10 ft (3 m) below ground surface.



SCALE: N/A

DONLIN GOLD

PIPER PLOT GROUNDWATER MONITORING WELLS

DONLIN GOLD PROJECT

FIGURE: 2-8

SOURCE:BGC, 2014, Conceptual Hydrogeological Model- Report (DWG No.25)

DG: PER0109.mxd, 04/06/16, R02

Contour (100 ft)

Proposed Infrastructure Layout

Permafrost Distribution

Ice-Rich Permafrost Present

Permafrost Present in Hole

No Permafrost in Hole

No Permafrost; Unconfirmed *

Seward Meridian, UTM Zone 4, NAD83

* Field observations found no ice down hole, however the absence of permafrost has not been confirmed by ground temperatures.

DONLIN GOLD

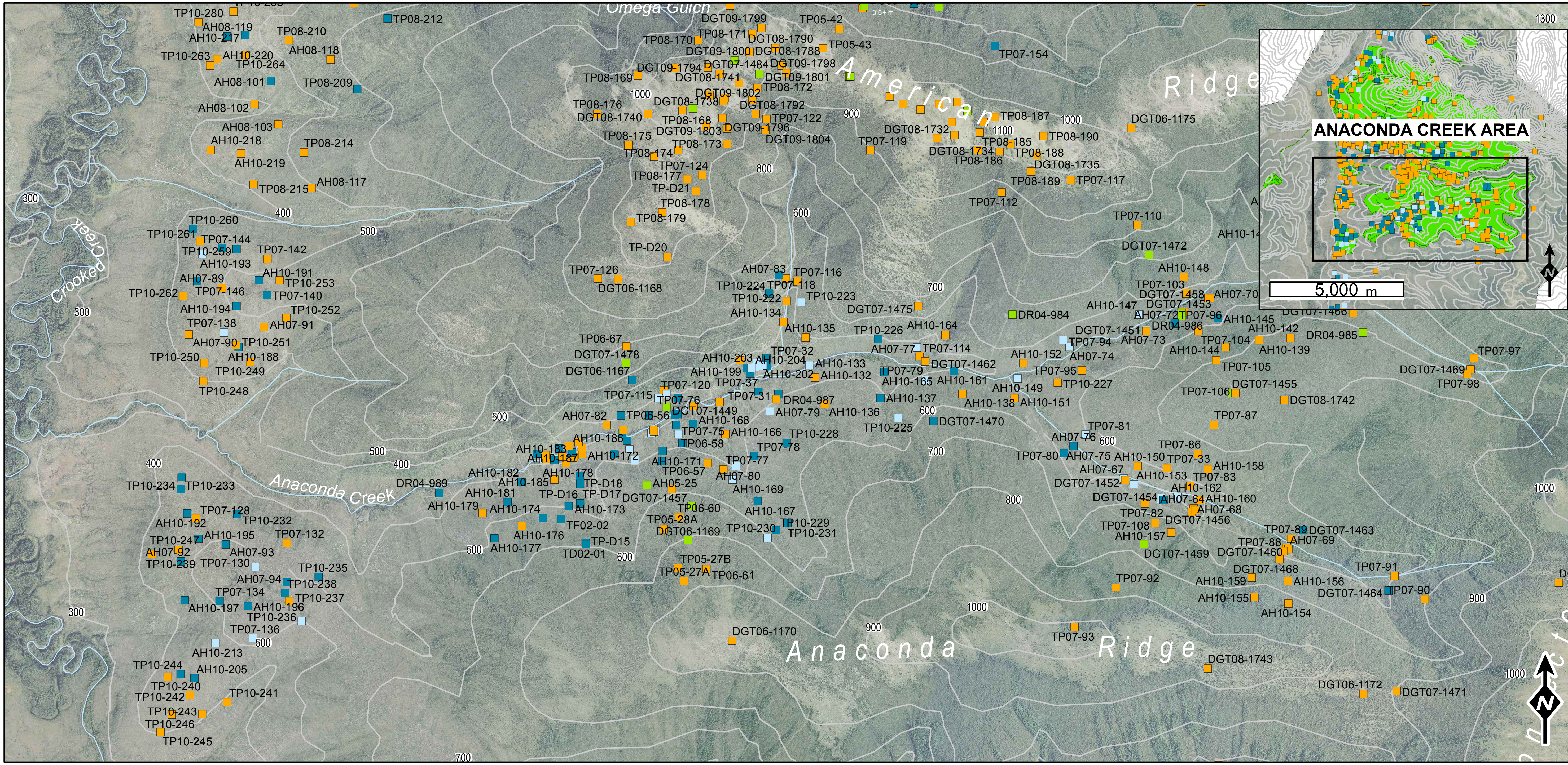
PERMAFROST DISTRIBUTION AMERICAN CREEK AREA

DONLIN GOLD PROJECT

SCALE: 0 400 800 1,600 ft; 0 125 250 500 m

FIGURE: 2-9

DG: PER0288.mxd, 04/06/16, R03



Contours (100 ft)

Proposed Infrastructure Layout

Permafrost Distribution

- Ice-Rich Permafrost Present
- Permafrost Present in Hole
- No Permafrost in Hole
- No Permafrost; Unconfirmed *

Seward Meridian, UTM Zone 4, NAD83

* Field observations found no ice down hole, however the absence of permafrost has not been confirmed by ground temperatures.

DONLIN GOLD

PERMAFROST DISTRIBUTION ANACONDA CREEK AREA

DONLIN GOLD PROJECT

SCALE: 0 500 1,000 2,000 ft / 0 125 250 500 m

FIGURE: 2-10

DG: PER0287.mxd, 04/06/16, R04

A total of 684 sites (diamond drillholes, auger holes, and test pits) are presented in Figure 2-9, Figure 2-10 and Figure 2-11. Of these, 238 sites encountered permafrost. Of the 238 sites that had permafrost, approximately 60% (144 sites) encountered the soil-bedrock interface. At these 144 locations, permafrost was confined to the overburden approximately half (48%) of the time. Where permafrost extended into bedrock, it typically reached depths of approximately 6.6 to 10 ft (2 to 3 m) below the top of bedrock, which was generally classified as highly to moderately weathered bedrock. The maximum recorded depth for permafrost below the top of bedrock is approximately 33 ft (10 m); however, it is not known how deep the permafrost penetrates those sites where drilling refusal occurred prior to encountering base of permafrost. Of the 238 sites that had permafrost, approximately 30% were found to have “ice-rich” permafrost, which has been defined for this project to be ground containing more than 20% ice by volume.

The permafrost at the proposed Donlin Gold project site is classified as sporadic discontinuous permafrost, meaning the extent of land area underlain by permafrost ranges from approximately 10% to 35%. Due to the nature of sporadic permafrost, it is not uncommon for neighboring sites to have different ground thermal regimes, as confirmed by the patchy distribution of permafrost versus non-permafrost sites, especially in American Creek valley and near Crooked Creek.

Generally, the thickness of permafrost at the proposed Donlin Gold project site decreases with increased elevation. At these higher elevations, the vegetation mat (peat, lichens and moss) and tree cover decreases, thereby decreasing potential insulation which could sustain permafrost under these specific microclimatic conditions.

3.0 PROJECT WATER MANAGEMENT REQUIREMENTS

The overall water management strategy for the proposed Donlin Gold Project requires the construction, maintenance, and operation of numerous structures. Table 3-1 indicates the general timeline from initial water management during construction (e.g., American Creek Fresh Water Diversion Dam [FWDD], temporary TSF Fresh Water Diversion Dams, etc.) and ongoing water management requirements during operations and post-closure as further described in the following sections. Life of mine (LOM) years are used to describe the period of time the process plant is in operation, and closure years describe the period of time after the process plant ceases operation.

Table 3-1: Life of Mine Water Management Timeline

Period	Construction 4 Years		Process Plant Operation 27 Years		Post Closure	
					Pit Lake Filling 52 Years	Long-Term Water Treatment
Timeline	LOM Year -4 through -3	LOM Year -2 through -1	LOM Year 1 through 25	LOM Year 26 through 27	Closure Year 1 through 52	Closure ~Year 52>
Pit Dewatering Wells Active						
Operations Water Treatment Plant Active						
Pit Lake reaches managed level – Seasonally Treat & Discharge						

Blue indicates dewatering and/or water treatment

Water balance predictions for the construction, operations, and closure phases of the proposed Donlin Gold project were completed using both deterministic and probabilistic (stochastic) modeling methods (BGC 2011b, 2016b). The models are spreadsheet-based to facilitate review and operation, yet sophisticated enough to accurately represent the complexities of each component of the water balance models. The water balance models are detailed in Appendix B.

This chapter describes water management during construction (Section 3.1), operations (Sections 3.2 and 3.3), and closure (Section 3.4). Treatment of water that will be discharged off-site is described separately in Chapter 4.

3.1 Water Supply and Management Concept – Construction

Site construction, as currently scheduled, would take place over a three to four-year period. Water management objectives during construction are to:

- Treat and discharge all pit dewatering groundwater to prevent the excessive build-up of water in the Lower CWD
- Minimize the need to treat and discharge contact water
- Provide an adequate supply of water to the process plant for commissioning
- Provide adequate pit depressurization

- Eliminate the need to store water in the TSF facility until immediately before process plant start-up.

Project components requiring water management during construction are shown in Figure 3-1. A schematic of water supply and routing during construction, including the anticipated average annual flow rates over the three-year construction period, is presented in Figures 3-2 and 3-3.

The American Creek drainage flows, pit dewatering water, ore stockpile berm, stormwater runoff from overburden stockpiles, construction camp potable water wells and domestic WTP discharge, Snow Gulch Reservoir, and the TSF (Anaconda runoff) are the primary components of the water supply and management during construction and are further described in the following subsections.

3.1.1 American Creek Runoff

Runoff from mine facilities in the American Creek drainage, including the pre-stripping excavations for the open pits, the waste rock facility (WRF), and other mine facilities as shown on Figure 3-1, would be managed as contact water, as defined in Section 1.3.1, unless suitable for coverage under a APDES general permit for stormwater discharges.

Lower and Upper Contact Water Dams

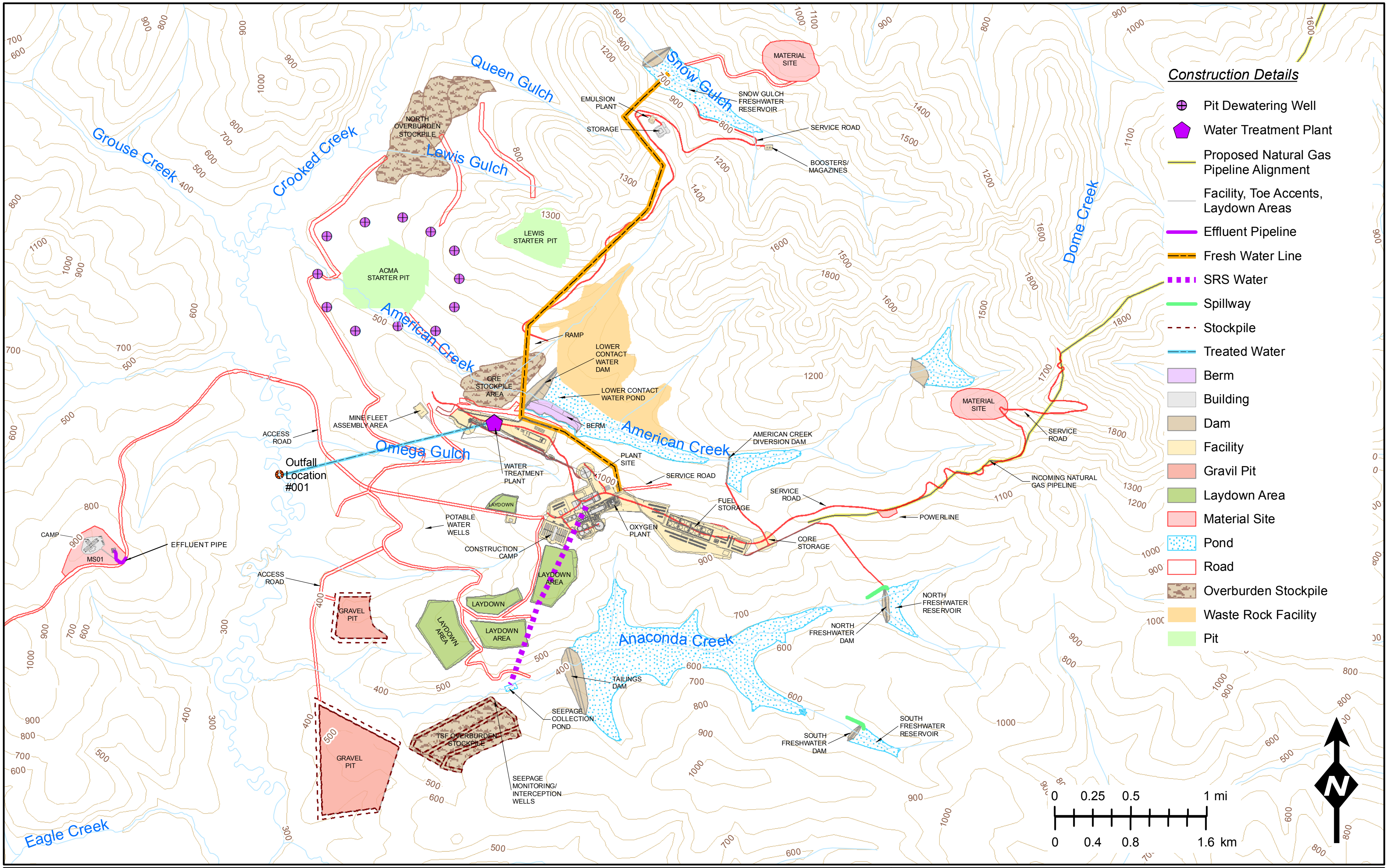
The first of two contact water dams, the Lower CWD, will be constructed in the American Creek drainage and will be complete at the end of the first quarter of Year -1. Non-acid generating (NAG) waste rock with metal leaching potential could be used for construction of the Lower CWD. There is potential for the generation of seepage and runoff with elevated metals concentrations derived from metal leaching; however, this seepage would be collected by the Ore Stockpile Berm and later by the pit dewatering system, so the seepage and runoff cannot migrate off site.

The Lower CWD would intercept an approximate drainage area of 1,705 acres (690 ha). The dam also receives runoff from the pre-stripped ground of the two pit areas that are being advanced and the intervening undisturbed ground. This area is 877 acres (355 ha) after pre-stripping is complete.

The Upper CWD will be constructed at the ultimate upstream extent of the Waste Rock Facility in the American Creek drainage, and will provide additional capacity for storage of contact water. The Upper CWD will retain surface water and stormwater from undisturbed areas in the upper American Creek drainage and water pumped from the Lower CWD. The Upper CWD will be complete at the end of Year -1.

American Creek Fresh Water Diversion Dam

To limit inflows to the Lower CWD during construction, a fresh water diversion dam is proposed on American Creek (American Creek FWDD) upstream of the WRF and would be completed in LOM Year -2. Excess fresh water (non-contact) accumulating in the American Creek FWDD would be stored up to a maximum capacity of 867 acre-ft (1.07 Mm^3), with the excess discharged to Crooked Creek at Omega Gulch. To minimize the potential for overflows to occur, the installed pumping capacity will be capable of a maximum flow rate of 3,963 gpm (900 m^3/h). Appropriate energy dissipation structures would be installed to



Seward Meridian, UTM Zone 4, NAD83

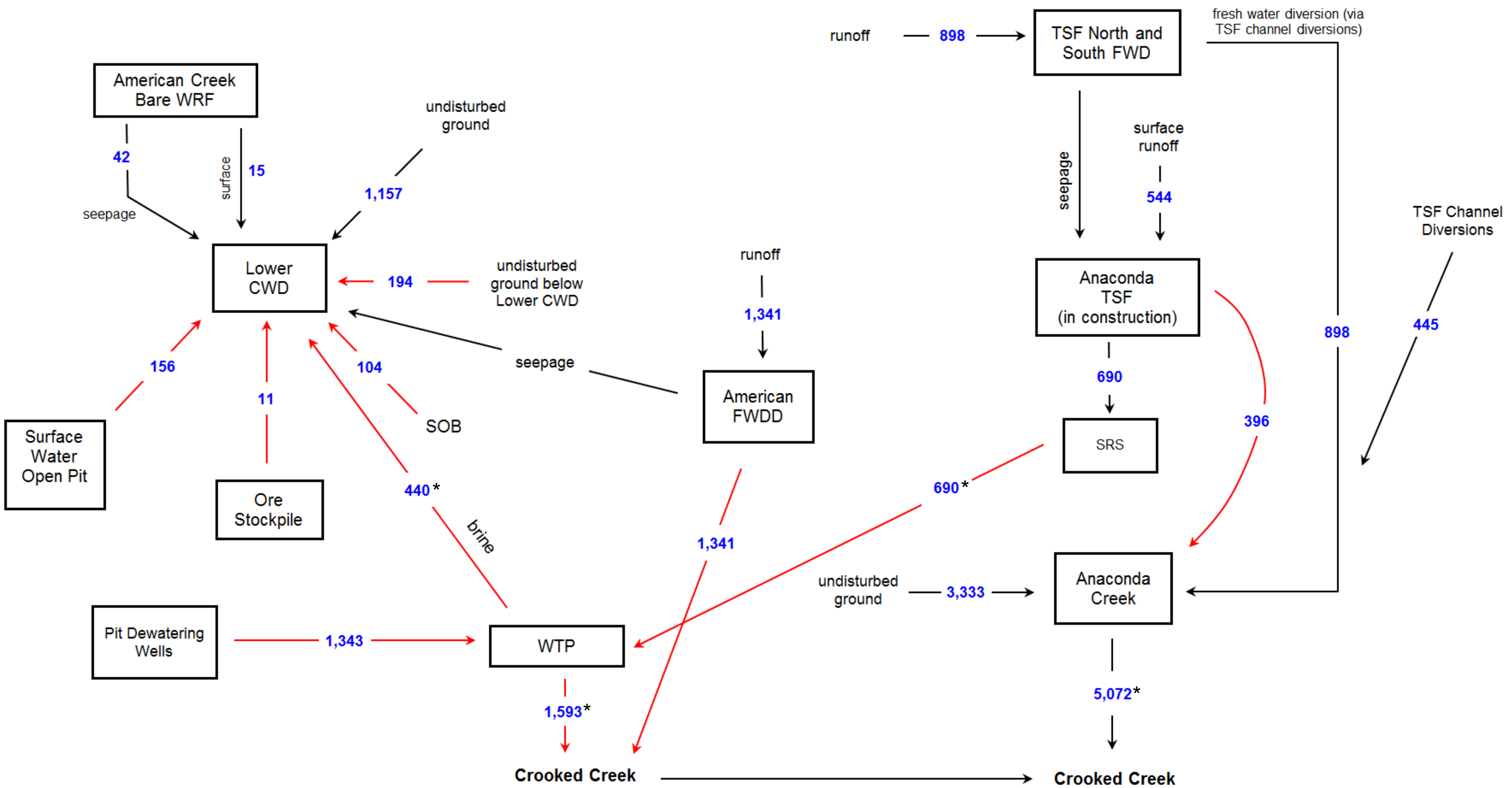
DONLIN GOLD

MINE WATER MANAGEMENT FEATURES (CONSTRUCTION)

DONLIN GOLD PROJECT

FIGURE: 3-1

DG: PER289.mxd, 02/06/17, R11



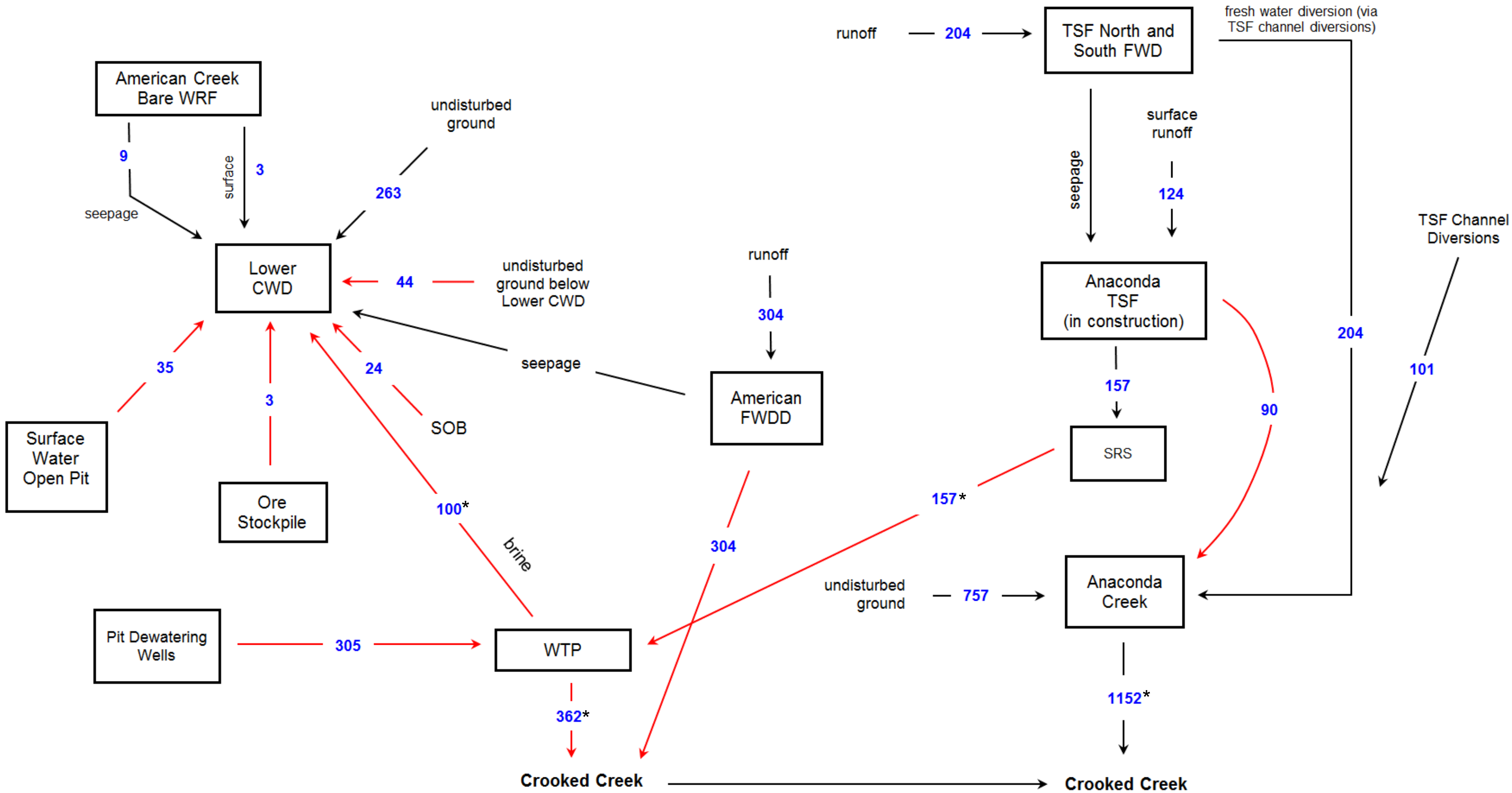
Note: Values shown are averaged over the simulation period and represent average precipitation conditions. Rates are in gpm.
Red arrows denote pumping routes.
All notes do not balance, in particular the contact water dams and fresh water dam depicted. These notes do not balance as the dams either start with or end with a surplus of water.
* - Assuming SRS water is treated. Treatment of SRS water as required based on water quality, refer to Section 3.12

DONLIN GOLD

SCHEMATIC WATER BALANCE (US STANDARD) CONSTRUCTION

DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	3-2



Note: Values shown are averaged over the simulation period and represent average precipitation conditions. Rates are in m^3/h.
Red arrows denote pumping routes.
All notes do not balance, in particular the contact water dams and fresh water dam depicted. These notes do not balance as the dams either start with or end with a surplus of water.
*- Assuming SRS water is treated. Treatment of SRS water as required based on water quality, refer to Section 3.12

DONLIN GOLD	SCHEMATIC WATER BALANCE (METRIC) CONSTRUCTION DONLIN GOLD PROJECT	
	SCALE: NA	FIGURE: 3-3

control erosion at the American Creek FWDD spillway and at the discharge site to Crooked Creek. The diversion dam would only be utilized until the end of the first year of operations. After the first year of operations, the process plant would be at full capacity and the diverted water would be required in the process.

Initial Pit Dewatering

Pre-stripping begins in ACMA and Lewis Pits, approximately 15 months prior to commencement of processing plant operation. To achieve pit depressurization targets, pumping from perimeter dewatering wells would begin six months before the start of pre-stripping. Construction of the operations WTP would be completed prior to pre-stripping. Twelve perimeter dewatering wells will be operational for this purpose by LOM Year -1.75; five additional perimeter dewatering wells will be required during LOM Year -1 (BGC 2014b). Pit dewatering water collected during construction would be treated in the WTP and discharged to Crooked Creek near the confluence of Omega Gulch under an APDES permit as described in Section 4.

Open Pit Pre-Stripping Areas

Pre-stripping excavations for the open pits commence LOM Year -1.25: excavations are limited to the ACMA Pit area in Year -1 and by the end of Q4 of LOM Year -1 the pit footprint is approximately 99 acres (40 ha). Initial excavations occur on the north sideslopes of American Creek, where relatively dry soil conditions are anticipated relative to the valley bottom. Because of the terrain, the pit footprint at the end of Q4 of LOM Year -1 is a sidehill cut rather than a pit excavation. Runoff from this pit footprint will be managed as contact water.

Controlling runoff from the sidehill cut will require a berm on the downgradient side of the excavation, as well as a sump and pump system to convey runoff to the Lower CWD. Pit excavations in the valley bottom of American Creek will eliminate the need for a berm in ACMA Pit starting in Q1 of Year 1. However, initial pre-stripping of Lewis Pit in Q2 of LOM Year 1 also involves a sidehill cut and a similar strategy will be required, although the collected runoff could be diverted to the ACMA Pit or Rob's Gulch rather than being pumped to the Lower CWD (BGC 2011b).

Ore Stockpile Berm

During construction, contact water will be generated downstream of the Lower CWD from the ore stockpile, as well as from shallow seepage from the Lower CWD. This water will be captured in the ore stockpile berm which will be constructed above the ACMA Pit. Water from the lower reaches of Rob's Gulch below the diversion will also be captured by the ore stockpile berm. Water in the ore stockpile berm area will be pumped back to the Lower CWD. Once the ACMA Pit intersects American Creek in LOM Year 1, the Ore Stockpile Berm is not required to capture contact water as the pit would capture seepage from the Lower CWD and runoff from the ore stockpile. However, the berm will remain in operation throughout operations in order to minimize the amount of runoff reporting to the ACMA Pit. The water within this bermed area will be a combination of runoff from disturbed surface areas and roadways (combination of contact water and stormwater), runoff from undisturbed areas (stormwater), and precipitation runoff from the ore stockpile (process wastewater).

During the initial years of construction, a maximum watershed area of 395 acres (160 ha) of undisturbed ground would lie below the ore stockpile berm and the pre-stripping excavations in the ACMA Pit. Water management for roads will focus on stormwater control using best management practices. These aspects of construction water management will be developed further in the stormwater pollution prevention plan (SWPPP), which is required as part of the mine permitting process. Beginning in Q1 of LOM Year 1, runoff from the undisturbed ground located downgradient of the Ore Stockpile Berm will be captured by pit excavations that intersect American Creek, and runoff from the undisturbed ground will be captured by the open pit drainage system and pumped to the Lower CWD.

The ore stockpile berm would not be sized to contain a particular runoff event; rather, the berm would be designed to minimize upslope drainage entering the pit. The bermed area would have an approximate storage volume of 16.2 acre-ft (20,000 m^3) and an approximate height of 10 ft (3 m) based on runoff from an area of 395 acres (160 ha). Water accumulating in the bermed area would be pumped back to the Lower CWD where it would co-mingle with other water to be used as process plant makeup water, or treated and released. A maximum pumping capacity of approximately 1,760 gpm (400 m^3/h) is proposed.

Waste Rock Facility

Waste rock would be placed in the WRF beginning in LOM Year -1. Runoff from the WRF will be retained in the Lower CWD, or treated and released. Management of waste rock is described in the *Waste Rock Management Plan, Volume IIIB*, SRK 2016c.

3.1.2 Anaconda Creek Runoff

The water management structures to control runoff in the Anaconda Creek drainage are described below.

TSF Temporary Fresh Water Diversion Dams

Two temporary FWDDs would be constructed upstream of the TSF in Anaconda Creek and completed in LOM Year -2. The diversion dams would minimize runoff to the TSF from undisturbed ground and also divert fresh water (surface water and noncontact stormwater) during construction of the TSF starter dam and placement of the impoundment liner.

Water levels behind the temporary FWDDs will be controlled by pumping water out of the ponds into diversion channels that would be constructed on either side of the TSF. The North FWDD would have an approximate maximum pumping capacity of 2,200 gpm (500 m^3/h) to the North Diversion Channel, and the South FWDD would have an approximate pumping capacity of 1,100 gpm (250 m^3/h) to the South Diversion Channel. The dams would be in use until LOM Year 3 of operation, at which time both the TSF North and South FWDD would be decommissioned and the area would be regraded and incorporated into the ultimate TSF impoundment to allow for additional tailings storage.

TSF SRS

A rock fill underdrain capable of handling the base flow through the Anaconda Creek valley is to be placed beneath the liner system to prevent the build-up of pore pressures beneath the TSF. The underdrain will be placed prior to installing the impoundment liner. The underdrain will be placed in the main drainage paths of significant tributaries and connect to a main underdrain trunk along the base of Anaconda Creek. Base flows from outside the liner footprint will pass through the rock underdrain and report to the SRS pond located at the toe of the TSF Dam (BGC 2011b). During construction, discharge from the SRS may require treatment prior to discharge and if needed would be treated in the WTP and discharged to Crooked Creek near the confluence of Omega Gulch under an APDES permit as described in Section 4. An average annual discharge of 1,496 gpm (340 m^3/h) from the SRS is anticipated during late construction (BGC 2011b).

3.1.3 Overburden Stockpiles

A number of overburden stockpiles are required to store material that would be used to reclaim the TSF and WRFs. The north overburden stockpile (NOB) would be constructed beginning with initial pre-stripping of the pit and continue as organic material from the surface is stripped during the pit expansion. The stockpiled material would remain in place until concurrent or final reclamation is initiated. The south overburden stockpile (SOB) would contain overburden from the more mineralized portions of the pit and remain active as material is used for concurrent reclamation and new material added as required by the mine plan. The TSF overburden stockpiles will be expanded as the TSF impoundment is stripped of organics and growth media prior to liner installation. The TSF overburden stockpiles will be stabilized and remain in place until final closure of the TSF. The details and procedures for stockpiling initial topsoil and overburden (growth media) stripping and for area-specific reclamation of such facilities as the pit, WRF, and TSF are discussed in *Reclamation and Closure Plan, Volume IV*, SRK 2017.

For the purposes of this WRMP, the term "growth media" refers to all native (in-place) soil material with the physical and chemical properties capable of germinating and sustaining vegetation growth with or without amendments, and is interchangeable with the terms "topsoil" and "overburden"[5] in relation to the proposed Donlin Gold site. Overburden material suitable for use as growth media is unconsolidated material that may consist of terrace gravels, colluvium, loess, and other non-organic material that lies between the topsoil horizon (where present) and bedrock.

Interim reclamation will be completed shortly after the stockpiles are constructed. These stockpiles lie beyond areas that drain into proposed dams and, therefore, require separate sediment control structures.

The stockpiles requiring sediment control are shown on Figure 3-1, as follows:

- The NOB stockpile will be located north of American Creek on the east side of Crooked Creek.
- The SOB stockpile will be located between Omega Gulch and Anaconda Creek on the east side of Crooked Creek.

[5] “topsoil” is the upper, outermost layer of soil, usually the top 2 inches (5.1 cm) to 8 inches (20 cm). It has the highest concentration of organic matter and microorganisms.
“overburden” is the material that lies above an area of economic or scientific interest. Overburden is also described as the soil and other material that lies above a specific geologic feature.

- Overburden excavated from the TSF impoundment footprint will be stockpiled at three sites located downstream of the TSF dam within the lower Anaconda valley.

Runoff from these stockpiles would be managed by intercepting and directing surface runoff toward sediment ponds sized to contain the 10-year return period, 24-hour duration storm. The diversion channels would be sized for the 100-year rainfall event. Two sets of diversion channels are proposed. Upslope diversions would limit runoff to the overburden stockpiles, while channels on the downslope side would direct surface runoff to the sediment ponds.

The NOB stockpile and overburden stockpiles in the Anaconda Creek drainage are not considered to pose an acid rock drainage (ARD) or metal leaching (ML) concern. Runoff and seepage flows are, therefore, assumed to be suitable for discharge to the environment without treatment, other than stormwater and sediment runoff control. Stormwater management is described in Section 4.4.

With the initiation of pit stripping and mining operations, overburden would start to be placed at the SOB stockpile. In contrast to the other overburden dumps, the SOB would contain terrace gravel and colluvium materials sourced from the open pits. These materials are considered potentially metal leaching; seepage and runoff derived from precipitation that comes into contact with materials stored in the SOB may require collection and treatment. Surface and seepage runoff would be captured in a 6.5 acre-ft (8,000 m^3) pond and, as needed, sent to the Lower CWD. The pond would be designed to store the runoff associated with a 24-hour, 10-year return period rainfall event. Interim reclamation would proceed immediately after placement of material.

3.1.4 Construction Camp Potable Water Supply

The source of water supply for the construction camp and, later, the plant site potable water systems, would be an array of eight wells south of Omega Gulch, near Crooked Creek. The approximate locations of these wells are shown on Figure 3-1.

3.1.5 Construction Camp Domestic Waste Water

Wastewater from the construction camp will be treated in a conventional wastewater treatment system and discharged under an APDES general permit. The treatment system is described in more detail in Section 4.

3.1.6 Plant Start-Up Water Supply

Approximately 186 acre-ft (0.23 Mm^3) of non-turbid water would be required for process plant commissioning, and 2,513 acre-ft (3.1 Mm^3) would be required at process plant start-up (BGC 2011b). This start-up volume would be based on the ability to meet the process water requirements until reclaim water from the TSF can be relied on (i.e., sediment content/clarity is suitable for mill use). The deterministic and stochastic water balance model results indicate this volume would be met by the Lower CWD, even in dry years. In extreme dry years, the remaining water requirement could be supplied from the Snow Gulch Reservoir and/or the American FWDD.

3.2 Water Supply and Management Concept – Operations

The water supply and management concept during operations is designed to provide sufficient fresh water for process during operations, ensure that treated water discharged to the environment meets water quality standards, and minimize the TSF pond volume during operation and at closure. A number of structures and operating rules have been designed to meet these objectives. Operations water management components and structures are shown in Figure 3-4.

Water for the process plant would be obtained from the following sources:

- dewatering well water
- TSF reclaim water
- TSF - SRS water
- Lower and Upper CWDs that will impound runoff from the WRF and water from pit dewatering
- Retentate (brine) from the WTP
- Fresh water from the Snow Gulch Reservoir.

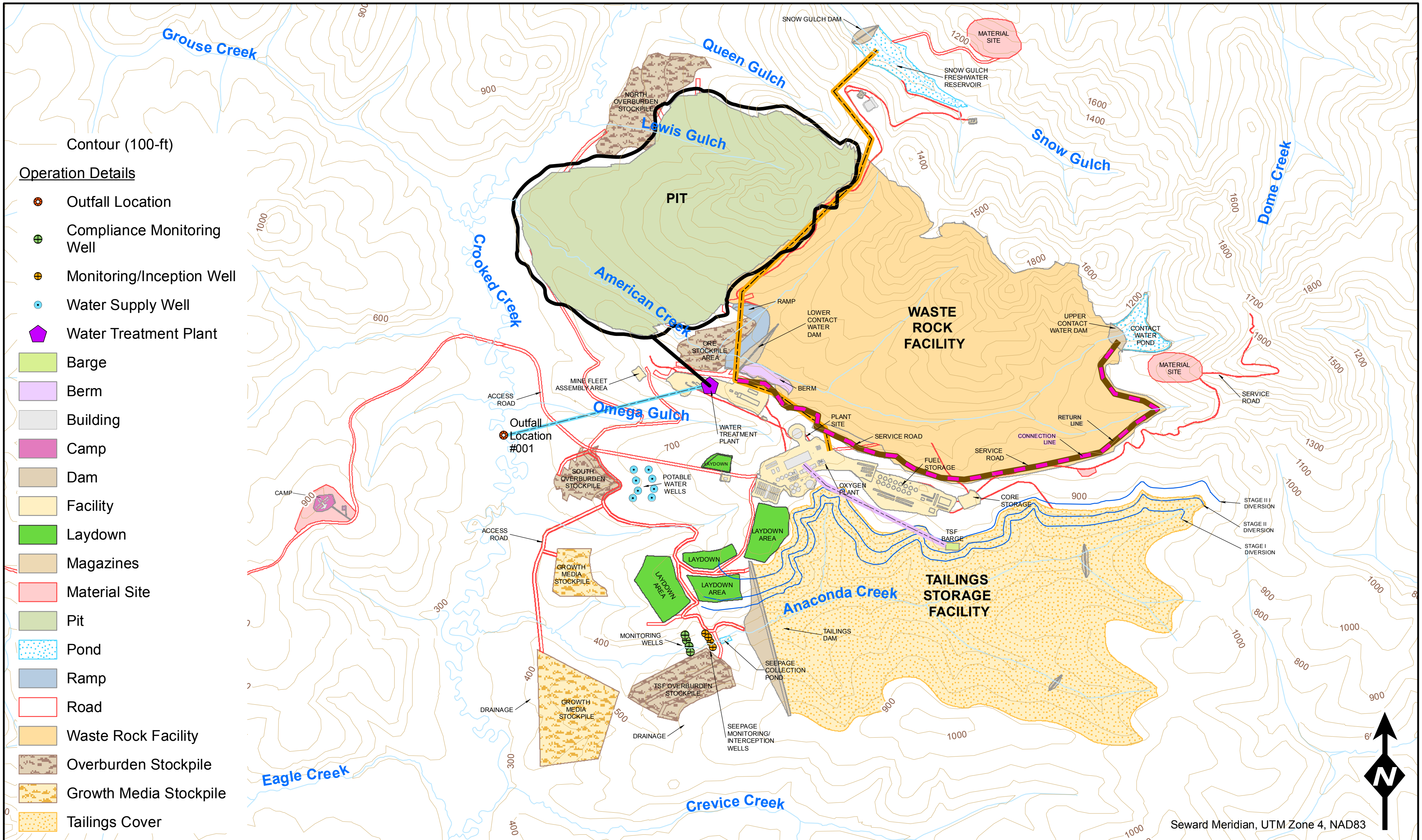
In parallel, the following management procedures would prevent excess water from accumulating in the system:

- Runoff to the TSF would be minimized by the construction of three staged diversion channels on the north and south sides of the facility.
- A single staged diversion dam would be constructed in the mid- to upper-reaches of American Creek to minimize fresh water runoff to the Lower CWD (active beginning in Q3 of Year -2 and use discontinued after the first year of operations).
- The Upper CWD would be completed prior to the first quarter of year 1 of operations with a capacity of 3,240 acre-ft (4 Mm^3).
- The WTP would be operated to treat pit dewatering well, CWD, TSF reclaim (in quantities not to exceed net precipitation), and SRS water when climatic conditions require treatment and discharge.

In addition to the WTP, evaporative sprayers would be employed on the TSF to help reduce the build-up of pond volumes, as required. The air blast evaporator system would spray water into the atmosphere to enhance evaporation (BGC 2016b). It was assumed these units would only be employed during the late spring and summer and when TSF pond volumes exceed 7,300 acre-ft (9.0 Mm^3).

The overall site plan, as shown on Figure 3-4, includes the following components associated with water management during operations:

- Process plant site on American Ridge
- Lined TSF impoundment in Anaconda Creek
- Underdrain below the lined TSF reporting to the associated SRS pond
- Temporary North and South FWDDs in Anaconda Creek, upstream of the TSF
- Staged fresh water diversion channels on the north and south sides of the TSF



Dewatering Well Water Lines Connection Line (Lower CWD to Upper CWD) Fresh Water Line	Return Line TSF Reclaim Line Treated Water TSF Diversion	SCALE: 0 0.25 0.5 1 mi 0 0.375 0.75 1.5 km	DONLIN GOLD	MINE WATER MANAGEMENT FEATURES (OPERATIONS) DONLIN GOLD PROJECT	FIGURE: 3-4

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- Lower and Upper CWDs in American Creek
- Staged WRF with Rob's Gulch diverted to the Lower CWD
- Temporary FWDD in American Creek, upstream of the Lower CWD
- Snow Gulch Reservoir
- Dewatering wells along the perimeter and within the ACMA and Lewis Pits
- Operations WTP
- WTP discharge near the confluence of Omega Gulch and Crooked Creek (Outfall 001).

A schematic of water routing during operations LOM Years 2 to 27, including the anticipated average annual flow rates over this period, is presented in Figures 3-5 and 3-6.

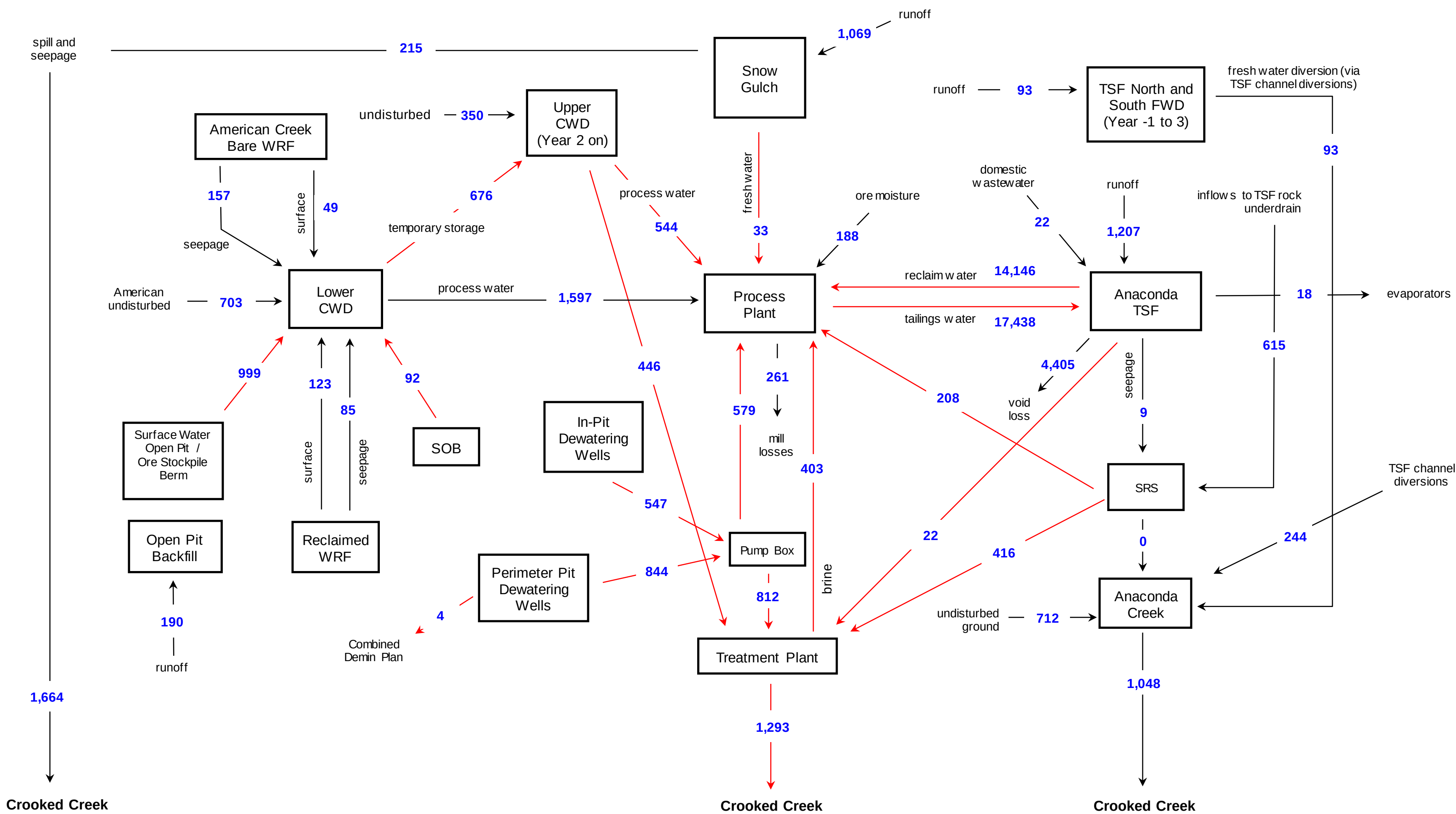
3.2.1 Process Water Requirements

Water requirements for the process facilities are summarized below. Water requirements depend on process plant feed rates, which vary annually (BGC 2016b):

- During the active operating period of the mine, the process plant requires an average water supply of 18,000 gpm (4,088 m^3/h)
- Process plant water loss averages approximately 273 gpm (62 m^3/h)
- The process plant requires a minimum 2,500 gpm (568 m^3/h) of makeup water; this includes water from the contact water ponds, pit dewatering water, water from the TSF SRS and, if required, from the Snow Gulch Reservoir.
- Reclaim water from the TSF is pumped back to the process plant at an average rate of approximately 14,150 gpm (3,213 m^3/h).

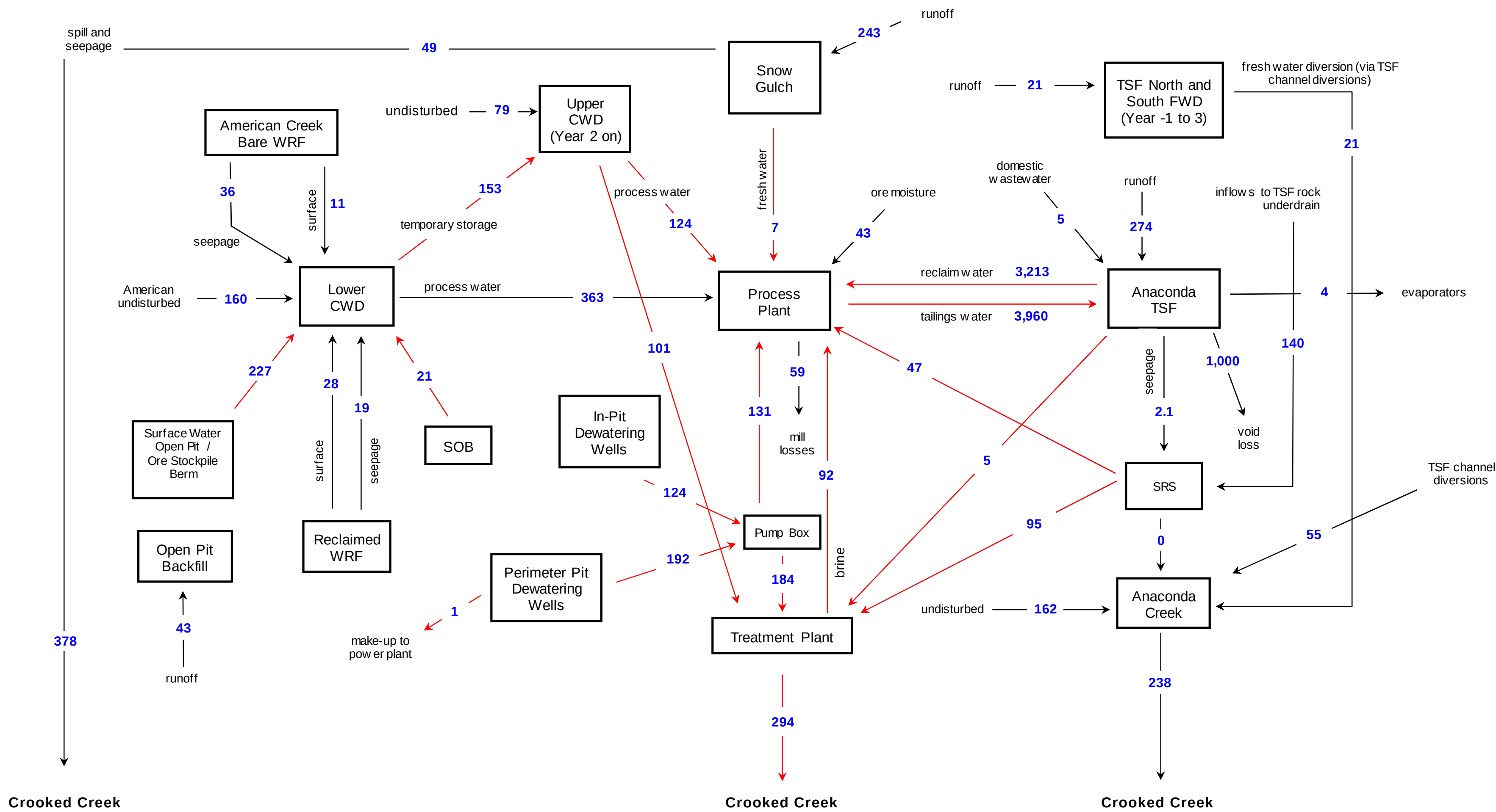
Reclaim water is maximized at approximately 15,500 gpm (3,520 m^3/h) when TSF pond volumes exceed 4,864 acre-ft (6.0 Mm^3). During operations active water treatment would use a WTP with a maximum treatment rate of approximately 4,750 gpm (1,080 m^3/h), treating water from the following sources:

- Dewatering well water would be treated at a maximum rate of approximately 2,400 gpm (540 m^3/hr) and an average rate of approximately 800 gpm (181 m^3/hr)
- Contact water from the CWDs would be treated at a maximum rate of 1,100 gpm (250 m^3/h) and an average rate of approximately 440 gpm (101 m^3/hr)
- It is assumed that TSF pond water would be treated at a maximum rate of approximately 44 gpm (10 m^3/h) and an approximate average rate of 22 gpm (5 m^3/h) based on conservative estimates of water quality
- SRS water would be treated at an approximate maximum annual rate of 1,035 gpm (235 m^3/h) and an approximate average rate of 420 gpm (95 m^3/h).



Note:
Red arrows denote pumping routes. Depicted values are in gpm.
All nodes do not balance, in particular the contact water dams and fresh water dams depicted. These nodes do not balance as the dams either start or end with a surplus of water.

(Year 2 to Year 27)	SCALE: N/A	DONLIN GOLD	SCHEMATIC WATER BALANCE (US STANDARD) OPERATIONS DONLIN GOLD PROJECT	FIGURE: 3-5



Note:
Red arrows denote pumping routes. Depicted values are in m³/h.
All nodes do not balance, in particular the contact water dams and fresh water dams depicted. These nodes do not balance as the dams either start or end with a surplus of water.

(Year 2 to Year 27)	SCALE: N/A	DONLIN GOLD	SCHEMATIC WATER BALANCE (METRIC) OPERATIONS DONLIN GOLD PROJECT	FIGURE: 3-6

In years with below average precipitation, the Lower and Upper CWDs, SRS and pit dewatering system would not be able to meet the year-round fresh water requirements for the plant. In this case, additional water would be obtained from the Snow Gulch Reservoir.

The priority of water use for processing would be as follows:

- TSF reclaim
- WTP brine
- SRS water
- CWDs (runoff from the WRF and the pit)
- Pit dewatering water
- Fresh water from the Snow Gulch Reservoir.

3.2.2 Lower and Upper Contact Water Dams

The Lower and Upper CWDs are located in American Creek, with the objective of managing runoff of contact water from the WRF and pit.

The Lower and Upper CWD parameters are summarized in Table 3-2. There is no spillway proposed for the Lower CWD because there would be sufficient capacity in the pond to store the 24-hour probable maximum precipitation (PMP) event, plus a substantial operating pond. The Upper CWD would have a spillway with sufficient capacity to convey the probable maximum flood (PMF) event. Water flowing over the spillway would ultimately flow to the Lower CWD.

Table 3-2: Lower and Upper CWD Parameters

Contact Water Dams	Upper CWD		Lower CWD	
	U.S. Standard	Metric	U.S. Standard	Metric
Drainage Area[1] (acres, ha)	509	206	3,435	1,390
Storage Capacity[2] (acre-ft, Mm^3)	3,240	4.0	7,151	8.82
Dam Height (ft, m)	193.4	59	151	46

1 The drainage area for the Lower CWD includes that area reporting to the Upper CWD.
2 The storage capacity for the Lower CWD reflects conditions after Year 1.

The American Creek FWDD, upstream of the Lower CWD, would be nominally sized to contain runoff associated with the 100-year snowmelt of 867 acre-ft (1.07 Mm^3), and would have an approximate pumping capacity of 4,000 gpm (908 m^3/h). Water collected at this facility would be pumped to Crooked Creek for discharge.

The Upper CWD would be operational during the first year the processing plant is operational (LOM Year 1) to provide additional storage capacity for contact water. The Upper CWD has been designed in an effort to optimize the placement of waste rock. Sensitivity analyses conducted with the water balance model indicates that the approximate maximum storage capacity of the Upper CWD should be 3,240 acre-ft (4 Mm^3) (BGC 2016b).

The ultimate WRF layout has been designed such that the Lower CWD can store approximately 405 acre-ft (0.5 Mm^3) of contact water without inundating any of the waste rock. As storage volumes increase, the waste rock becomes progressively inundated. There are three concerns with the waste rock becoming excessively inundated by the pond storage: 1) potential siltation of the underdrain voids over time, 2) geotechnical stability issues with the potential siltation of the underdrains, and 3) geochemical interactions. Constant wetting and drying of the waste rock could degrade the water quality of runoff to the Lower CWD, such that it could no longer be considered as a water source for the process plant. Water quality issues would be addressed during operations by limiting pond volumes in the Lower CWD such that a volume of 405 acre-ft (0.5 Mm^3) is not exceeded more than 5% of the time. Therefore, a pumping plan that limits storage volumes within the Lower CWD has been developed. During operations when the Lower CWD volume exceeds 284 acre-ft (0.35 Mm^3), water would be pumped to the Upper CWD for temporary storage. A pipeline would be constructed from the Upper CWD to the process plant. Therefore, at times both CWDs may be a source of makeup water to the process plant.

During construction, no waste rock would be placed within the footprint of the Lower CWD. The approximate storage capacity of the Lower CWD during this period is 7,150 acre-ft (8.82 Mm^3): the 99th percentile of contact water stored during the first half of the open pit pre-stripping period (April LOM Year -1 to end of November LOM Year -1), plus the runoff associated with the 24-hour PMP. In the event of an extremely wet year such that the PMP storage capacity is compromised prior to spring melt in Year 1, a contingency plan would be in place to pump excess water either to the TSF or to the open pit depending on the construction status of these facilities, or to treat the water in the Operations WTP and release.

The Lower CWD would receive water from a variety of sources:

- Surface and seepage runoff from the WRF (bare and reclaimed)
- Runoff from undisturbed ground upgradient of the WRF
- Surface runoff and horizontal drains within the open pit footprint
- Pit dewatering well water not required for process or sent to the WTP
- Runoff collected within the ore stockpile berm
- Runoff from the SOB dump.

During operations, the Lower CWD would have sufficient storage to contain the following flood events without spilling (and hence potentially inundating the ACMA Pit): an operating pond of 405 acre-ft (0.5 Mm^3), plus the PMP of 3,870 acre-ft (4.77 Mm^3). No spillway would be constructed given the conservative storage volume.

The Upper and Lower CWDs would also be designed to store water that would be used throughout the year as a source of makeup water for the process plant. Peak runoff would be limited to the spring and summer months, with negligible runoff volumes between mid-October and the beginning of April. These variable flows would be in contrast to the constant fresh water demand. During the former period, runoff volumes would be in excess of fresh water requirements and this excess water will be stored. The stored water would be a useful source of water during the fall and winter, when inflows would be minimal.

3.2.3 Tailings Storage Facility

Tailings consist of streams from flotation tailings, wash thickener overflow, and the detoxified cyanide slurry from the CIL. The TSF consists of a main lined embankment, two temporary FWDDs, a reclaim water system, and underdrain discharging to the SRS pond.

Information on tailings management can be found in the *Tailings Management Plan, Volume IIIA,* SRK 2016d. Details of the TSF dam siting and design can be found in documents submitted to ADNR in support of the dam safety certification process. Below is a summary.

TSF Dam

The TSF dam would be constructed of compacted rockfill using the downstream method. The tailings impoundment footprint would be lined with a 60 mil (1.5 mm) textured LLDPE liner over a 3.3 ft (1.0 m) thick layer of broadly-graded silty sand and gravel acting as a cushion layer.

The TSF would provide sufficient storage capacity for the tailings, operating pond, flood water, and emergency freeboard of 6.6 ft (2 m). In accordance with Federal Emergency Management Administration (FEMA) requirements, the inflow design flood (IDF) is the PMF, including allowance for snowmelt for dams of significant hazard classification. The corresponding IDF for the TSF is the 200-year snowmelt, plus runoff from a 24-hour PMP. The PMP is assumed to occur at the end of the 200-year snowmelt with the ground fully saturated; therefore, the entire PMP runs off the catchment area. The TSF would store the full volume of the IDF without discharge. The TSF would also store water in excess of the site water balance under average operating and flood conditions; the site water balance is presented as Appendix B.

To meet these requirements, the starter dam would be 198 ft (60 m) high. Ultimate height with the 7 ft (2 m) frost cap would be 471 ft (143.5 m), length would be 5,863 ft (1,787 m), impounding approximately 568,000,000 st (515,000,000 t) of tailings, with capacity for over 366,000 acre-ft (451.7 Mm^3) of water comprised of water entrained in tailings, supernatant water, and flood storage.

The TSF is designed to contain the IDF without release from the impoundment. Consequently, no spillway would be required during operations. A spillway would be required upon closure with the peak design flow based on the 24-hour PMP rainfall event. The freeboard above the IDF allows for wind-generated wave height, setup, and run-up, for estimated settlements and seismic deformation, and for hydrologic uncertainty.

The downstream face of the main TSF dam would be constructed out of NAG waste rock. As such, this stormwater runoff from the face would be collected at the downstream toe of the main TSF dam during operations. A ditch along the base of the dam would direct stormwater runoff from the dam face to the SRS pond.

The design slurry flow (water and solids) would be 24,218 gpm (5,500 m^3/h) to the TSF (average flow would be approximately 17,400 gpm [3,960 m^3/h]). The tailings would flow by gravity from the process plant through a 48-inch (1,200 mm) diameter HDPE pipeline. The pipeline would be surface-run and installed in a 52.5 ft (16 m) wide HDPE-lined pipeline service corridor, together with the reclaim water and other utility pipelines. The tailings pipeline would not be insulated. The pipeline service corridor would run along the south side of the process plant site up to the high point. It would be aligned horizontally and vertically to drain down to the tailings impoundment (2016d*).*

Reclaim water from the tailings pond would be pumped back to the process plant at an average flow rate of approximately 14,150 gpm (3,213 m^3/h) and a maximum annual flow rate of approximately 15,500 gpm (3,520 m^3/h) (BGC 2016b). The reclaim water would be pumped to the reclaim water tank at the process plant via a 1.55-mile (2.5 km) long 32-inch (800 mm) diameter pipe, including a 0.56 mile (900 m) section of steel pipe and a 0.93 mile (1.5 km) section of 36-inch (900 mm) diameter HDPE pipe.

TSF Seepage Recovery System

A SRS would be installed as part of the lined TSF dam. The SRS would incorporate a seepage collection pond, seepage monitoring/collection wells, and compliance monitoring wells (BGC 2016a).

The seepage collection pond, located at the toe of the TSF, would be the collection point of surface and groundwater that enters the TSF underdrains, which includes potential seepage from the lined TSF, as well as any surface water runoff that seeps through the downstream face of the TSF dam. The SRS collection pond is sized to provide storage for 3 days of underdrain flow as well as the 200-yr, 24 hour rainfall event assuming the diversion ditches are operating. The 16.4 ft (5 m) deep, 98.4 ft (30 m) wide unlined pond will be constructed in bedrock, overburden stripping for the TSF dam foundation will be extended through the SRS area. A 3.3 ft (1 m) high rockfill berm, with a LLDPE liner on the upstream face, will be constructed on three sides of the pond. The TSF rockfill underdrain will tie in to the upstream face of the pond excavation.

The SRS pond water would be sent directly to the process plant as part of the process fresh water requirement or pumped to the WTP for treatment and discharge. The collection pond would be designed to accommodate three days' worth of underflow drain and bedrock seepage flow at a maximum rate of approximately 1,200 gpm (272 m^3/h). The total SRS pond storage volume required is 16.2 acre-ft (20,000 m^3).

The monitoring/interceptor wells would be installed downstream of the seepage collection pond, and include two wells to 164 ft (50 m) depth and two wells to 328 ft (100 m) depth. These interceptor wells would be pumped if routine water monitoring detected a TSF seepage water signature above action levels. Each well would have a submersible pump capable of pumping between 45 and 90 gpm (10 and 20 m^3/h), and would discharge to the seepage collection pond. The maximum design pumping rate of seepage from the pond would be 1,760 gpm (400 m^3/h). Because the pond is anticipated to intercept TSF seepage, the collection wells would be operated only if monitoring indicates they are needed.

Compliance monitoring wells would be located downslope of the monitoring/interceptor wells, and would be sampled in the event a TSF seepage signature was detected in water from the monitoring/collection wells.

TSF Diversions

Three stages of channel diversions are currently proposed for the TSF to limit runoff from undisturbed ground. The channel diversions would be constructed on the north and south slopes of the facility and would divert runoff from areas ranging in size for the north diversions from approximately 620 acres (251 ha) to 940 acres (380 ha), and the south diversions from approximately 150 acres (61 ha) to 400 acres (162 ha).

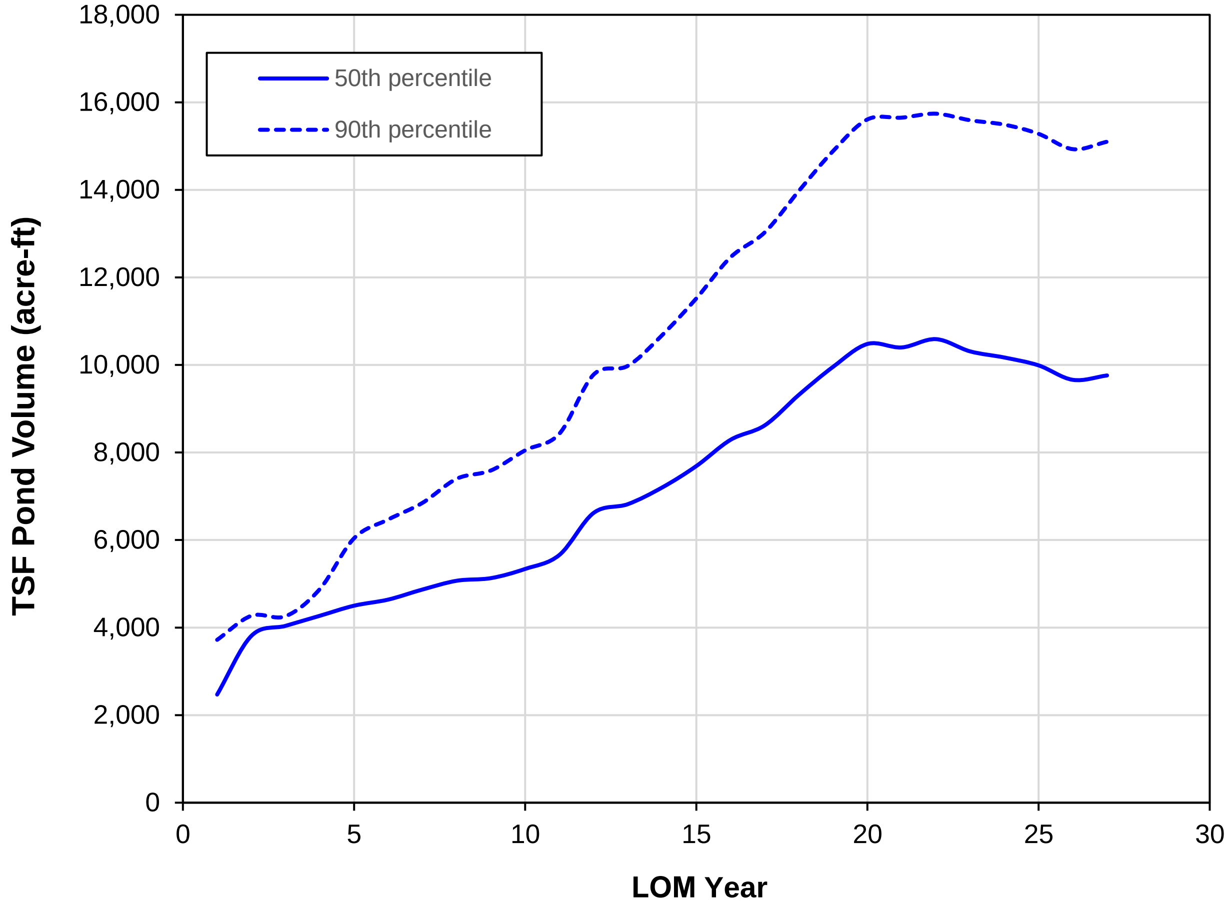
The diversion channels would be lined with 40 mil (1 mm) LLDPE and have an expected efficiency of 90%. All channels would be constructed at an approximate gradient of 0.5%. It is assumed that the channels would intercept surface flows only (i.e., fast runoff in the Vandewiele model), not deeper groundwater flow (i.e., slow runoff). The diversion channels would require excavations to accommodate 200-year return period peak flows of 32 to 131 cfs (0.9 to 3.7 m^3/s). Lining of the channels would be required because water accumulating in the upper TSF temporary FWDDs would be removed by pumping water into the upstream end of these channels. Without lining, seepage losses into the TSF could be significant.

TSF Ice Formation

Given the sub-arctic climate at the project site, ice is expected to form on the operating pond during the winter months. In contrast, ice is not expected to form on the tailings beach due to the high temperature of the tailings when discharged. An unfavorable situation could potentially develop if the operating pond inundates portions of the impoundment where the tailings beach does not entirely cover the liner. Pond water in direct contact with the liner, could lead to the potential liner damage due to ice-loading. Damage could result from either horizontal ice movement due to wind loading or thermal expansion, or vertical ice loads due to rising or lowering pond levels during the winter. To address this risk, the TSF would be operated such that the beach above water has a slope of 0.5%, and the beach below water (subaqueous) has a slope of 1.0% (BGC 2013). By keeping TSF water within the inner cone, ice loading issues will be mitigated (SRK 2016d).

TSF Impoundment Volume

The stochastic WBM was used to predict the likely range the TSF impoundment volume over the LOM and at the end of Operations. The 50th and 95th percentile values over LOM are shown in Figure 3-7. While the stochastic WBM results show a steady increase in the TSF impoundment volume over the LOM, impoundment volumes are expected to fluctuate from year to year (BGC 2016b).



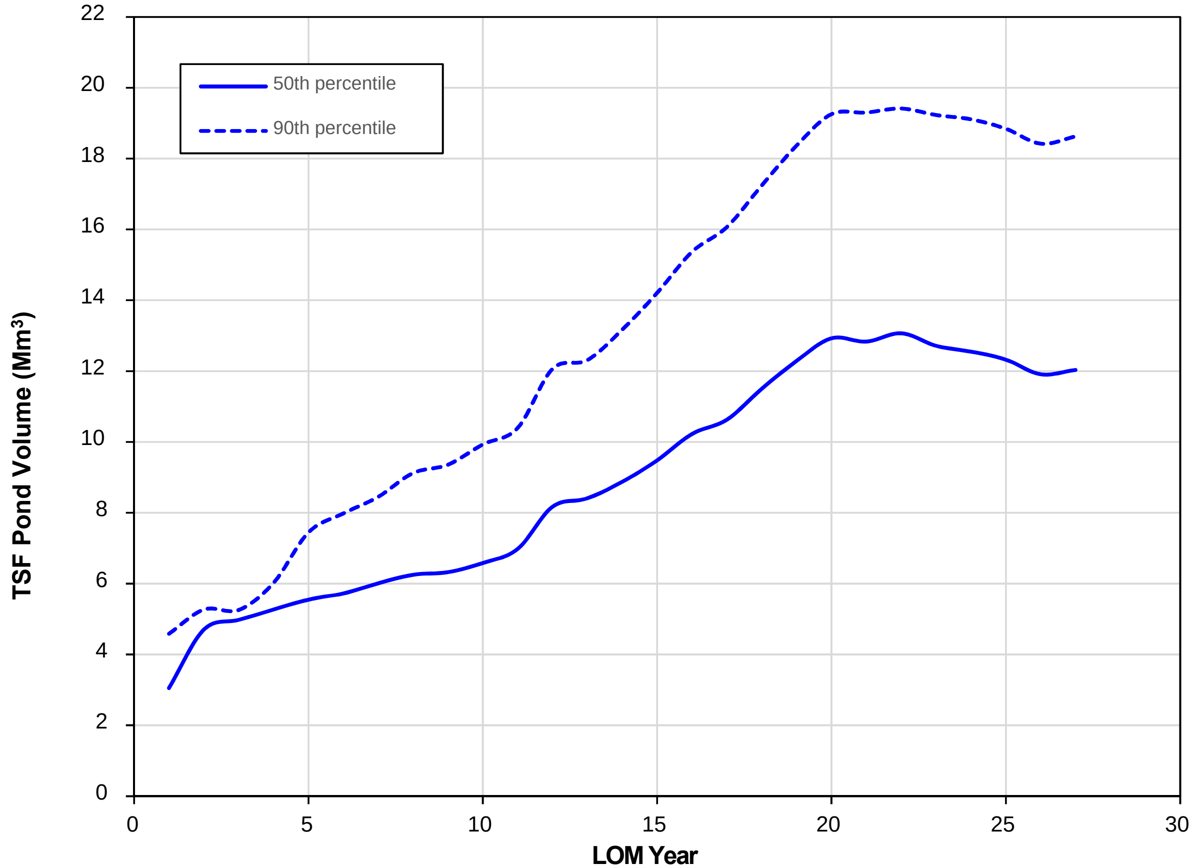
Annual TSF pond volumes over the life-of-mine using the stochastic water balance model.

DONLIN GOLD

TSF POND VOLUME
OVER LIFE OF MINE
(US STANDARD)

DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	3-7



Annual TSF pond volumes over the life-of-mine using the stochastic water balance model.

DONLIN GOLD

TSF POND VOLUME OVER LIFE OF MINE (METRIC)

DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	3-8

3.2.4 Snow Gulch Reservoir

The contingency source of makeup water to the process plant during operations will be a reservoir in Snow Gulch (Figure 3-4). The proposed Snow Gulch Reservoir would have an approximate operating capacity of 3,240 acre-ft (4 Mm^3), and the dam spillway would be designed to pass the predicted peak runoff from a 1-in-100-year probability storm. Except when water is withdrawn from the pond for use in process, the dam would be kept at its maximum storage capacity (i.e., the spillway will be used on a near continuous basis). Fresh water from this reservoir would be pumped up to the process plant. The catchment area of the Snow Gulch Reservoir is approximately 1,560 acres (631 ha). Table 3-3 presents the design criteria for the dam and pumping configuration required to meet the fresh water process requirements.

The dam would be constructed and completed during Year -2, allowing 20 months for runoff to accumulate in the dam before process plant startup. If the dam is not at capacity by the end of Year -2 (and storage volumes in the Lower and Upper CWDs are at a minimum), water could be pumped from Crooked Creek to the Snow Gulch Reservoir during the spring melt (subject to environmental permitting).

Table 3-3: Snow Gulch Reservoir Design Criteria

Snow Gulch	U.S. Standard	Metric
Drainage Area (acres, ha)	~1,560	~631
Storage Capacity (acre-ft, Mm^3)	~3,240	~4.0
Dam Height (ft, m)	151	46
Q_{100} (cfs, m^3/s)	~175	~4.9
Maximum Pumping Capacity (gpm, m^3/h)	~7,930	~1,800

Source: BGC 2011b

3.2.5 Waste Rock Facility

The American Creek WRF would ultimately cover an approximate area of 3.5 sq miles (9 km^2). Runoff from the WRF would be captured by the Lower CWD, immediately upstream of the pit area. As shown in Figure 3-4, a single diversion dam is included in the mid- to upper-reaches of American Creek to minimize runoff to the Lower CWD until the Upper CWD is operational in the first quarter of LOM Year 2.

3.2.6 Ore Stockpile Berm

Downstream of the Lower CWD, contact water will be generated from the ore stockpile. To prevent this catchment area from discharging into the open pit, a small berm will be constructed on American Creek immediately downstream of the proposed ore stockpile (Figure 3-4). Runoff from the ore stockpile, as well as shallow seepage from the Lower CWD, will be captured by the ore stockpile berm and pumped back to the Lower CWD.

3.2.7 Plant Site Runoff

The plant site would be located on the ridge between American Creek and Anaconda Creek. Runoff from the plant site would be diverted into the CWDs or TSF, but the drainage would be controlled to prevent it from entering the downstream TSF diversion channels, which would be designed to divert non-contact stormwater runoff from the north slopes of the TSF.

Stormwater runoff from the crusher, truck shop, and fuel storage areas would be pumped or drain to the Lower CWD.

3.2.8 Open Pit and Dewatering

The ultimate combined footprint for the Lewis and ACMA Pits would be 1,462 acres (592 ha), and the pit would require dewatering to provide dry and safe working conditions for mine crews. The pit dewatering wells are summarized in Table 3-4.

As the pit expands, the number of dewatering wells would increase to a dewatering scenario incorporating a total of 115 wells (i.e., 35 perimeters and 80 in-pit) over the mine life. The total average annual groundwater extraction rate for the dewatering scenario is predicted to increase from approximately 1,700 gpm (386 m^3/h) when the system is turned on in LOM Year -2, to approximately 2,400 gpm (540 m^3/h) in LOM Year 12. After LOM Year 20, the total average annual dewatering rate is predicted to generally decrease to approximately 1,100 gpm (250 m^3/h) because the perimeter wells surrounding the pits would be progressively turned off during pit backfilling activities (BGC 2014b, 2016b). Remaining groundwater inflows to the open pits were assumed to be captured by horizontal drains. It was estimated that approximately 167 miles (268 km) of horizontal drains would be required over the life of the mine to aid in depressurizing the pit slopes (BGC 2014b).

Table 3-4: Summary of Open Pit Dewatering Wells

Open Pit Dewatering Wells	U.S. Standard	Metric
Average Perimeter well depth (ft, m)	705	215
Average In-pit well depth (ft, m)	617	188
Minimum pumping rate: combined wells (gpm, m^3/h)	1,066	242
Maximum pumping rate: combined wells (gpm, m^3/h)	2,774	630
Number of Wells Over Mine Life	115	
Perimeter wells	35	
In-pit Wells	80	
Maximum number of wells operational at any one time	52 in Years 14 and 15	

Source: Numerical Hydrogeologic Model, BGC 2014b

Pit perimeter dewatering wells, in-pit dewatering wells and horizontal drains will result in lowering the water table in the mine area, which will affect the baseline flow of streams in the area. In LOM Year 20 the water table will reach its lowest level at approximately -1,100 ft amsl (-335 m amsl) which will allow safe and stable mine operations when the ACMA Pit floor reaches the lowest elevation.

During operations all groundwater from pit dewatering wells would be sent to the process plant as a source of water, unless the combined contact dam storage exceeds 1,460 acre-ft (1.8 Mm^3). In this event, this water would be sent to the WTP and discharged to Crooked Creek.

The pit dewatering groundwater would be treated and discharged when not required for make-up water in the process plant. Treatment rates would vary as a function of the pit dewatering rates and the site water balance needs during operations. The predicted pit dewatering groundwater chemistry is summarized in Table 6, Appendix D.

Runoff from areas upslope of active mining areas would be intercepted by a ditch and diverted around the pit perimeter. Runoff and snowmelt in the open pit would be collected and pumped to the Lower CWD using a large collection system of surface water ditches, sumps, submersible pumps, booster pumping stations, and pipelines. There would be two main components to this system, a network of pumping stations and gravity sumps installed around the crest of the pit, and a network of in-pit pipelines, pumps, and ditches for lifting water out of the pit.

The first component would consist of three main pumping stations and a series of gravity sumps and pipelines installed around the pit perimeter that would direct contact water by pumping or gravity from the pit excavations to the Lower CWD. The second component consists of ditches, sumps and pumps for collecting and lifting water out of the pit. Once the pit excavation has started submersible pumps would keep the working areas clear of standing water. Booster pumps would be needed when the excavation is about 330 ft (100 m) below the pit rim. Booster pumps would be required for each sequential increment of about 330 ft (100 m) as the pit deepens.

The pumping system would be designed with a peak capacity of 8,300 gpm (1,885 m^3/h) in the perimeter pumping stations. The pit surface water management system would be designed to pump runoff from a 2-year return period, 24-hour storm event of 1.2 inches (30 mm) from the excavation within 3 days, and a 100-year return period, 24-hour storm event of 3 inches (76 mm) within 7 days. Runoff would be collected in low points of the open pits during these events; however, during such infrequent times, the mine could reschedule mining into drier areas of the pit. Skid- or trailer-mounted pumping systems would be included in the proposed dewatering system design and could be mobilized to required locations to reduce these time frames if needed.

Ditches would be constructed along roads and on other strategically located benches while excavating the pits. These ditches would intercept surface and horizontal drain runoff and direct the water into sumps. The sump water would then be picked up with a primary pump and discharged into the perimeter system. The system of ditches and sumps would intercept water at the highest practical points to reduce pumping costs.

3.2.9 Process Plant Makeup Water Requirement and Distribution

Water required for the plant distribution system would come from contact water from the Lower and Upper CWDs, brine from the WTP, groundwater from pit dewatering, reclaim water from the TSF, SRS water, and fresh water from the Snow Gulch Reservoir. These sources are required to meet ore processing requirements for an average process plant throughput of 59,000 stpd (53,500 t/d). Average estimated flows over the life of mine from these sources to the process plant (Figures 3-5 and 3-6) would be as follows:

- Lower CWD – 1,597 gpm (363 m^3/h)
- Upper CWD – 544 gpm (124 m^3/h)
- Pit dewatering wells – 579 gpm (131 m^3/h)
- Brine solution from the WTP – 403 gpm (92 m^3/h)
- Snow Gulch Reservoir – 33 gpm (7 m^3/h)
- Reclaim from the TSF – 14,146 gpm (3,213 m^3/h)
- SRS – 208 gpm (47 m^3/h).

Contact Water Dams

Water in the CWDs consists of a combination of contact water, stormwater, surface water and process wastewater. Typically, the mix would be of good quality with low levels of suspended and dissolved solids and would be used for:

- elution
- electrowinning and refining
- autoclave process water system (quench and gland)
- concentrate counter current decant (CCD) wash glands and wash water
- reagent mixing.

During periods of high runoff into the contact ponds, when quality could degrade and quantities would be large, contact water would be substituted for TSF reclaim water in flotation and throughout the plant. In turn, water from the pit dewatering wells and fresh water could be substituted for normal contact water uses if the quality of the contact water suffers from high suspended solids.

Pit Dewatering Well Water

The highest-quality water for use in the plant would be expected to come from the pit dewatering wells. As long as contact water is of sufficient quality and quantity, and contact water volumes exceeds 1,216 acre-ft (1.5 Mm^3), the water from the pit dewatering wells would be treated and discharged to Crooked Creek. When required to supplement or replace contact water, it would be suitable for all contact water usages. Water from the pit dewatering wells would also be an additional source of water for charging process plant cooling and heat transfer systems.

Retentate

Retentate (brine) from the water treatment plant reverse osmosis (RO) units will be directed to the process plant reclaim water tank. This water will supplement the reclaim water drawn from the TSF.

Makeup Water

When the quantity of water in the CWDs, SRS, and pit dewatering wells would be insufficient for the water requirements of the process plant, then water from the Snow Gulch Reservoir would be pumped to a fresh/firewater tank for use in the plant. Fresh water uses include, but are not limited to, pressure oxidation (POX) blowdown water, the POX off-gas cleaning circuits, and demineralized water.

Reclaim Water

The reclaim water system supplies water to processes that do not need high-quality water. Reclaim water from settled tailings in the TSF would be pumped to a reclaim water head tank or WTP as required.

3.3 Summary of Operational Rules

A summary of operational rules for water management is provided for below average, average, and greater than average annual precipitation conditions. Estimates of the annual precipitation for these conditions are (BGC 2011b):

- below average (dry) = 18.6 inches (472 mm)
- average = 19.6 inches (499 mm)
- greater than average = 20.8 inches (529 mm).

Below Average Precipitation Conditions

The following rules would be implemented when below average precipitation conditions occur.

- TSF reclaim water use in the process plant would be maximized, with an upper limit at the point where a minimum pond volume remained for continued reclaim water use and to minimize fugitive dust from the TSF.
- SRS water would be pumped to the process plant.
- Runoff to the CWDs, combined with all of the pit dewatering water, would be insufficient to meet the fresh water demand for the process plant.

Process plant makeup water from the Snow Gulch Reservoir would be required. This demand typically occurs between January and March, although it could occur anytime of the year except for the snowmelt period.

Because of this demand for make-up water, the water volume in Snow Gulch Reservoir would be less than the maximum volume of 3,243 acre-ft (4 Mm^3) (the volume when the water level is at the spillway crest).

Average Precipitation Conditions

The following rules would be implemented when average precipitation conditions occur:

- TSF reclaim water to the process plant would typically be maximized, maintaining a small pond volume in the TSF.
- SRS water would be used in the process plant and a portion (416 gpm [95 m^3/hr]) would also be sent to the WTP and discharged to Crooked Creek.
- Runoff to the Upper and Lower CWDs, combined with pit dewatering water and water from the SRS, would generally be sufficient to meet makeup water demand for the process plant.

When the combined pond volumes of the Upper and Lower CWDs exceed 1,216 acre-ft (1.5 Mm^3), the groundwater pumped from the pit perimeter and in-pit dewatering wells would be sent to the WTP then discharged to Crooked Creek.

Greater Than Average Precipitation Conditions

The following rules would be implemented when above average precipitation conditions occur:

- TSF reclaim water to the process plant would be minimized to use and manage the potential surplus water in the Lower and Upper CWDs and pond volumes in the TSF would temporarily increase (the TSF operating pond would be sized to store all excess water in the site water balance).

- Runoff to the Upper and Lower CWDs would be sufficient to meet the water demand for the process plant.
- Fresh water make-up would be not required from the Snow Gulch Reservoir.
- SRS water would be sent to the WTP and discharged to Crooked Creek.
- When the combined pond volume for the Upper and Lower CWDs exceeds 1,460 acre-ft (1.8 Mm^3), groundwater pumped from the pit dewatering wells would be sent to the WTP and discharged to Crooked Creek.
- When the combined contact pond volume exceeds 1,860 acre-ft (2.3 Mm^3), CWD water would be pumped to the WTP at a maximum rate of 1,101 gpm (250 m^3/h) where it is combined with other sources of water for treatment. Treatment of TSF water would be maximized during this time.
- When the combined pond volume of the Lower and Upper CWDs exceed 2,920 acre-ft (3.6 Mm^3), the entire process water demand would be pumped from the Lower CWD (and Upper CWD if required) to the process plant (BGC 2016b). No TSF reclaim would occur during these periods.

3.4 Water Supply and Management Concept – Closure

The overall site plan for closure includes the following components presented in Figure 3-9:

- Reclaimed TSF surface that would direct surface water drainage toward the southeast corner of the TSF.
- A spillway would be excavated in the ridge dividing Anaconda and Crevice Creek catchments to allow surface runoff from the TSF cover system to flow into Crevice Creek (once suitable for discharge).
- Reclaimed WRF with surface and seepage flows draining into the ACMA and Lewis Pits
- A lake in the partially backfilled ACMA and Lewis Pits with a constructed emergency spillway.

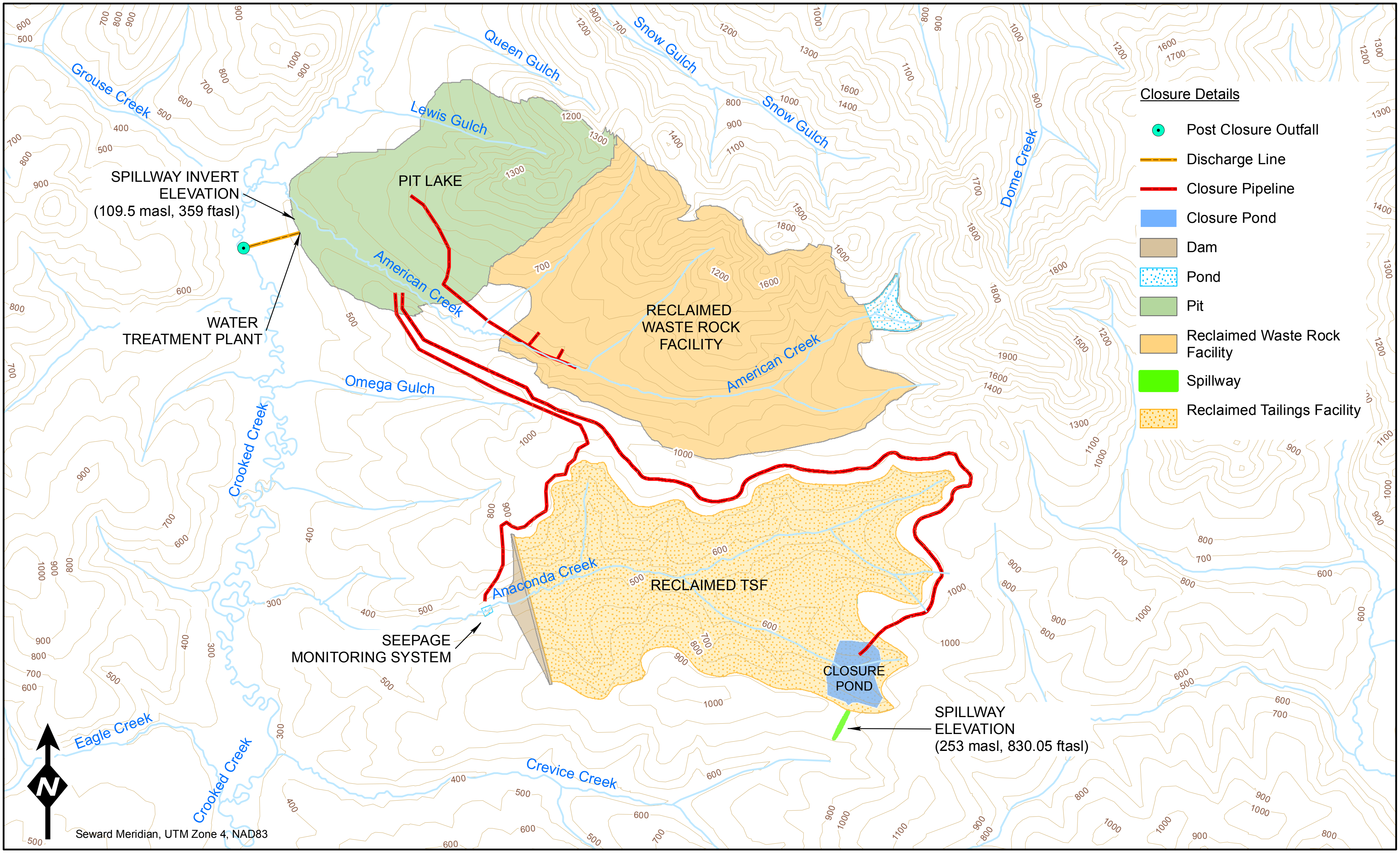
A schematic of the long-term water routing during closure is presented in Figures 3-10 and 3-11. Details of reclamation and closure can be found in the *Reclamation and Closure Plan, Volume IV,* SRK 2017 and is summarized below.

3.4.1 Anaconda Creek and TSF

Conditions in the Anaconda Creek valley at closure include:

- The TSF in Anaconda Creek would be covered with 14 inches (0.35 m) of peat/organic (growth medium) cover, over 12 inches (0.3 m) of colluvium or terrace gravel, over 39 inches (1.0 m) of competent rockfill material, which provide a capillary break.
- Final soil covers would be installed on the TSF dam face as described above, but without the rockfill layer.
- The TSF surface would be contoured so that runoff flows to the east toward the southeast corner of the TSF.
- A spillway will be excavated in the ridge dividing Anaconda and Crevice Creek catchments to allow surface runoff from the cover system to flow into Crevice Creek (it is anticipated that surface water will meet applicable AWQS approximately five years after closure). The spillway invert elevation would be at approximately 833 ft amsl (254 m amsl). The spillway will be designed to accommodate a PMF of 13,420 cfs (380 m^3/s) (BGC 2014d).
- Drain sumps installed in manholes would be used to collect water from the competent NAG rockfill layer of the cover, which includes excess tailings consolidation water and water infiltrating the cover. The excess pore water would be kept separate from cover runoff water and would be pumped to the pit until tailings consolidation is essentially complete after closure (approximately 51 years), or until water quality indicates discharge is appropriate.

The SRS downstream of the TSF main dam, consisting of a seepage collection pond and seepage monitoring/interceptor wells, would be maintained during closure and into post-closure until applicable water quality standards are met. Water from the SRS collection pond would be pumped to the pit lake. Average flow from the TSF underdrain to the SRS collection pond at closure is estimated at 448 gpm (102 m^3/h).



Contour (100-ft)

SCALE:

0 0.25 0.5 1 mi

0 0.4 0.8 1.6 km

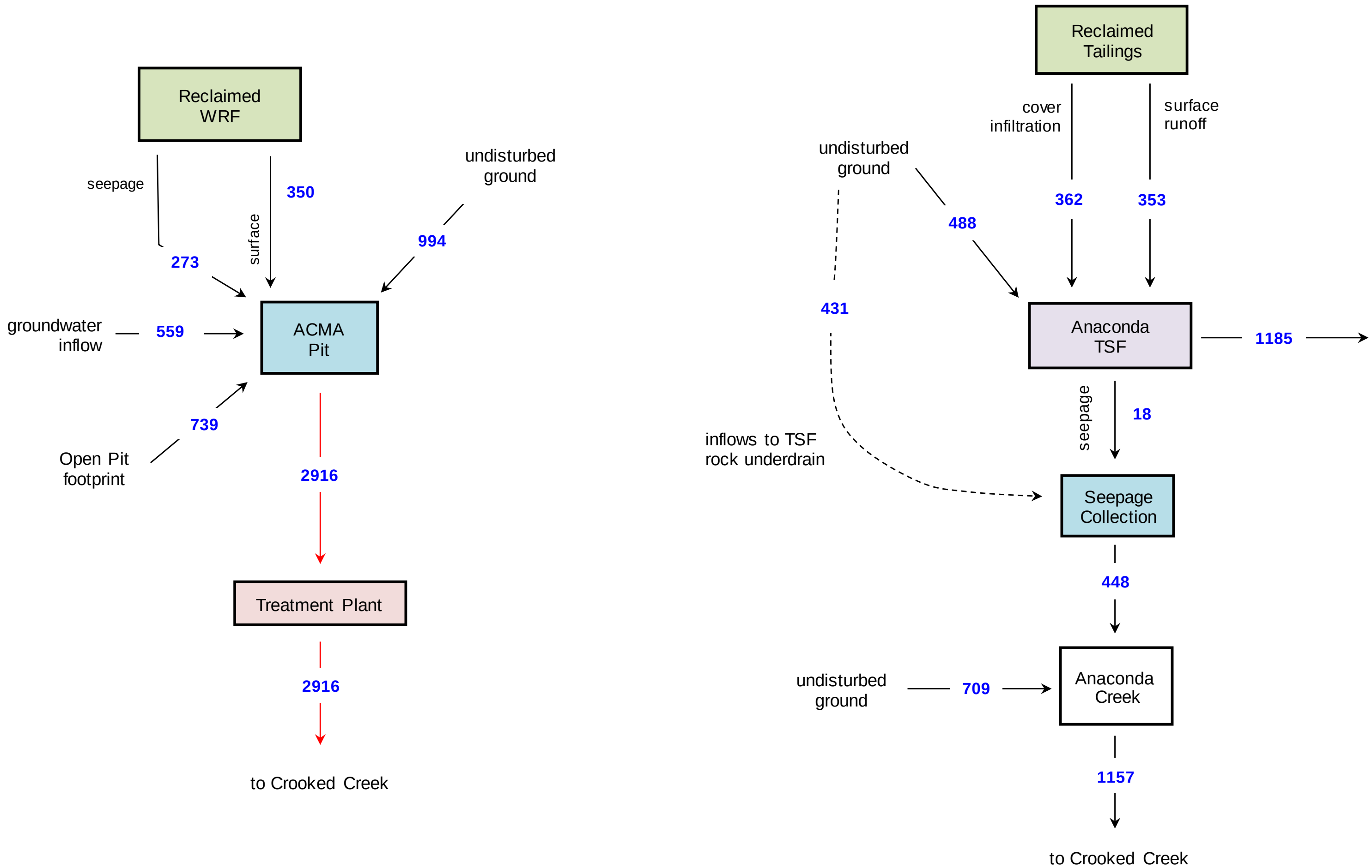
DONLIN GOLD

MINE WATER MANAGEMENT FEATURES (CLOSURE)

DONLIN GOLD PROJECT

FIGURE: 3-9

DG: PER0291.mxd, 11/22/16, R11



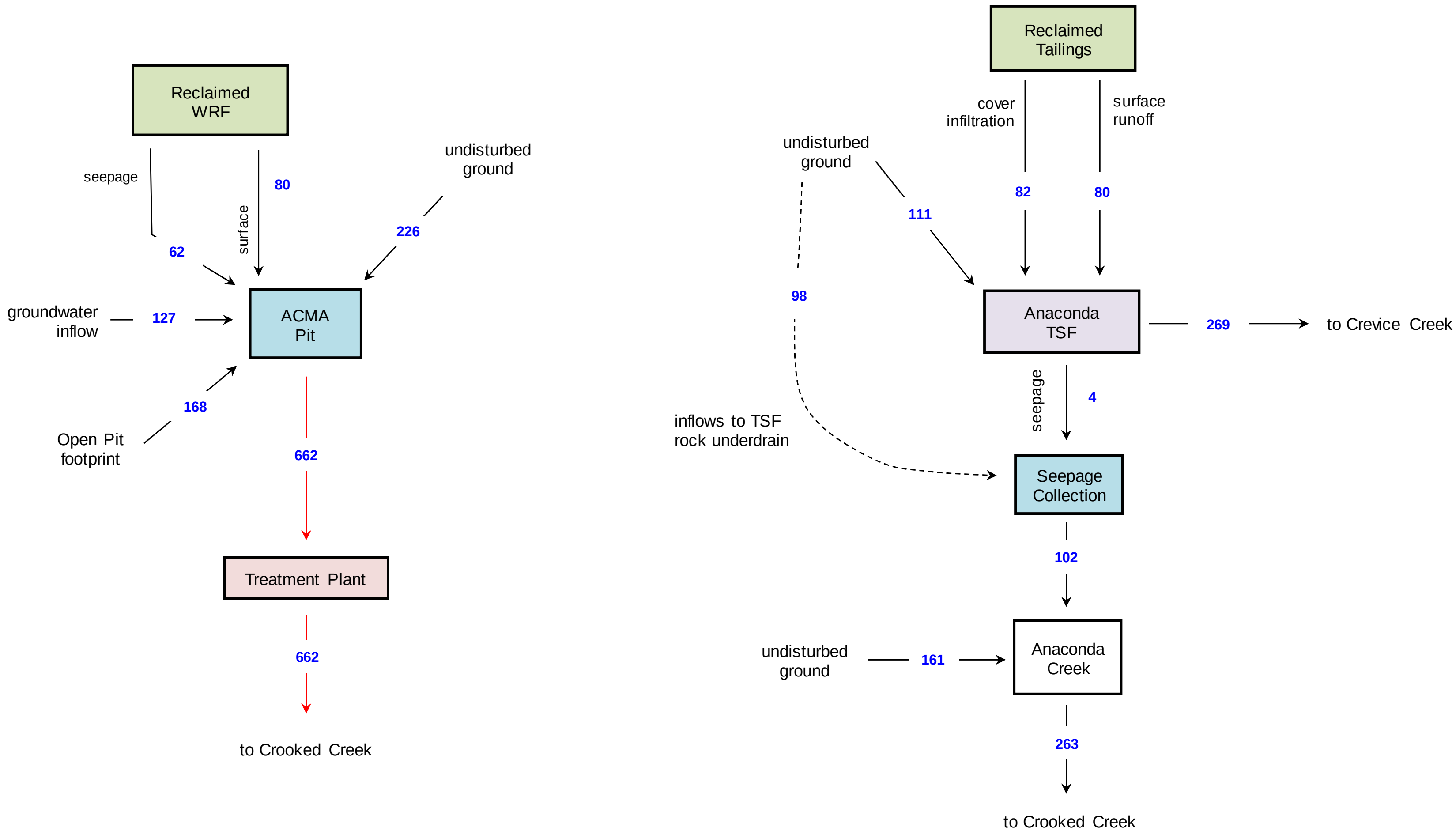
Closure (Year 52 On)

NOTE:

Values (gmp) shown are averaged over Years 52 to 200 of closure.
Red arrouws denote pumping routes

SCHEMATIC WATER BALANCE
CLOSURE (Year 52 On)
(US STANDARD)
DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	3-10



Closure (Year 52 On)

NOTE:

Values (m^3/h) shown are averaged over Years 52 to 200 of closure.

Red arrouws denote pumping routes

DONLIN GOLD

SCHEMATIC WATER BALANCE
CLOSURE (Year 52 On)
(METRIC)

DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	3-11

DG: WRMP0006mp, 11/03/16, R00

The TSF area would be reclaimed over a closure period of five years. In the first year, TSF pond water would be pumped back to the pit through the TSF reclaim pipeline. After the TSF water is pumped out, the tailings surface would be selectively allowed to dry out. Pumping would continue for incoming runoff onto the tailings surface; however, some pond would be maintained to minimize dust generation during cover construction. During each of the subsequent four years, approximately one-quarter of the tailings surface would be progressively reclaimed with the engineered cover. As part of cover construction, waste rock would be placed in the TSF to compensate for expected deformation due to consolidation of tailings. Pumping to the pit would continue to prevent a large pond from redeveloping in the TSF. Runoff would include void water ejected from the pore space of the consolidating tailings (BGC 2011c).

From Years 6 to 52 of closure, water would be pumped out of the competent NAG rockfill layer that provides a capillary break between the tailings and the cover. The pumping would be required to capture void water generated by ongoing consolidation of the tailings and to drain water infiltrating the TSF cover. Drain sumps installed in manholes would be used for this purpose. The consolidation water would mix with water that infiltrates the cover. This mixed water would be assumed to be unacceptable for discharge and would be pumped to the pit. It is anticipated that by the end of Year 52, consolidation would be complete, and only minimum pumping would be required in the future. The total volume of void water released during closure consolidation is estimated at approximately 13,200 acre-ft (16.28 Mm^3).

Runoff from the constructed TSF cover in Years 6 to 52 of closure would be collected in a lined pond at the southeast corner of the reclaimed TSF, as shown in Figure 3-7. The pond would be sized to accommodate the average monthly runoff of 162 acre-ft (200,000 m^3). The water would be held and tested to verify suitable water quality. Assuming this water would be of suitable quality, runoff from the pond would be permitted to flow over a constructed spillway into Crevice Creek after Year 10 of closure.

3.4.2 American Creek, WRF, and Open Pit

Conditions in the American Creek valley at closure are projected to be as follows:

- The WRF would be covered with 14 inches (0.35 m) of peat/organic (growth medium) cover over 12 inches (0.30 m) of colluvium or terrace gravel. Progressive (concurrent) reclamation would be conducted during operations, but final cover materials would need to be placed in the remaining incomplete areas such as active haul roads and Upper CWD.
- The Lower and Upper CWDs would be removed.
- Surface runoff from the WRF would be directed to the ACMA Pit.
- Seepage from the WRF would be collected and piped to the bottom of the ACMA Pit.
- A portion of the ACMA Pit and part of Lewis Pit would be progressively backfilled with waste rock during operations, starting in Year 20. Backfill would be completed to an approximate elevation of 111.5 ft amsl (34 m amsl) in the Lewis portion of the pit, or approximately 250 ft (76 m) below the lowest elevation of the pit rim by the end of

operations. The ACMA Pit would be backfilled to approximately -695 ft amsl (-212 m amsl), or approximately 1,023 ft (312 m) below the pit rim by the end of operations. Once the pit lake is near capacity, water would be treated and discharged to Crooked Creek in accordance with the processes and standards set out in Section 4.4 to avoid uncontrolled flow into Crooked Creek.

- An emergency spillway would be constructed prior to the pit lake nearing capacity with an invert overflow elevation of about 359 ft amsl (109.5 m amsl).

The seepage flows from the WRF would be isolated by constructing four small, concrete containment structures at the outlet of the rock drains for American Creek and Rob's Gulch. The seepage water then would be piped to the bottom of ACMA Pit to encourage pit lake stratification. Surface runoff would drain naturally to the surface of the pit lake.

An emergency spillway would be constructed between the rim of the pit lake and Crooked Creek to accommodate the PMF of 11,301 cfs (320 m^3/s) (BGC 2015a). The spillway dimensions would be 5 by 98 ft (1.5 by 30 m) and designed to prevent fish passage from Crooked Creek to the pit lake. The pit lake water is predicted to have constituent concentrations exceeding the most stringent AWQS. Therefore, a closure WTP to treat pit water prior to discharge to Crooked Creek will be required as described in Section 4.4.

4.0 DISCHARGE SOURCE WATER QUALITY AND TREATMENT

This section describes the water treatment that will occur during construction, operations, and closure. This section also describes the quality of waters from mining-related operations at the facility that will be treated and discharged.

4.1 Construction Water Treatment and Discharge

A modular construction WTP would be commissioned to coincide with site earthworks. The construction WTP would be operational prior to construction, commissioning, and operation of the Operations WTP, and would be used as a best management practice to treat stormwater, where necessary, to comply with the Construction General Permit or Multi-Sector General Permit, depending on the construction area. Treated water from the construction WTP would be discharged to Crooked Creek.

Pit dewatering commences in LOM Year -2, which is the point at which construction of the Operations WTP is complete. Groundwater from the pit dewatering wells is not anticipated to meet AWQS, and will be treated in the Operations WTP and discharged to Crooked Creek. The TSF will be complete in LOM Year -1, and water from the SRS pond, which may also not meet AWQS, may also be treated in the Operations WTP and discharged to Crooked Creek. Water from the Lower CWD may also be treated in the Operations WTP, if required. Retenate (brine) from the WTP will be retained in the Lower CWD during construction for future use in the processing plant. The approximate maximum flow of water to the Operations WTP during construction, 2,135 gpm (485 m^3/h), occurs in LOM Year -1, assuming SRS pond water is treated.

4.2 Operations Water Treatment and Discharge

At LOM Year 1, process plant operation will begin, at which point the WTP would treat water from the following sources:

- Pit perimeter and in-pit dewatering wells
- SRS water
- Contact water from the Upper CWD
- Contact water from the Lower CWD if water quality permits
- TSF reclaim (annual volume would not exceed the anticipated net of precipitation falling on the TSF impoundment and ore stock pile catchment areas minus evaporation from ponds).

4.2.1 Source Water Flows to Operations WTP

The maximum annual predicted individual and cumulative flows that would be sent to the operations WTP over the LOM are summarized in Table 4-1 and discussed as follows. Average flows over the operations period were described previously in Section 3, and are shown on Figures 3-2 and 3-3 (construction) and Figure 3-5 and 3-6 (operations).

CWD, TSF, SRS, and pit dewatering water may be treated and discharged during operations. The maximum flow to the WTP from the dewatering wells will be approximately, 2,300 gpm (513 m^3/h), is predicted to occur in LOM Year 12. Over the operations period a maximum seasonal rate of approximately 1,100 gpm (250 m^3/h) from the CWDs, 44 gpm (10 m^3/h) from the TSF, and approximately 800 gpm (178 m^3/h) from the SRS would be treated.

The maximum combined flow to the WTP is approximately 4,441 gpm (1,009 m^3/h), which is predicted to occur in LOM Year 12 (Table 4-1) and represents the design treatment rate of the operations WTP.

Operation of the pit dewatering wells would end in LOM Year 25. Flow to the operations WTP would end after Year 27 (Table 4-1).

Maximum monthly flowrates from the dewatering wells and SRS for each year of operation were estimated from the water balance model, which in turn used information from groundwater and seepage models (Table 4-1).

The New Source Performance Standards, Effluent Limit Guidelines for gold mining (40 CFR 440 Subpart J) limit the maximum flow of process wastewater from the TSF to the WTP to the net precipitation (precipitation minus evaporation) that falls on the TSF pond area. The predicted net precipitation volumes for each TSF expansion campaign are included in Table 4-2. However, WTP efficiencies will likely limit the quantity of TSF water that can be transferred to the WTP.

Table 4-1: Average and Maximum Flowrates to the Operations WTP

Operation Years	Water Sources, Average Flow Rates, Seasonal Basis								Treatment Rate			
	Dewatering Wells		SRS		CWDs		TSF Reclaim		Average (Seasonal Basis)		Maximum (Monthly Basis)	
	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h
-2	1,471	334	–	–	–	–	–	–	1,471	334	1,469	334
-1	1,449	329	687	157	–	–	–	–	2,135	486	2,416	549
1	1,167	265	669	152	–	–	–	–	1,836	417	2,147	488
2	1,134	257	580	132	612	139	4	1	2,330	529	3,340	759
3	759	172	275	63	257	58	4	1	1,295	294	3,685	837
4	641	146	446	101	259	59	7	2	1,353	307	3,886	883
5	866	197	608	138	419	95	14	3	1,906	433	3,813	866
6	983	223	690	157	542	123	19	4	2,234	507	3,671	834
7	1,065	242	735	167	641	146	24	5	2,464	560	3,602	818
8	1,469	334	782	178	759	172	28	6	3,038	690	3,905	887
9	1,419	322	773	176	785	178	31	7	3,008	683	3,770	856
10	1,396	317	762	173	784	178	31	7	2,975	676	3,732	848
11	1,414	321	755	171	831	189	34	8	3,033	689	3,683	837
12	2,260	513	773	176	932	212	37	9	4,004	909	4,441	1009
13	1,984	451	753	171	960	218	40	9	3,737	849	4,092	929
14	1,788	406	732	166	982	223	40	9	3,542	805	3,850	874
15	1,716	390	718	163	1,029	234	42	9	3,505	796	3,726	846
16	1,824	414	698	158	1,034	235	43	10	3,598	817	3,800	863
17	1,733	393	675	153	1,030	234	43	10	3,481	790	3,680	836
18	1,747	397	695	158	1,032	234	43	10	3,518	799	3,715	844
19	1,724	392	675	153	1,027	233	43	10	3,470	788	3,665	832
20	923	210	655	149	996	226	43	10	2,618	594	2,840	645
21	1,035	235	634	144	836	190	43	10	2,548	579	2,940	668
22	1,083	246	616	140	738	168	43	10	2,479	563	2,976	676

Operation Years	Water Sources, Average Flow Rates, Seasonal Basis								Treatment Rate			
	Dewatering Wells		SRS		CWDs		TSF Reclaim		Average (Seasonal Basis)		Maximum (Monthly Basis)	
	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h	gpm	m^3/h
23	1,118	254	598	136	681	155	43	10	2,440	554	2,997	681
24	1,120	254	577	131	630	143	42	10	2,370	538	2,995	680
25	102	23	511	116	521	118	38	9	1,172	266	1,930	438
26	–	–	317	72	207	47	22	5	546	124	1,792	407
27	–	–	247	56	185	42	18	4	449	102	1,773	403

Table 4-2: Net Precipitation on the TSF Catchment Area by Campaign

Campaign Year (LOM)	TSF Catchment Area		Annual Net Precipitation		Potential Net Precipitation Discharge, annual basis	
	acres	hectares	acre-ft	m^3	gpm	m^3/h
-1	1,468	594	2,147	2,654,100	1,331	303
1	1,468	594	1,397	1,727,910	866	197
5	2,758	1,116	3,032	3,749,670	1,880	428
9	2,758	1,116	2,647	3,273,660	1,641	374
13	3,091	1,251	2,893	3,578,310	1,794	408
17	3,091	1,251	2,619	3,238,830	1623	370
21	3,781	1,530	3,512	4,343,220	2,177	496
25	3,781	1,530	3,398	4,203,000	2107	480

Predicted average monthly flowrates from the different sources to the WTP during operations (LOM Year 1 to 24) are summarized in Table 4-3 (BGC 2016b).

Table 4-3: Average Monthly Treatment Rates by Source during Operations Years 1 to 24*

a.) US Standard

Month	Treatment Rate (gpm)				
	Pit Dewatering Wells	SRS	TSF	CWD	Total
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	1,461	635	25	860	2,982
May	1,503	713	28	869	3,113
June	1,237	520	28	625	2,410
July	1,209	554	30	576	2,370
August	1,287	658	33	666	2,644
September	1,358	749	36	792	2,934
October	1,437	765	38	829	3,069
November	0	0	0	0	0
December	0	0	0	0	0
WTP Operating Season Average	**1,357**	**657**	**31**	**745**	**2,789**
Percentage	**48%**	**24%**	**1%**	**27%**	

b.) Metric

Month	Treatment Rate (m^3/h)				
	Pit Dewatering Wells	SRS	TSF	CWD	Total
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	332	144	6	195	677
May	341	162	6	197	707
June	281	118	6	142	547
July	274	126	7	131	538
August	292	149	8	151	600
September	308	170	8	180	666
October	326	174	9	188	697
November	0	0	0	0	0
December	0	0	0	0	0
WTP Operating Season Average	**308**	**149**	**7**	**169**	**633**
Percentage	**48%**	**24%**	**1%**	**27%**	

* – Pit dewatering wells do not operate in Years 26 and 27 as the process plant feed is from the ore stockpile, while dewatering rates are very low in Year 25. To avoid skewing the average values, only average monthly values from Years 1 to 24 are reported.

4.2.2 Source Water Quality to Operations WTP

The water chemistry predictions of maximum life of mine concentrations for sources of water to the operations WTP source are summarized in Table 4-4. The derivation of these water quality estimates is described in Appendix D.

4.2.3 Operations WTP Treatment Process

The Operations WTP facility and outfall location are shown on Figure 3-1. The WTP will utilize clarification, oxidation and greensand filtration, with reverse osmosis as required. A process flow diagram of the Operations WTP showing the flow through each treatment unit is included as Figure 4-1. The WTP will have a combined maximum design capacity of approximately 4,750 gpm (1,080 m^3/h), with an anticipated maximum treatment rate of approximately 4,441 gpm (1,009 m^3/h). The WTP operation system is summarized below (Hatch 2017).

The treatment process will include two feed equalization tanks. The first tank will exclusively receive feed from the pit dewatering wells with relatively good water quality, referred to as low mineralized wells. The second tank will collect the incoming feed from the CWD, SRS and TSF sources as well as from pit dewatering wells with relatively poor water quality, referred to as high mineralized wells. The first tank containing well water will feed Train #1. The second tank will ordinarily feed Train #2 and Train #3. Blowers will supply air to the WTP feed tanks for mixing and to allow for iron oxidation.

Table 4-4: Operations WTP Source Water Constituent Concentrations, to Year 10 of Discharge (total basis except where noted)

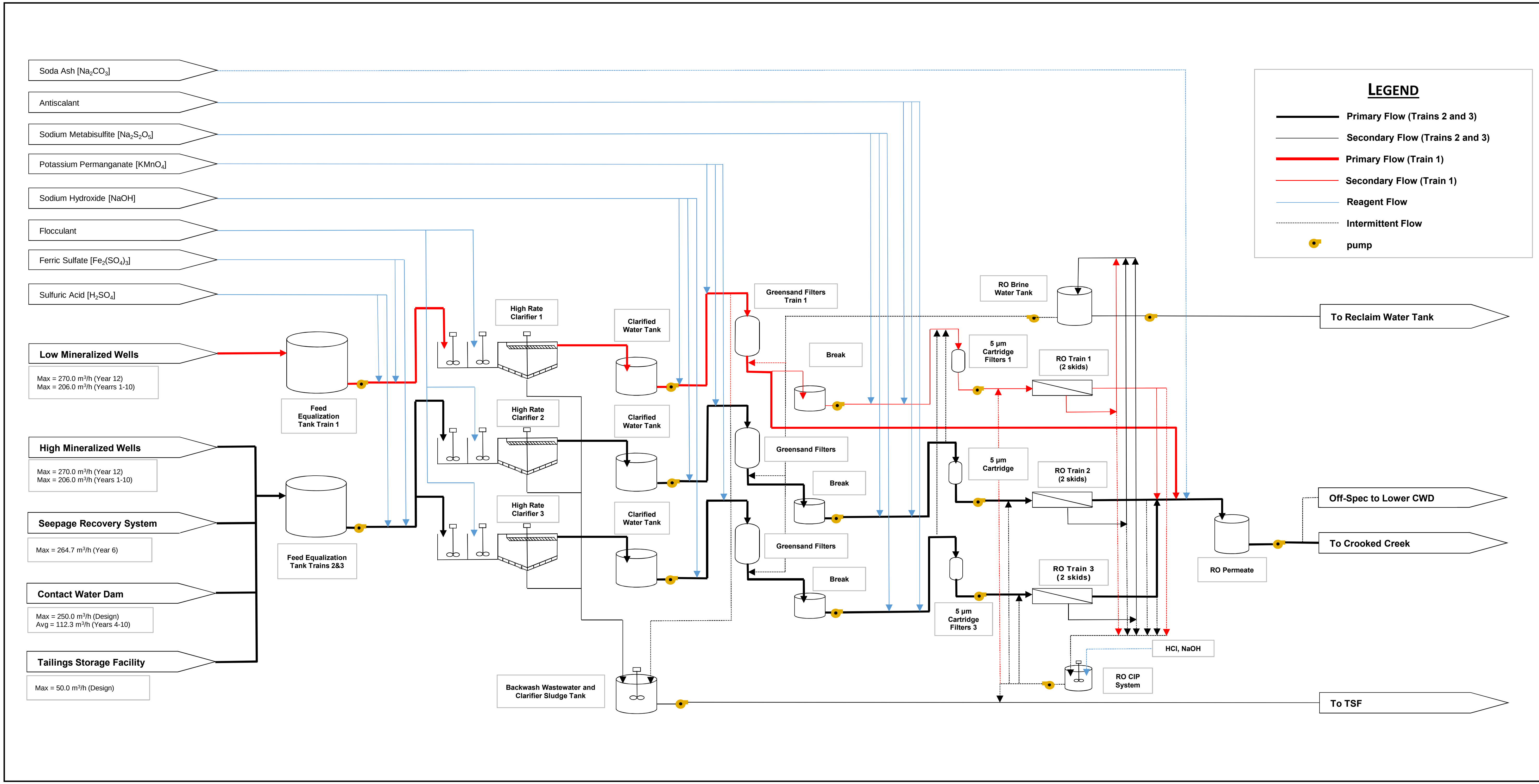
Constituent	Unit	Pit Dewatering[1], 95th Percentile		SRS	Upper CWD	TSF Reclaim
		Low Mineralized Wells	High Mineralized Wells	95th Percentile	95th Percentile	Steady State
Alkalinity	mg/L	151[a]	459[a]	127	113	25
Al	mg/L	0.10	3.9	0.033	0.085	0.013
Ammonia	mg/L	0.37	1.1	1.4	0.66	29
Sb	mg/L	0.00037	0.0058	0.016	0.60	0.022
As	mg/L	0.24	2.2	0.22	2.6	3.3
Ba	mg/L	0.87	1.5	0.15	0.16	0.011
Be	mg/L	0.000065	0.00059	0.000065	0.00038	0.00003
B	mg/L	0.040	0.19	0.016	0.11	0.59
Cd	mg/L	0.000075	0.00020	0.000085	0.00066	0.00073
Ca	mg/L	44[a]	64[a]	46	147	610
Cl	mg/L	0.92[a]	6.5[a]	2.0	1.9	26
Cr	mg/L	0.0015	0.0072	0.00073	0.015	0.012
Co	mg/L	0.0006	0.0030	0.00087	0.038	0.019
Cu	mg/L	0.00066	0.011	0.0012	0.0066	0.018
F	mg/L	0.17[a]	2.3[a]	0.12	0.15	2
Fe	mg/L	5.7	1.8	1.6	0.29	0.0044
Pb	mg/L	0.00044	0.0045	0.00025	0.059	0.003
Li	mg/L	0.016	0.17	0.0016	0.073	0.003
Mg	mg/L	16[a]	27[a]	23	23	1733
Mn	mg/L	1.4	0.13	0.45	1.5	2
Hg	mg/L	0.0000023	0.000022	0.00017	0.000093	0.010[c]
Mo	mg/L	0.0016	0.0081	0.0049	0.15	0.23
Ni	mg/L	0.0018	0.0092	0.0015	0.23	0.062
pH	s.u.[b]	7.8	8.9	7.8	8.4	7.7

Table 4-4: **Operations WTP Source Water Constituent Concentrations, to Year 10 of Discharge (total basis except where noted) (continued)**

Constituent	Unit	Pit Dewatering[1], 95th Percentile		SRS	Upper CWD	TSF Reclaim
		Low Mineralized Wells	High Mineralized Wells	95th Percentile	95th Percentile	Steady State
K	mg/L	0.80[a]	8.1[a]	3.4	18	120
Se	mg/L	0.00075	0.0016	0.0014	0.17	0.042
Si	mg/L	6.3	17	N/A	12	7
Ag	mg/L	0.00016	0.00016	0.00019	0.0009	0.00009
Na	mg/L	11[a]	235[a]	23	20	1100
St	mg/L	0.38	1.0	N/A	1.6	7.9
SO_4	mg/L	27[a]	99[a]	69	423	8605
TDS	mg/L	183[a]	690[a]	273	728	11550
Tl	mg/L	0.00016	0.00061	0.00016	0.00058	0.00041
TSS	mg/L	13	167	N/A	N/A	N/A
V	mg/L	0.0031	0.0084	0.0031	0.0043	0.0048
WAD Cyanide	mg/L	0.0039	0.0042	0.014	0.0041	0.14-0.73
Zn	mg/L	0.014	0.042	0.011	0.34	0.033

Notes:

"-" – not estimated
a – dissolved basis
b – standard units
c – Based on reductions observed at a Barrick facility using UNR reagent



OPERATIONS WTP PROCESS FLOW DIAGRAM

DONLIN GOLD PROJECT

SCALE:

FIGURE: 4-1

From the feed water tanks, the water in each train will be pumped to high rate clarifiers (HRCs). Sulfuric acid and ferric sulfate will be dosed in line ahead of the HRC to adjust pH for the iron co-precipitation process. The pH and ferric sulfate dosage will be adjusted to optimize antimony removal. In the HRC, a polymeric flocculant will be added to assist with the agglomeration of the precipitated ferric hydroxide and co-precipitates. The solids are separated in the clarification step. The overflow (treated water) from the HRC clarifier in each train will be collected in the clarified water transfer tank, and then pumped to the greensand media filters.

The greensand media filters will be dual media filters. The top layer will be anthracite intended for TSS removal and the bottom layer will be the greensand media itself. Potassium permanganate ($KMnO_4$) will be injected upstream of the greensand filters. The $KMnO_4$ will oxidize the manganese, which will be in the +2 oxidation state. Consumption of $KMnO_4$ for oxidation of iron is not expected because the iron should already be fully oxidized by aeration in the WTP feed tanks. The greensand filters will be backwashed with air and water. Brine from the RO will be used for backwash water. Wastewater from filter backwash will be sent to the Backwash Wastewater/Clarifier Sludge Receiver Tank. This combined wastewater will be pumped to the TSF or used in the process.

RO pre-treatment will be required to protect the membranes from oxidation, scaling, and fouling. Since the RO membranes are susceptible to degradation by any residual oxidant, sodium metabisulfite ($Na_2S_2O_5$) will be used to remove any trace of $KMnO_4$. Antiscalant will be added to maintain sparingly soluble salts in solution and prevent precipitation on the membranes. In order to protect the RO membranes from fouling, a 5-micron absolute cartridge filtration system will be installed ahead of the RO system. The RO systems will operate at 75% recovery.

The brine from the RO process will be collected in the RO brine water tank. The majority of the water from the brine water tank will be pumped to the reclaim water tank for reuse in the process plant. A small amount of the brine will be used for backwashing the greensand filters. Water from the brine water tank will be pumped to the reclaim water tank for reuse in the process plant or discharged to the TSF.

RO permeate will be discharged to the RO permeate water tank. Before entering the tank, the pH will be adjusted to within the discharge range (7.5 – 8) by addition of soda ash (Na_2CO_3) and to also increase the alkalinity of the treated water as required.

It is not expected that RO treatment will be required for the higher quality pit dewatering well water being treated in Train #1. Typically discharge from the greensand filters in Train #1 will be directed to the RO permeate water tank. RO units will be available to be used in Train #1 as a back-up system when required to meet discharge standards. In normal operation, treated water from Trains 1, 2, and 3 will be pumped from the RO permeate water tank to the discharge outfall at Crooked Creek. If, for any reason, the treated water is out of specification, then the water will be transferred to the Lower CWD until the problem is resolved.

4.2.4 Estimated Effluent Water Quality

The operations WTP effluent water quality was calculated using removal efficiencies for various parameters across the different WTP units. Removal efficiencies were estimated only for parameters requiring treatment in order to meet water quality standards at discharge. The WTP estimated removal efficiencies are summarized in Table 4-5 (Hatch 2017). The WTP effluent is predicted to meet all applicable water quality standards, after treatment of the feed water assuming predicted maximum parameter concentrations for each feed water source. The predicted 95th percentile constituent concentrations in the WTP discharge in the first 10 years of WTP operation and applicable AWQS for each constituent are summarized in Table 4-6.

Table 4-5: Operations WTP Removal Efficiencies

Parameter	**Predicted Removal by Treatment System**	
High Rate Clarifier	**Train #1**	**Train #2**
Al		~85%
Sb	~75%	~75%
As	~90%	~90%
Fe	~85%	~45%
Mn	~50%	~50%
Mo		~6%
Greensand Media Filtration System		
As	~75%	~75%
Fe	~90%	~80%
Mn	>92%	>86%
Reverse Osmosis System		
Al	97%	
Ammonia	80%	
Sb	90%	
As	91%	
Cd	94%	
Pb	97%	
Mn	97%	
Hg	96%	
Mo	91%	
Se	91%	
SO_4	97%	
TDS	97%	
WAD CN	80%	

Source: Hatch 2017, Tables 4-7, 4-8, 4-9, 4-10, and 4-11

Table 4-6: Predicted Operations WTP Effluent Water Quality, to Year 10 of Discharge

Constituent	Unit	Projected Maximum Concentration in WTP Effluent[1]	AWQS for Receiving Water[2]
Al	mg/L	<0.05	0.75
Ammonia	mg/L	<0.5	2.99
Sb	mg/L	<0.005	0.006
As	mg/L	<0.006	0.01
Ba	mg/L	<0.4	2
Be	mg/L	<0.000059[b]	0.004
B	mg/L	<0.05	0.75
Cd	mg/L	<0.0001	0.00023
Ca	mg/L	<240[a]	n/a
Cl	mg/L	<1	230
Cr	mg/L	<0.002	0.1
Co	mg/L	<0.001	0.05
Cu	mg/L	<0.001	0.0077
F	mg/L	<0.4	1
Fe	mg/L	<0.05	1
Pb	mg/L	<0.001	0.0024
Li	mg/L	<0.17[b]	2.5
Mg	mg/L	<240[a]	n/a
Mn	mg/L	<0.05	0.05
Hg	mg/L	<0.000012	0.000012
Mo	mg/L	<0.005	0.01
Ni	mg/L	<0.005	0.043
pH	s.u.	6.5 - 8.5	6.5 - 8.5
K	mg/L	<120[b]	n/a
Se	mg/L	<0.005	0.005
Si	mg/L	<17[b]	n/a
Ag	mg/L	<0.0014[b]	0.0026
Na	mg/L	<240[a]	n/a
St	mg/L	<7.9	n/a
SO_4	mg/L	<60	250
TDS	mg/L	<240	500
Tl	mg/L	<0.00082[b]	0.0017
TSS	mg/L	<1	20
V	mg/L	<0.0084[b]	0.1
WAD CN	mg/L	<0.005	0.0052
Zn	mg/L	<0.02	0.100

Notes:

1 – Hatch 2017, except where noted

2 – Most stringent Alaska Water Quality Standard. Where hardness, temperature, or pH based, calculated using baseline water quality monitoring data from station CCBO.

a – Capped at discharge TDS concentration

b – Based on the highest of the individual source concentrations, all source concentrations less than applicable AWQS

n/a – No applicable AWQS

4.3 Closure Water Treatment and Discharge

4.3.1 Pit Lake Water Flows and Quality

As the pit fills, the water level and quality (at different depths) would be monitored, and the numerical hydrological model and pit lake geochemical model would be re-calibrated as data become available to refine estimates of the time at which the pit lake would reach its managed level and what the water quality of surface water would be at this time. A post-closure WTP would be constructed five years prior to the pit reaching the managed water level, and seasonal (summer) treatment and discharge would begin two to three years before filling is complete to maintain the required freeboard. Unrestricted flows from the pit to Crooked Creek, in absence of water treatment, would average approximately 2,900 gpm (660 m^3/h). The WTP would be designed for a maximum capacity of 7,500 gpm (1,700 m^3/h), which would require an average annual operating period of just over 6 months per year; longer operating periods may be required for years with above-average precipitation. The managed pit lake level will be approximately 31 ft (9.5 m) below the low point (invert) of the pit spillway crest, which is at an elevation of 359 ft (109.5 m). The managed water level is predicted to be reached approximately 50 years after processing plant closure (BGC 2015b). The current plan is for the WTP to operate seasonally into perpetuity.

While pit lake water levels would be controlled through operation of the WTP, an emergency spillway is required to accommodate an attenuated PMF flow of 1,480 cfs (42 m^3/s) (BGC 2015a). The spillway would be designed to prevent fish passage from Crooked Creek into the pit lake (e.g., large steps that would also function as energy dissipation structures). The spillway would be located in the southwest corner of the pit, which is coincident with the low point of the pit crest (364.2 ft [111 m]). Approximate spillway dimensions would be 5 ft in depth by 98 ft in width (1.5 by 30 m).

Predictions of the post-closure chemistry of the ACMA Pit lake waters were required to assess the closure water management scenario for the ACMA Pit in support of the final reclamation and closure of the proposed Donlin Gold project. These predictions were done using a pit lake model. The model used for these predictions, PitMod is a coupled one-dimensional (1D) hydrodynamic-geochemical pit lake model (Lorax 2011, 2012, 2015). Model set-up involved several steps and commenced with the introduction of the geometry of the final ACMA into the model grid. This was followed by prescribing inflow configurations and water chemistry for all the inflows in the closure water management plan. The PitMod model is described further in Appendix C.

A summary of the predicted concentrations in the top 33 ft (10 m) of the water column for a suite of parameters under the closure water management scenario for the ACMA Pit is provided in Table 4-7. The results are compared to the most stringent AWQS. For the closure water management scenario evaluated, predictions were run through 100 years from initial pit lake formation to predict water quality conditions in the pit lake over time as listed in Table 4- 7. The most salient findings were as follows:

- The water management strategy of segregating the poorest quality water and preferentially discharging these waters at depth in the pit lake results in the formation of a highly stratified pit lake. Stratification results from the strong density and salinity gradients induced by the high salinity, high density bottom waters being overlain with comparatively fresh and much lower density surface waters. The stratification of the pit lake is substantial and prevents whole lake mixing or "turnover" throughout the 100-year modeling simulation period.

- Lake productivity and oxygen consumption rates were modeled under oligotrophic (low productivity and low oxygen consumption rates) conditions in the pit lake. Suboxia or anoxia does not develop in the model scenario despite bottom waters being isolated from atmospheric exchange.
- The assumption that all external source inputs delivered to the pit lake are fully oxygenated is considered a conservative assumption that prevents the formation of reducing conditions and limits the in-situ sulfide precipitation and removal processes.
- Sulfate concentrations in the pit lake mirror the density and salinity profile, with relatively low concentrations in the surface waters (<100 mg/L) with markedly increasing concentrations at depth below 328 ft (100 m) to values of approximately 4,000 mg/L. Sulfate is the primary dissolved ion imparting the salinity and density gradient in the pit lake.
- The pit lake model results indicate that a number of parameters including Al, As, Sb, Cd, Cu, Mn, Hg, and Se would be present at concentrations that exceed the most stringent AWQS (Table 4-5) and therefore, require treatment prior to discharge.

Table 4-7: Summary of Preliminary Surface Water Quality Estimates for ACMA Pit Lake at Year 99

Parameter	Predicted Concentration (mg/L) in top 33 ft (10 m) of Pit Lake	Most Stringent Alaska Standard (mg/L)	
		Aquatic Life CMC	Drinking Water (DW) or Human Health (HH)
SO_4	41	N/A	250[DW]
pH	5.0 – 6.0[a]	6.5 – 9.0	6.5 – 8.5
CN_{WAD}	0	0.0052	0.2[DW]
Al	1.57	0.087[b]	NA
Sb	0.067	N/A	0.006 [DW]
As	0.114	0.15	0.01 [DW]
Cd	0.00035	0.00023	0.005 [DW]
Cu	0.0105	0.0076	1.3 [HH]
Cr	0.0046	0.071[III]; 0.011[IV]	NA
Pb	0.0026	0.0023	NA
Mn	0.176	NA	0.05 [HH]
Hg	0.000025	0.000012[c]	0.00005 [HH]
Ni	0.019	0.043	0.61 [HH]
Se	0.02	0.005	0.05 [DW]
Zn	0.053	0.098	9.1[HH]

Notes:
a – not modeled but estimated from input pH
b – chronic criteria for locations with pH less than 7.0 or hardness less than 50 mg/L as $CaCO_3$
c – EPA Region 10
CMC – criteria maximum concentration
N/A – no applicable standard

4.3.2 Closure WTP

The Post-Closure WTP would treat pit lake water. The WTP would use conventional chemical precipitation technology, specifically HDS, and would target elements such as aluminum, arsenic, manganese, antimony, cadmium, copper, and mercury (CEMI 2008). The WTP would have a design treatment rate of 6,600 gpm (1,500 m^3/h) and a maximum capacity of approximately 7,500 gpm (1,700 m^3/h) and operate approximately six months per year with an average annual flow to Crooked Creek of approximately 2,900 gpm (662 m^3/h). The final WTP configuration will be updated closer to the end of the mine life to incorporate advances in treatment technologies.

4.4 Non-Contact Stormwater Management

As described in Section 3, non-contact stormwater would be managed at the site during construction, operations, closure, and post closure. Non-contact stormwater water is stormwater that has not come into direct contact with mining infrastructure (e.g., airstrip, permanent camp, etc.). Examples include stormwater runoff diverted around mining infrastructure.

4.5 Construction and Operations Domestic Wastewater Treatment and Discharge

Two modular sanitary treatment plant (STP) systems would be provided for the treatment and discharge of domestic wastewater from camp facilities. The STP for the permanent accommodations facility 6 miles (10 km) west of the plant site would be sized to accommodate 638 people, and the STP for the construction camp immediately west of the plant site would be sized for 2,560 people.

Discharge from the construction camp STP to Crooked Creek is anticipated to peak at 140,800 gallons per day (533 m^3/day). Water consumption per person per day, including showers, laundry, drinking, and toilet usage, cooking and miscellaneous, is estimated to be 55 gallons (208 L). Treated effluent would be pumped to the discharge outfalls at Crooked Creek during construction, and would be permitted under an APDES general permit (AKG572000). Solids from the STP systems would be incinerated.

The sanitary treatment plant for the construction camp would later be reduced in size to accommodate wastewater generated in the plant site area. The discharge from the plant-site STP and the permanent accommodations facility STP would be re-directed to the process plant or TSF during operations. Bio-solids from the STP would be incinerated after filter pressing to remove excess water.

Untreated sanitary effluent from each building at the plant site would be pumped via overland or interior pipelines to the STP. Untreated sanitary effluent from portable Sani-Huts would be collected and trucked to the permanent camp STP.

A septic tank and leach field sized for the maximum anticipated crew (approximately 20 persons) would be installed at the Jungjuk Port. The leach field would be placed in an appropriate location, considering soil conditions and traffic. The tank would be pumped out as necessary and trucked to a STP.

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Appendix A
Baseline Water Quality

Table A-1 Summary of Water Quality Data from Category 1 Surface Water Monitoring Stations, 2005-2015

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Major Cations						
Calcium	mg/L	227/227 (100%)	0.031 - 0.62	6.48 - 88.9	ANUP	26.1
Magnesium	mg/L	227/227 (100%)	0.015 - 0.62	2.26 - 43.5	CRDN	8.48
Potassium	mg/L	222/227 (98%)	0.15 - 1.2	0.301 - 4.17	CRDN	0.398
Sodium	mg/L	227/227 (100%)	0.15 - 1.2	1.42 - 53.1	CRDN	5.19
Major Anions						
Total Alkalinity (as CaCO3)	mg/L	226/226 (100%)	3.1 - 12.4	22.5 - 410	DCBO	95.4
Bicarbonate	mg/L	226/226 (100%)	3.1 - 12.4	22.5 - 410	DCBO	95.4
Carbonate	mg/L	1/227 (0%)	3.1 - 12.4	7.36 - 7.36	CRDN	1.87
Hydroxide	mg/L	0/227 (0%)	3.1 - 12.4	N/A	N/A	N/A
Chloride	mg/L	227/227 (100%)	0.031 - 0.031	0.163 - 7.63	ACAW	0.650
Fluoride	mg/L	204/209 (98%)	0.031 - 0.031	0.031 - 0.161	ANDA	0.0374
Sulfate	mg/L	227/227 (100%)	0.031 - 0.155	0.883 - 53.2	SNUP	11.7
Nutrients						
Nitrite + Nitrate(as N)	mg/L	227/227 (100%)	0.0062 - 0.031	0.0415 - 3.73	ACAW	0.450
Ammonia (as N)	mg/L	82/227 (36%)	0.031 - 0.031	0.031 - 0.497	CRDN	0.0353
Cyanide						
Cyanide, Total	mg/L	39/227 (17%)	0.0015 - 0.0025	0.0015 - 0.017	ACAW	0.000949
Cyanide, WAD	mg/L	49/227 (22%)	0.0015 - 0.0025	0.0015 - 0.017	ACAW	0.000889
Metals						
Aluminum, dissolved	mg/L	132/192 (69%)	0.0062 - 0.031	0.006 - 2.38	CRDN	0.0309
Aluminum, total	mg/L	223/226 (99%)	0.0062 - 0.155	0.00705 - 25.4	DCBO	0.818
Antimony, dissolved	mg/L	19/191 (10%)	0.00031 - 0.00031	0.000316 - 0.00493	SNUP	0.000191
Antimony, total	mg/L	17/226 (8%)	0.00031 - 0.00155	0.000322 - 0.00447	SNUP	0.000191
Arsenic, dissolved	mg/L	12/192 (6%)	0.0015 - 0.0025	0.00165 - 0.231	QRTZ	0.00127
Arsenic, total	mg/L	38/227 (17%)	0.0015 - 0.0125	0.0008 - 0.194	QRTZ	0.00226
Barium, dissolved	mg/L	192/192 (100%)	0.00094 - 0.00094	0.0192 - 0.226	ANDA	0.0788

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Barium, total	mg/L	227/227 (100%)	0.00094 - 0.0047	0.0278 - 0.95	DCBO	0.0980
Beryllium, dissolved	mg/L	0/192 (0%)	0.00013 - 0.00013	N/A	N/A	N/A
Beryllium, total	mg/L	19/227 (8%)	0.00013 - 0.00065	0.00013 - 0.00162	DCBO	0.0000805
Boron, dissolved	mg/L	31/192 (16%)	0.0031 - 0.015	0.00358 - 0.0319	CRDN	0.00707
Boron, total	mg/L	66/227 (29%)	0.0031 - 0.075	0.00333 - 0.0728	CRDN	0.00775
Cadmium, dissolved	mg/L	1/192 (1%)	0.00015 - 0.00015	0.000267 - 0.000321	DCBO	0.0000761
Cadmium, total	mg/L	16/227 (7%)	0.00000075 - 0.00015	0.0000725 - 0.003	DCBO	0.000100
Chromium, dissolved	mg/L	39/192 (20%)	0.00031 - 0.00062	0.000621 - 0.00349	CRDN	0.000355
Chromium, total	mg/L	96/226 (43%)	0.00031 - 0.0031	0.0002 - 0.0363	DCBO	0.00117
Cobalt, dissolved	mg/L	23/192 (12%)	0.0012 - 0.0012	0.00016 - 0.0117	CRUP	0.000962
Cobalt, total	mg/L	29/226 (13%)	0.0012 - 0.006	0.0001 - 0.0237	DCBO	0.000932
Copper, dissolved	mg/L	166/192 (86%)	0.00031 - 0.00031	0.000311 - 0.00402	CRDN	0.000432
Copper, total	mg/L	203/226 (90%)	0.00031 - 0.00155	0.000313 - 0.0465	QRTZ	0.00173
Iron, dissolved	mg/L	145/192 (76%)	0.0062 - 0.078	0.01 - 3.43	CRDN	0.179
Iron, total	mg/L	205/225 (91%)	0.0062 - 0.39	0.00862 - 38.1	DCBO	1.37
Lead, dissolved	mg/L	44/192 (23%)	0.000062 - 0.000062	0.0000639 - 0.00131	CRDN	0.0000480
Lead, total	mg/L	146/227 (64%)	0.000062 - 0.00031	0.000066 - 0.0197	DCBO	0.000558
Lithium, dissolved	mg/L	14/192 (7%)	0.0031 - 0.0031	0.00317 - 0.00929	DCBO	0.00158
Lithium, total	mg/L	41/209 (20%)	0.0031 - 0.0155	0.00314 - 0.0354	DCBO	0.00213
Manganese, dissolved	mg/L	186/192 (97%)	0.00031 - 0.00031	0.000328 - 0.868	CRDN	0.0573
Manganese, total	mg/L	225/226 (100%)	0.00031 - 0.00155	0.000484 - 2.35	DCBO	0.0905
Mercury, dissolved	mg/L	20/20 (100%)	0.0000005 – 0.0000005	0.000000551 - 0.00002	CRDN	0.00000230
Mercury, total	mg/L	226/237 (95%)	0.0000005 - 0.000005	0.00000054 - 0.0195	CRUP	0.00000811
Molybdenum, dissolved	mg/L	6/192 (3%)	0.00062 - 0.0031	0.000707 - 0.00121	DCBO	0.00139
Molybdenum, total	mg/L	15/227 (7%)	0.00062 - 0.0155	0.0006 - 0.00871	CRDN	0.00162
Nickel, dissolved	mg/L	162/191 (85%)	0.00062 - 0.00062	0.000627 - 0.00369	CRDN	0.000523
Nickel, total	mg/L	216/226 (96%)	0.00062 - 0.0031	0.00063 - 0.0444	DCBO	0.00165
Selenium, dissolved	mg/L	6/192 (3%)	0.0015 - 0.0015	0.0001 - 0.00346	ACAW	0.00075
Selenium, total	mg/L	12/227 (5%)	0.0015 - 0.0075	0.0001 - 0.00398	ACAW	0.0000805

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Silver, dissolved	mg/L	0/192 (0%)	0.00031 - 0.00031	N/A	N/A	N/A
Silver, total	mg/L	7/227 (3%)	0.00031 - 0.00155	0.00062 - 0.00062	ANDA	0.000172
Thallium, dissolved	mg/L	0/192 (0%)	0.00031 - 0.00031	N/A	N/A	N/A
Thallium, total	mg/L	12/227 (5%)	0.00031 - 0.00155	0.000338 - 0.000696	ANDA	0.000179
Vanadium, dissolved	mg/L	1/192 (1%)	0.0062 - 0.0062	0.0012 - 0.00655	ANDA	0.00312
Vanadium, total	mg/L	26/227 (11%)	0.0062 - 0.031	0.0006 - 0.0653	DCBO	0.00416
Zinc, dissolved	mg/L	77/191 (41%)	0.0025 - 0.0025	0.00255 - 0.0156	SNUP	0.00237
Zinc, total	mg/L	134/227 (59%)	0.0015 - 0.0125	0.00165 - 0.159	QRTZ	0.00610
General Water Quality Parameters						
Hardness ($CaC0_3$)	mg/L	253/253 (100%)	–	17.9 – 401	DCBO	98.0
Total Diss. Solids	mg/L	226/226 (100%)	3.1 - 3.1	47 - 478	DCBO	125
Total Susp. Solids	mg/L	224/226 (99%)	0.141 - 6	0.204 - 1470	ANDA	42.6
Field Parameters						
Conductivity (lab)	umhos/cm	228/228 (100%)	–	58.5 - 809	DCBO	210
Conductivity, field	umhos/cm	233/233 (100%)	–	0.105 - 755	ACAW	124
Dissolved Oxygen, field (2)	mg/L	219/219 (100%)	–	3.46 - 24.5	ANDA	13.7
ORP (orp/eh), field	mV	231/231 (100%)	–	-262 - 1121	ANDA	93.0
pH (lab)	pH Units	227/227 (100%)	–	6.5 - 8.3	CRDN	7.51
pH, field (3)	pH Units	206/206 (100%)	–	4.42 - 12.9	ANDA	7.42
Temperature, field	ºC	232/232 (100%)	–	-0.53 – 10.5	BELL	2.35
Turbidity, field	NTU	191/192 (99%)	–	0 - 242	CRDN	13.5

Notes:

ND = non-detect

N/A = not applicable

1 - Calculated using one-half method detection limit for non-detects

2 - Dissolved oxygen readings above 25 mg/L were assumed to be anomalous and were not included in this summary.

3 - pH readings above 14 were assumed to be anomalous and were not included in this summary.

“–“ - not specified

Table A-2 Summary of Water Quality Data from Category 2 Surface Water Monitoring Stations, 2005-2015

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration [1]
Major Cations						
Calcium	mg/L	101/101 (100%)	0.031 - 0.2	15.6 - 55.5	SNDN	29.2
Magnesium	mg/L	92/92 (100%)	0.015 - 0.2	6.02 - 25.5	SNDN	12.4
Potassium	mg/L	98/101 (97%)	0.15 - 1.2	0.327 - 1.34	AMER	0.499
Sodium	mg/L	101/101 (100%)	0.15 - 1.2	1.32 - 13.9	AMER	3.46
Major Anions						
Total Alkalinity (as CaCO3)	mg/L	101/101 (100%)	2 - 12.4	57 - 166	SNDN	104
Bicarbonate	mg/L	101/101 (100%)	2 - 12.4	57 - 166	SNDN	104
Carbonate	mg/L	0/101 (0%)	2 - 12.4	N/A	N/A	N/A
Hydroxide	mg/L	0/101 (0%)	2 - 12.4	N/A	N/A	N/A
Chloride	mg/L	101/101 (100%)	0.031 - 0.5	0.356 - 59.2	AMER	1.60
Fluoride	mg/L	86/86 (100%)	0.031 - 0.1	0.038 - 0.116	AMER	0.071
Sulfate	mg/L	101/101 (100%)	0.031 - 0.5	7.81 - 51.3	SNDN	21.3
Nutrients						
Nitrite + Nitrate(as N)	mg/L	101/101 (100%)	0.02 - 0.0372	0.101 - 3.24	AMER	0.508
Ammonia (as N)	mg/L	19/68 (28%)	0.031 - 0.031	0.032 - 0.239	ACBW	0.0402
Cyanide						
Cyanide, Total	mg/L	13/101 (13%)	0.0015 - 0.003	0.0015 - 0.0041	SNDN	0.00102
Cyanide, WAD	mg/L	16/101 (16%)	0.0015 - 0.003	0.0015 - 0.0034	AMER	0.00105
Metals						
Aluminum, dissolved	mg/L	51/77 (66%)	0.001 - 0.0062	0.0063 - 0.889	AMER	0.0656
Aluminum, total	mg/L	77/77 (100%)	0.001 - 0.0248	0.00673 - 4.24	SNDN	0.302
Antimony, dissolved	mg/L	20/77 (26%)	0.00031 - 0.0004	0.000311 - 0.00105	SNDN	0.00226
Antimony, total	mg/L	31/101 (31%)	0.00031 - 0.0004	0.000313 - 0.00717	AMER	0.00185
Arsenic, dissolved	mg/L	54/77 (70%)	0.0005 - 0.0025	0.00168 - 0.0118	SNDN	0.00327
Arsenic, total	mg/L	81/101 (80%)	0.0005 - 0.0025	0.00151 - 0.15	SNDN	0.00691
Barium, dissolved	mg/L	77/77 (100%)	0.0005 - 0.00094	0.0373 - 0.151	AMER	0.0550

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Barium, total	mg/L	101/101 (100%)	0.0005 - 0.00094	0.0399 - 0.167	SNDN	0.0606
Beryllium, dissolved	mg/L	0/77 (0%)	0.0001 - 0.00013	N/A	N/A	N/A
Beryllium, total	mg/L	5/101 (5%)	0.0001 - 0.00013	0.000143 - 0.000143	SNDN	0.000715
Boron, dissolved	mg/L	14/77 (18%)	0.0031 - 0.015	0.00316 - 0.0252	SNDN	0.105
Boron, total	mg/L	32/101 (32%)	0.0031 - 0.015	0.00337 - 0.0356	SNDN	0.0819
Cadmium, dissolved	mg/L	1/77 (1%)	0.0001 - 0.00015	0.000168 - 0.000168	AMER	0.0000762
Cadmium, total	mg/L	9/101 (9%)	0.00005 - 0.00015	0.000071 - 0.003	AMER	0.000110
Chromium, dissolved	mg/L	8/76 (11%)	0.00031 - 0.00062	0.000657 - 0.00318	AMER	0.00446
Chromium, total	mg/L	39/101 (39%)	0.00031 - 0.00062	0.000485 - 0.00714	SNDN	0.00388
Cobalt, dissolved	mg/L	10/77 (13%)	0.00005 - 0.0012	0.00141 - 0.0116	SNDN	0.00891
Cobalt, total	mg/L	5/101 (5%)	0.00005 - 0.0012	0.00139 - 0.00374	SNDN	0.00663
Copper, dissolved	mg/L	66/77 (86%)	0.00031 - 0.0005	0.000312 - 0.00163	AMER	0.000547
Copper, total	mg/L	91/101 (90%)	0.00031 - 0.0005	0.00034 - 0.00547	SNDN	0.000922
Iron, dissolved	mg/L	69/77 (90%)	0.0062 - 0.078	0.0389 - 1.19	AMER	0.179
Iron, total	mg/L	101/101 (100%)	0.0062 - 0.078	0.0248 - 7.93	AMER	0.679
Lead, dissolved	mg/L	21/76 (28%)	0.000062 - 0.0001	0.000063 - 0.000591	AMER	0.000479
Lead, total	mg/L	59/100 (59%)	0.000062 - 0.0001	0.000066 - 0.00318	SNDN	0.000565
Lithium, dissolved	mg/L	15/77 (19%)	0.0031 - 0.02	0.00312 - 0.00594	SNDN	0.00205
Lithium, total	mg/L	19/86 (22%)	0.0031 - 0.02	0.00315 - 0.0106	SNDN	0.00226
Manganese, dissolved	mg/L	77/77 (100%)	0.00031 - 0.0005	0.015 - 0.76	AMER	0.0967
Manganese, total	mg/L	101/101 (100%)	0.00031 - 0.0005	0.000531 - 0.751	SNDN	0.107
Mercury, dissolved	mg/L	4/4 (100%)	0.0000005 - 0.0000005	0.000000804 - 0.00000257	AMER	0.00000127
Mercury, total	mg/L	102/105 (97%)	0.0000001 - 0.000001	0.000000561 - 0.0000467	SNDN	0.00000611
Molybdenum, dissolved	mg/L	0/77 (0%)	0.0005 - 0.0031	N/A	N/A	
Molybdenum, total	mg/L	6/101 (6%)	0.0005 - 0.0031	0.000895 - 0.0062	SNDN	0.0170
Nickel, dissolved	mg/L	71/77 (92%)	0.0006 - 0.00062	0.000663 - 0.00258	AMER	0.00107
Nickel, total	mg/L	99/101 (98%)	0.0006 - 0.00062	0.000665 - 0.00816	SNDN	0.00145
Selenium, dissolved	mg/L	1/77 (1%)	0.0001 - 0.0015	0.00168 - 0.00168	SNDN	0.000762
Selenium, total	mg/L	3/101 (3%)	0.0001 - 0.0015	0.00166 - 0.003	SNDN	0.000804

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Silver, dissolved	mg/L	0/77 (0%)	0.00005 - 0.00031	N/A	N/A	N/A
Silver, total	mg/L	2/101 (2%)	0.00005 - 0.00031	0.00062 - 0.00062	ACBW	0.00170
Thallium, dissolved	mg/L	1/77 (1%)	0.0001 - 0.00031	0.000364 - 0.000364	ACBW	0.00217
Thallium, total	mg/L	7/101 (7%)	0.0001 - 0.00031	0.000341 - 0.000865	AMER	0.00172
Vanadium, dissolved	mg/L	0/77 (0%)	0.0002 - 0.0062	N/A	N/A	N/A
Vanadium, total	mg/L	5/101 (5%)	0.0002 - 0.0062	0.00838 - 80.5	SNDN	0.0342
Zinc, dissolved	mg/L	27/77 (35%)	0.002 - 0.0025	0.00258 - 0.0124	ACBW	0.0186
Zinc, total	mg/L	51/99 (52%)	0.0015 - 0.0025	0.00163 - 0.0268	SNDN	0.0162
General Water Quality Parameters						
Hardness ($CaC0_3$)	mg/L	103/103 (100%)	–	22.4 - 206	SNDN	120
Total Diss. Solids	mg/L	101/101 (100%)	3.1 - 10	76 - 274	AMER	141
Total Susp. Solids	mg/L	100/101 (99%)	0.143 - 1.5	0.2 - 141	AMER	15.9
Field Parameters						
Conductivity (lab)	umhos/cm	101/101 (100%)	–	130 - 470	AMER	243
Conductivity, field	umhos/cm	100/100 (100%)	–	0.124 - 1620	SNDN	156
Dissolved Oxygen, field (2)	mg/L	100/100 (100%)	–	3.36 - 24.0	AMER	14.3
ORP (orp/eh), field	mV	100/100 (100%)	–	-292.7 - 271	ACBW	73
pH (lab)	pH Units	101/101 (100%)	–	5.6 - 8.0	ACBW	7.51
pH, field	pH Units	100/100 (100%)	–	5.54 - 8.94	AMER	7.44
Temperature, field	ºC	100/100 (100%)	–	-0.51 - 9.4	ACBW	2.22
Turbidity, field	NTU	75/75 (100%)	–	0.81 - 97.2	AMER	9.41

Notes:

ND = non-detect

N/A = not applicable

1 - Calculated using one-half method detection limit for non-detects

2 - Dissolved oxygen readings above 25 mg/L were assumed to be anomalous and were not included in this summary.

"–" - not specified

Table A-3 Summary of Water Quality Data from Category 3 Surface Water Monitoring Stations, 2005-2015

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Major Cations						
Calcium	mg/L	214/214 (100%)	0.013 - 0.62	9.8 - 53.8	SNOW	29.5
Magnesium	mg/L	214/214 (100%)	0.012 - 0.62	3.97 - 30.5	SNOW	12.4
Potassium	mg/L	210/214 (98%)	0.15 - 1.2	0.312 - 1.45	EAGL	0.424
Sodium	mg/L	214/214 (100%)	0.028 - 1.2	1.45 - 18.3	EAGL	4.44
Major Anions						
Total Alkalinity (as CaCO3)	mg/L	214/214 (100%)	0.77 - 12.4	37.5 - 260	CCBO	116
Bicarbonate	mg/L	214/214 (100%)	0.77 - 12.4	37.5 - 260	CCBO	116
Carbonate	mg/L	0/214 (0%)	0.031 - 12.4	N/A	N/A	N/A
Hydroxide	mg/L	0/214 (0%)	0.04 - 12.4	N/A	N/A	N/A
Chloride	mg/L	215/215 (100%)	0.03 - 0.5	0.183 - 1.78	SNOW	0.628
Fluoride	mg/L	192/192 (100%)	0.031 - 0.1	0.033 - 0.93	SNOW	0.0440
Sulfate	mg/L	215/215 (100%)	0.01 - 0.5	2.19 - 48.3	SNOW	15.6
Nutrients						
Nitrite + Nitrate(as N)	mg/L	213/215 (99%)	0.015 - 0.031	0.033 - 1.4	CCAC	0.329
Ammonia (as N)	mg/L	59/215 (27%)	0.000027 - 12.4	0.0315 - 0.393	CCBB	0.0281
Phosphorus	mg/L	0/50 (0%)	0.03 - 0.5	N/A	N/A	N/A
Cyanide						
Cyanide, Total	mg/L	41/215 (19%)	0.0015 - 0.003	0.0015 - 0.0056	CCBB	0.000904
Cyanide, WAD	mg/L	48/215 (22%)	0.0012 - 0.0062	0.0015 - 0.0048	CCBW	0.000840
Metals						
Aluminum, dissolved	mg/L	106/177 (60%)	0.00033 - 0.0062	0.003 - 0.898	CCAK	0.0715
Aluminum, total	mg/L	206/215 (96%)	0.00033 - 0.062	0.00632 - 18.1	EAGL	0.379
Antimony, dissolved	mg/L	32/176 (18%)	0.000027 - 0.0004	0.000302 - 0.00114	CCAK	0.00280
Antimony, total	mg/L	23/213 (11%)	0.000027 - 0.0004	0.000282 - 0.00241	CCAC	0.00454
Arsenic, dissolved	mg/L	34/176 (19%)	0.000044 - 0.0025	0.001 - 0.00443	SNOW	0.0224
Arsenic, total	mg/L	96/214 (45%)	0.000044 - 0.0025	0.0012 - 0.0321	EAGL	0.0368
Barium, dissolved	mg/L	177/177 (100%)	0.000082 - 0.00094	0.0387 - 0.216	EAGL	0.0770

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Barium, total	mg/L	215/215 (100%)	0.000082 - 0.00094	0.0398 - 0.488	EAGL	0.0846
Beryllium, dissolved	mg/L	1/177 (1%)	0.000045 - 0.00013	0.000132 - 0.000132	CCBW	0.00117
Beryllium, total	mg/L	6/215 (3%)	0.000045 - 0.00013	0.00013 - 0.000681	EAGL	0.00189
Bismuth	mg/L	0/105 (0%)	0.0001 - 0.005	N/A	N/A	N/A
Boron, dissolved	mg/L	29/176 (16%)	0.00031 - 0.015	0.00331 - 0.0214	CCBC	0.134
Boron, total	mg/L	65/215 (30%)	0.00031 - 0.015	0.00325 - 0.0883	SNOW	0.217
Cadmium, dissolved	mg/L	1/177 (1%)	0.00005 - 0.00015	0.000266 - 0.000266	CCBC	0.00135
Cadmium, total	mg/L	13/215 (6%)	0.00005 - 0.00015	0.000137 - 0.000419	EAGL	0.0000832
Chromium, dissolved	mg/L	32/175 (18%)	0.000048 - 0.00062	0.000579 - 0.00232	CCAK	0.00564
Chromium, total	mg/L	73/213 (34%)	0.000048 - 0.00062	0.0005 - 0.0257	EAGL	0.00936
Cobalt, dissolved	mg/L	24/177 (14%)	0.00005 - 0.0012	0.00045 - 0.0103	EAGL	0.00764
Cobalt, total	mg/L	7/215 (3%)	0.00005 - 0.0012	0.00015 - 0.0117	EAGL	0.0175
Copper, dissolved	mg/L	162/173 (94%)	0.000034 - 0.0005	0.000144 - 0.00232	CCAK	0.00310
Copper, total	mg/L	201/212 (95%)	0.000034 - 0.0005	0.00016 - 0.025	SNOW	0.00400
Iron, dissolved	mg/L	157/176 (89%)	0.0027 - 0.078	0.00906 - 3.16	CCBW	0.912
Iron, total	mg/L	213/215 (99%)	0.0027 - 0.078	0.0491 - 27.1	EAGL	1.00
Lead, dissolved	mg/L	36/177 (20%)	0.00003 - 0.0001	0.000062 - 0.000611	CCAK	0.000573
Lead, total	mg/L	118/214 (55%)	0.00003 - 0.0001	0.0000623 - 0.0118	EAGL	0.000836
Lithium, dissolved	mg/L	31/176 (18%)	0.00072 - 0.02	0.0031 - 0.00566	SNOW	0.0280
Lithium, total	mg/L	43/192 (22%)	0.00072 - 0.02	0.00312 - 0.0196	EAGL	0.0502
Manganese, dissolved	mg/L	177/177 (100%)	0.000017 - 0.0005	0.000362 - 1.17	CCBW	0.0789
Manganese, total	mg/L	215/215 (100%)	0.000017 - 0.0005	0.00261 - 1.46	CCBW	0.102
Mercury, dissolved	mg/L	20/21 (95%)	0.0000005 - 0.0000005	0.00000107 - 0.0000243	CCAK	0.00000320
Mercury, total	mg/L	217/222 (98%)	0.0000001 - 0.000005	0.000000518 - 0.00026	CCBW	0.00000831
Molybdenum, dissolved	mg/L	4/177 (2%)	0.00013 - 0.0031	0.000674 - 0.00423	CCBO	0.0276
Molybdenum, total	mg/L	5/215 (2%)	0.00013 - 0.0031	0.00062 - 0.0062	EAGL	0.0447
Nickel, dissolved	mg/L	171/176 (97%)	0.00005 - 0.00062	0.000651 - 0.00269	EAGL	0.00403
Nickel, total	mg/L	212/214 (99%)	0.00005 - 0.00062	0.000659 - 0.0262	EAGL	0.00979
Selenium, dissolved	mg/L	1/177 (1%)	0.0001 - 0.0015	0.0002 - 0.00188	CCBW	0.0134
Selenium, total	mg/L	6/215 (3%)	0.0001 - 0.0015	0.0002 - 0.003	CCBO	0.000781

Parameter	Unit	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Maximum Sample Location	Arithmetic Average Concentration (1)
Silver, dissolved	mg/L	0/177 (0%)	0.000028 - 0.00031	N/A	N/A	N/A
Silver, total	mg/L	3/215 (1%)	0.000028 - 0.00031	0.00062 - 0.00062	CCAC	0.00448
Thallium, dissolved	mg/L	2/177 (1%)	0.000017 - 0.00031	0.000486 - 0.0006	SNOW	0.00278
Thallium, total	mg/L	5/215 (2%)	0.000017 - 0.00031	0.00031 - 0.00062	CCAK	0.00449
Tin, dissolved	mg/L	2/131 (2%)	0.0001 - 0.05	0.00279 - 0.00462	CCAK	0.0347
Titanium, dissolved	mg/L	34/131 (26%)	0.0001 - 0.01	0.0008 - 0.0535	SNOW	0.00748
Vanadium, dissolved	mg/L	1/177 (1%)	0.0002 - 0.0062	0.00653 - 0.00653	CCBO	0.0556
Vanadium, total	mg/L	8/215 (4%)	0.0002 - 0.0062	0.00124 - 0.041	EAGL	0.0899
Zinc, dissolved	mg/L	69/175 (39%)	0.000084 - 0.0025	0.000518 - 0.0205	SNOW	0.0235
Zinc, total	mg/L	107/214 (50%)	0.000084 - 0.0025	0.000374 - 0.0753	EAGL	0.0384
General Water Quality Parameters						
Hardness ($CaC0_3$)	mg/L	215/215 (100%)	–	29.2 - 260	SNOW	122
Total Diss. Solids	mg/L	214/214 (100%)	3.1 - 12	73 - 248	SNOW	144
Total Susp. Solids	mg/L	212/214 (99%)	0.141 - 5	0.2 - 896	EAGL	20.3
Field Parameters						
Conductivity (lab)	umhos/cm	214/214 (100%)	–	89.1 - 465	SNOW	250
Conductivity, field	umhos/cm	217/217 (100%)	–	0.125 - 518	SNOW	140
Dissolved Oxygen, field (2)	mg/L	202/202 (100%)	–	2.14 - 22.8	CCBW	12.8
ORP (orp/eh), field	mV	217/217 (100%)	–	-390 - 525	EAGL	93.9
pH (lab)	pH Units	214/214 (100%)	–	6.7 - 8.1	CCBC	7.53
pH, field (3)	pH Units	215/215 (100%)	–	4.6 - 9.8	CCAC	7.40
Temperature, field (4)	ºC	215/215 (100%)	–	-0.5 – 13.0	CCAC	3.30
Turbidity, field	NTU	172/172 (100%)	–	0.34 - 393	EAGL	8.91

Notes:

ND = non-detect
N/A = not applicable
1 - Calculated using one-half method detection limit for non-detects
2 - Dissolved oxygen readings above 25 mg/L were assumed to be anomalous and were not included in this summary.
3 - pH readings above 14 were assumed to be anomalous and were not included in this summary.
4 – Temperature reading below -2 C was assumed to be anomalous and was not included in this summary.
"–" - not specified

Table A-4 Surface Water and Groundwater Organics Analyses

Location	Sample Date	Parameter	Units	Method Detection Limit	Detected Concentration
Surface Water Sampling Stations					
MW03-01	6/10/2012	Biological Oxygen Demand	mg/L	2.00	ND
MW03-02	6/10/2012	Biological Oxygen Demand	mg/L	2.00	ND
MW03-04	6/10/2012	Biological Oxygen Demand	mg/L	2.00	ND
MW03-14	6/17/2012	Biological Oxygen Demand	mg/L	2.00	10.2
MW03-15	6/17/2012	Biological Oxygen Demand	mg/L	2.00	ND
MW03-16	6/10/2012	Biological Oxygen Demand	mg/L	2.00	2.67
MW03-01	6/10/2012	Chemical Oxygen Demand	mg/L	6.20	10.6 (Trace)
MW03-02	6/10/2012	Chemical Oxygen Demand	mg/L	6.20	ND
MW03-04	6/10/2012	Chemical Oxygen Demand	mg/L	6.20	6.26 (Trace)
MW03-14	6/17/2012	Chemical Oxygen Demand	mg/L	6.20	6.26 (Trace)
MW03-15	6/17/2012	Chemical Oxygen Demand	mg/L	6.20	6.26 (Trace)
MW03-16	6/10/2012	Chemical Oxygen Demand	mg/L	6.20	8.42 (Trace)
MW03-01	6/10/2012	Total Organic Carbon	mg/L	0.150	0.499 (Trace)
MW03-02	6/10/2012	Total Organic Carbon	mg/L	0.150	1.13
MW03-04	6/10/2012	Total Organic Carbon	mg/L	0.150	3.06
MW03-14	6/17/2012	Total Organic Carbon	mg/L	0.150	2.63
MW03-15	6/17/2012	Total Organic Carbon	mg/L	0.150	2.11
MW03-16	6/10/2012	Total Organic Carbon	mg/L	0.150	3.23
Groundwater Monitoring Wells					
ACAW	9/16/2014	Biological Oxygen Demand	mg/L	2.00	ND
AMER	9/16/2014	Biological Oxygen Demand	mg/L	2.00	ND
ANDA	9/16/2014	Biological Oxygen Demand	mg/L	2.00	ND
ANUP	9/16/2014	Biological Oxygen Demand	mg/L	2.00	ND
CCBO	6/17/2012	Biological Oxygen Demand	mg/L	2.00	ND
CCBW	9/16/2014	Biological Oxygen Demand	mg/L	2.00	ND
SNUP	9/16/2014	Biological Oxygen Demand	mg/L	2.00	ND
ACAW	9/12/2014	Chemical Oxygen Demand	mg/L	6.20	ND
AMER	9/12/2014	Chemical Oxygen Demand	mg/L	6.20	13.9 (Trace)
ANDA	9/12/2014	Chemical Oxygen Demand	mg/L	6.20	ND
ANUP	9/12/2014	Chemical Oxygen Demand	mg/L	6.20	ND
CCBO	6/17/2012	Chemical Oxygen Demand	mg/L	6.20	6.26 (Trace)
CCBW	9/12/2014	Chemical Oxygen Demand	mg/L	6.20	ND
SNUP	9/12/2014	Chemical Oxygen Demand	mg/L	6.20	10.9 (Trace)
ACAW	9/12/2014	Total Organic Carbon	mg/L	0.150	1.73
AMER	9/12/2014	Total Organic Carbon	mg/L	0.150	3.02
ANDA	9/12/2014	Total Organic Carbon	mg/L	0.150	4.76
ANUP	9/12/2014	Total Organic Carbon	mg/L	0.150	2.52
CCBO	6/17/2012	Total Organic Carbon	mg/L	0.150	5.81
CCBW	9/12/2014	Total Organic Carbon	mg/L	0.150	4.40
SNUP	9/12/2014	Total Organic Carbon	mg/L	0.150	1.88

Notes:

ND = non-detect

Trace = estimated value, detected above method detection limit and below method reporting limit

Table A-5 - Water Quality in Bedrock Wells within the Pit Area, Average Concentrations

Parameter	Unit	AWQS	MW03-01	MW03-02	MW03-04	MW03-14	MW03-15	MW03-16	MW05-23	MW07-11	MW13-03
Filter Pack Interval, feet below ground surface			49-75	53.7-70	41.5-59.5	525-581	53-80	570-610	474-584	110-620*	35-165*
Filter Pack Interval, meters below ground surface			14.9-22.9	16.4-21.3	12.7-18.1	160-177	16.2-24.4	173.8-186	144.5-178	33.5-188.9*	10.7-50.3*
Number of Sample Events			32	33	33	14	29	21	3	1	3
Field Parameters and Anions/Cations											
DO, Field	mg/L	--	3.1	5.5	3.7	4.2	5.1	3.8	0.1	1.0	--
eH (ORP), Field	mV	--	-1.6	24	-40	-20	-34	-32	-53	-65	--
pH, Field	pH Units	6.5 to 8.5	7.0	8.1	7.2	**8.7**	7.5	7.6	8.2	7.5	8.1
Conductivity, Field	uS/cm	--	170	315	172	635	164	336	785	44	--
Total Alkalinity	mg CaCO3/L	--	131	287	138	448	130	202	474	240	272
Hardness	mg CaCO3/L	--	148	63.7	128	10.2	118	274	26.9	--	66.7
TDS	mg/L	500	169	305	165	**584**	152	331	**566**	219	323
Sulfate	mg/L	250	24.9	4.20	8.42	26.2	8.68	85.3	39.5	8.90	11.6
Fluoride F	mg/L	1	0.126	0.147	0.0736	**2.22**	0.134	0.198	--	<0.031	0.283
Chloride Cl	mg/L	230	0.564	0.657	0.618	5.17	0.797	0.861	5.88	0.834	1.35
Nitrite-Nitrate (as N)	mg N/L	10	0.0331	0.0545	0.0708	0.0271	0.0253	0.0205	<0.031	<0.031	<0.031
Ammonia	mg N/L	2.99	0.0790	1.05	0.156	0.735	0.321	0.341	0.208	0.776	0.850
Cyanide (WAD)	mg/L	0.0052	0.00102	0.00108	0.000934	0.000946	<0.0025	0.00104	<0.0025	<0.0015	<0.0015
Carbonate (CO_3)	mg/L	--	<12.4	2.39	<12.4	23.2	<12.4	<12.4	44.7	--	<3.1
Bicarbonate (HCO_3)	mg/L	--	131	286	138	421	130	202	429	--	272
Dissolved Metals											
Aluminum	mg/L	0.75	<0.0062	0.00580	<0.0062	0.102	<0.0062	0.00395	0.310	<0.0062	<0.0062
Antimony	mg/L	0.006	<0.00031	0.000211	<0.00031	0.000237	<0.00031	0.000404	**0.0552**	<0.00031	0.00213
Arsenic	mg/L	0.01	**0.223**	**0.0108**	**0.0186**	**0.207**	**0.0878**	**1.87**	**0.236**	<0.0025	**0.0708**
Barium	mg/L	2	0.0392	1.30	0.841	0.0552	0.144	0.0332	0.224	0.143	1.27
Beryllium	mg/L	0.004	<0.00013	0.0000837	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013
Boron	mg/L	0.75	0.0160	0.119	0.0105	0.185	0.0138	0.0137	0.178	--	0.110
Cadmium	mg/L	0.00023	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00005	<0.00015	<0.00015
Calcium	mg/L	--	32.8	9.57	40.2	2.31	30.2	63.4	6.26	34.7	11.4
Chromium	mg/L	0.1	<0.00062	<0.00062	<0.00062	0.000541	<0.00062	0.000678	0.00585	<0.00031	<0.00062
Cobalt	mg/L	0.05	<0.0012	0.000917	<0.0012	<0.0012	<0.0012	<0.0012	0.00749	<0.0012	<0.0012
Copper	mg/L	0.0077	<0.00031	0.000180	0.000213	0.00473	<0.00031	0.000389	0.00160	<0.00031	<0.00031
Iron	mg/L	1	**1.75**	0.0387	**5.27**	0.0542	**2.02**	0.620	0.0497	<0.078	0.878
Lead	mg/L	0.0024	0.0000512	0.0000439	0.0000464	0.000231	<0.000062	0.0000703	0.00176	0.000383	0.000125
Lithium	mg/L	2.5	0.0158	0.0701	0.00276	0.168	0.00420	0.0285	--	--	0.0709
Magnesium	mg/L	--	15.9	9.38	6.54	1.01	10.2	27.6	2.73	25.7	9.30
Manganese	mg/L	0.05	**0.219**	0.00690	**1.39**	0.0121	**0.388**	**0.0622**	0.0238	0.0327	**0.078**
Molybdenum	mg/L	0.01	<0.0031	<0.0031	<0.0031	0.00181	<0.0031	<0.0031	0.00775	<0.0031	<0.0031
Nickel	mg/L	0.043	0.000602	0.000617	0.000487	0.00176	0.000373	0.00151	0.00449	<0.00062	0.00187
Potassium	mg/L	--	0.874	1.67	0.808	1.42	0.772	1.30	1.56	1.30	1.54
Selenium	mg/L	0.005	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	0.00213	<0.0015	<0.0015
Silicon	mg/L	--	--	--	--	--	--	--	--	4.72	--
Sodium	mg/L	--	4.47	105	8.56	222	10.9	13.7	210	15.2	107
Thallium	mg/L	0.0017	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	0.000593	<0.00031	<0.00031
Vanadium	mg/L	0.1	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	0.00835	<0.0062	<0.0062
Zinc	mg/L	0.1	0.00192	0.00753	0.00223	0.00564	0.00233	0.00467	**0.519**	**0.239**	0.0145

Table A-5 - Water Quality in Bedrock Wells within the Pit Area, Average Concentrations (continued)

Parameter	Unit	AWQS	MW03-01	MW03-02	MW03-04	MW03-14	MW03-15	MW03-16	MW05-23	MW07-11	MW13-03
Filter Pack Interval, feet below ground surface			49-75	53.7-70	41.5-59.5	525-581	53-80	570-610	474-584	110-620*	35-165*
Filter Pack Interval, meters below ground surface			14.9-22.9	16.4-21.3	12.7-18.1	160-177	16.2-24.4	173.8-186	144.5-178	33.5-188.9*	10.7-50.3*
Number of Sample Events			32	33	33	14	29	21	3	1	3
Total Metals											
Aluminum	mg/L	0.75	0.00338	0.532	0.00581	0.691	0.0907	0.0827	**5.05**	<0.0062	0.0319
Antimony	mg/L	0.006	<0.00031	0.000196	0.000183	0.000391	0.000215	0.000928	**0.0300**	<0.00031	0.00221
Arsenic	mg/L	0.01	**0.212**	**0.0117**	**0.0186**	**0.234**	**0.0909**	**1.97**	**0.302**	<0.0025	**0.0716**
Barium	mg/L	2	0.0388	1.37	0.819	0.0618	0.150	0.0401	0.476	0.139	1.29
Beryllium	mg/L	0.004	<0.00013	0.0000907	<0.00013	0.0000917	<0.00013	0.000146	0.000467	<0.00013	<0.00013
Boron	mg/L	0.75	0.0213	0.121	0.0108	0.186	0.0168	0.0195	0.176	--	0.112
Cadmium	mg/L	0.00023	<0.00015	0.0000786	<0.00015	0.0000771	0.0000790	0.000167	<0.00005	<0.00015	<0.00015
Chromium	mg/L	0.1	0.000374	0.00130	0.000385	0.00149	0.000592	0.000509	0.0410	<0.00031	<0.00062
Cobalt	mg/L	0.05	<0.0012	0.000854	<0.0012	<0.0012	<0.0012	0.000663	0.00268	<0.0012	<0.0012
Copper	mg/L	0.0077	0.000168	0.00184	0.000195	0.00613	0.000295	0.000859	**0.00913**	<0.00031	<0.00031
Iron	mg/L	1	**1.75**	0.272	**5.33**	0.122	**2.09**	0.701	**2.12**	<0.078	0.900
Lead	mg/L	0.0024	0.0000608	0.00109	0.0000665	0.000620	0.000240	0.000438	**0.0128**	0.000554	0.000164
Lithium	mg/L	2.5	0.0152	0.0705	0.00304	0.164	0.00538	**0.0283**	**--**	--	0.0733
Manganese	mg/L	0.05	**0.229**	0.0144	**1.38**	0.0122	**0.387**	**0.0801**	**0.0803**	0.0358	**0.0782**
Mercury	mg/L	0.000012	0.000000406	0.00000344	0.000000415	0.00000479	0.000000605	0.00000189	**0.0000406**	<0.0000005	<0.0000005
Molybdenum	mg/L	0.01	<0.0031	0.00170	<0.0031	0.00342	<0.0031	<0.0031	0.00948	<0.0031	<0.0031
Nickel	mg/L	0.043	0.000756	0.00150	0.000592	0.00234	0.000649	0.00253	0.0116	<0.00062	0.000920
Selenium	mg/L	0.005	<0.0015	0.000787	<0.0015	<0.0015	<0.0015	0.000790	0.00168	<0.0015	<0.0015
Thallium	mg/L	0.0017	<0.00031	0.000202	<0.00031	<0.00031	<0.00031	0.000207	<0.00031	<0.00031	<0.00031
Vanadium	mg/L	0.1	<0.0062	<0.0062	<0.0062	0.00400	<0.0062	<0.0062	0.0122	<0.0062	<0.0062
Zinc	mg/L	0.1	0.00142	0.00839	0.00539	0.00618	0.00264	0.00369	**1.40**	**0.264**	0.0170

Notes:
Average concentrations calculated using one-half the method detection limit for non-detects
* – denotes open interval from base of shale packer/surface casing to bottom of drill hole, no artificial filter pack installed
Data is from Q2-2005 through Q3-2013, as available for each well, primary and field duplicates are averaged, non-detects assigned a concentration of one-half the method detection limit
BOLD – concentration is above most stringent applicable AWQS

Table A-6 - Water Quality in Bedrock Wells outside Pit Area, Average Concentrations

Parameter	Unit	AWQS	MW03-07	MW03-08	MW03-09	MW03-10	MW03-12	MW07-01	MW07-02	MW07-03	MW07-04	MW07-05	MW07-06	MW07-07	MW07-09	MW07-10
Filter Pack Interval, feet below ground surface			10.5-20	60-90	36-63	74-91	144.5-160.5	60.5-83.5	134-157	36.1-58.7	130.1-157.6	54.5-78	107.4-130.9	123.1-147.9	131.7-156.1	44.1-67.3
Filter Pack Interval, meters below ground surface			3.2-6.1	18.3-27.4	11-19.2	22.6-27.7	44.1-48.9	18.4-25.5	40.9-47.9	11-17.9	39.7-48	16.6-23.8	32.7-39.9	37.5-45.1	40.2-47.6	13.5-20.5
Number of Sample Events			32	35	33	33	30	25	25	21	25	21	23	24	25	25
Field Parameters and Anions/Cations																
DO, Field	mg/L	--	4.1	9.9	8.7	4.5	3.8	4.2	2.9	7.2	3.8	2.7	2.5	2.5	3.1	5.1
eH (ORP), Field	mV	--	4.5	94	110	-20	-20	36	23	90	51	29	22	13	108	109
pH, Field	pH Units	6.5 to 8.5	7.6	7.5	7.1	7.9	7.2	6.9	7.1	6.9	7.5	7.6	8.2	7.9	7.4	6.7
Conductivity, Field	uS/cm	--	137	94	86	218	323	175	146	132	240	206	217	198	120	66
Total Alkalinity	mg CaCO3/L	--	113	75.5	68.0	198	308	90.4	78.9	126	227	203	210	184	106	56.1
Hardness	mg CaCO3/L	--	77.6	74.0	65.6	60.9	268	144	120	106	184	145	35.9	104	97.8	53.3
TDS	mg/L	500	127	86.3	77.0	219	345	179	153	139	224	207	223	193	109	65.6
Sulfate	mg/L	250	5.26	5.03	1.79	0.706	0.718	60.5	44.6	3.17	4.06	2.10	2.06	0.976	2.85	2.07
Fluoride F	mg/L	1	0.0808	0.120	0.0493	0.153	0.0334	0.124	0.147	0.0393	0.0506	0.130	0.171	0.104	0.0343	0.0348
Chloride Cl	mg/L	230	0.565	0.464	0.557	0.667	0.701	0.720	0.611	0.684	0.709	0.525	0.526	0.603	0.566	0.585
Nitrite-Nitrate (as N)	mg N/L	10	0.0379	0.294	0.607	0.0323	0.0287	0.0253	0.0299	0.0927	0.0352	0.0363	0.0991	0.0296	0.286	0.639
Ammonia	mg N/L	2.99	0.109	0.0234	0.0259	0.382	0.707	0.0201	0.0205	0.0293	0.814	0.335	0.545	0.480	0.0416	0.0243
Cyanide (WAD)	mg/L	0.0052	0.000898	0.00101	0.00102	0.000972	<0.0025	<0.0015	<0.0015	0.000790	<0.0015	<0.0015	0.000825	<0.0015	0.000812	0.000810
Carbonate (CO_3)	mg/L	--	<12.4	<12.4	<12.4	2.4	2.6	<3.1	<3.1	<3.1	<3.1	<3.1	2.3	<3.1	<3.1	<3.1
Bicarbonate (HCO_3)	mg/L	--	113	75.5	68.0	197	308	90.4	78.9	126	227	203	209	184	106	56.1
Dissolved Metals																
Aluminum	mg/L	0.75	<0.0062	<0.0062	0.0127	0.00352	0.00311	<0.0062	<0.0062	0.0258	0.0136	0.00741	0.00535	<0.0062	0.00445	0.0352
Antimony	mg/L	0.006	<0.00031	0.000214	<0.00031	<0.00031	<0.00031	**0.0350**	**0.0309**	<0.00031	0.000287	0.000190	0.000436	0.000237	<0.00031	<0.00031
Arsenic	mg/L	0.01	0.00931	<0.0025	<0.0025	<0.0025	**0.0224**	**0.174**	**0.143**	<0.0025	0.00311	0.00131	0.00215	0.00255	<0.0025	0.00116
Barium	mg/L	2	0.265	0.0945	0.0746	1.50	**6.17**	0.0454	0.0365	0.154	1.68	1.09	0.795	**2.56**	0.214	0.0596
Beryllium	mg/L	0.004	0.0000705	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013	0.0000836	<0.00013	<0.00013	<0.00013	<0.00013	<0.00013
Boron	mg/L	0.75	0.0130	0.00649	0.00590	0.0299	0.0169	0.00620	0.00621	0.00934	0.0485	0.0160	0.0721	0.0134	0.00660	0.00791
Cadmium	mg/L	0.00023	0.0000818	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.0000961	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Calcium	mg/L	--	24.0	21.7	20.1	20.6	81.9	36.2	32.3	27.4	37.0	40.5	7.89	30.7	30.1	15.0
Chromium	mg/L	0.1	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.000536	<0.00062	0.000325	<0.00062	0.000475	<0.00062	<0.00062
Cobalt	mg/L	0.05	0.000801	<0.0012	0.000813	<0.0012	<0.0012	0.000630	<0.0012	<0.0012	0.000949	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Copper	mg/L	0.0077	0.000164	0.000323	<0.00031	0.000254	0.000773	0.000216	<0.00031	0.00147	0.000309	0.000190	0.000221	0.000273	0.000175	0.000644
Iron	mg/L	1	0.148	0.0245	0.0237	0.0272	**1.60**	**4.94**	**5.28**	0.0626	0.0724	0.0698	0.0264	0.0514	0.0260	0.0337
Lead	mg/L	0.0024	0.0000334	0.0000495	0.0000474	0.0000671	0.0000353	0.0000327	<0.000062	0.0000455	0.0000584	0.0000449	0.0000549	0.0000327	<0.000062	<0.000062
Lithium	mg/L	2.5	0.0246	0.00174	<0.0031	0.0310	0.00862	0.00283	0.00275	0.00551	0.0186	0.0179	0.0402	0.0234	<0.0031	<0.0031
Magnesium	mg/L	--	4.13	4.80	3.81	2.24	15.2	13.0	9.59	10.1	21.9	10.6	4.09	6.61	5.64	3.97
Manganese	mg/L	0.05	**0.502**	0.000709	0.00107	0.0368	**0.512**	**0.259**	**0.229**	**0.0705**	0.0277	**0.0671**	0.00811	**0.0636**	0.0279	0.00178
Molybdenum	mg/L	0.01	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	0.00163	<0.0031	0.00164	<0.0031
Nickel	mg/L	0.043	0.000367	0.000355	0.000336	0.000347	0.00110	0.00478	0.00298	0.00318	0.000765	0.000493	<0.00062	0.000487	0.000417	0.000332
Potassium	mg/L	--	0.635	0.658	0.200	0.936	2.18	0.959	0.856	0.449	1.18	0.995	1.06	1.79	0.260	0.141
Selenium	mg/L	0.005	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	0.000804	<0.0015
Sodium	mg/L	--	20.4	2.52	2.17	64.4	17.6	3.05	2.36	10.5	22.5	26.1	82.4	36.1	5.20	3.31
Thallium	mg/L	0.0017	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	<0.00031	0.000165	<0.00031	<0.00031	<0.00031	<0.00031
Vanadium	mg/L	0.1	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062
Zinc	mg/L	0.1	0.00237	0.00259	0.00180	0.00862	0.0388	0.0202	0.0285	0.0172	0.00948	0.00703	0.00547	0.00757	0.00181	0.00166

Table A-6 - Water Quality in Bedrock Wells outside Pit Area, Average Concentrations (continued)

Parameter	Unit	AWQS	MW03-07	MW03-08	MW03-09	MW03-10	MW03-12	MW07-01	MW07-02	MW07-03	MW07-04	MW07-05	MW07-06	MW07-07	MW07-09	MW07-10
Filter Pack Interval, feet below ground surface			10.5-20	60-90	36-63	74-91	144.5-160.5	60.5-83.5	134-157	36.1-58.7	130.1-157.6	54.5-78	107.4-130.9	123.1-147.9	131.7-156.1	44.1-67.3
Filter Pack Interval, meters below ground surface			3.2-6.1	18.3-27.4	11-19.2	22.6-27.7	44.1-48.9	18.4-25.5	40.9-47.9	11-17.9	39.7-48	16.6-23.8	32.7-39.9	37.5-45.1	40.2-47.6	13.5-20.5
Number of Sample Events			32	35	33	33	30	25	25	21	25	21	23	24	25	25
Total Metals																
Aluminum	mg/L	0.75	0.286	0.109	0.208	0.0464	0.0336	0.0126	0.106	0.454	0.454	0.387	0.0368	0.0142	0.198	**0.965**
Antimony	mg/L	0.006	<0.00031	<0.00031	<0.00031	0.000185	<0.00031	**0.0358**	**0.0316**	0.000798	0.000220	0.000181	0.000600	0.000365	<0.00031	<0.00031
Arsenic	mg/L	0.01	**0.0103**	<0.0025	<0.0025	0.00118	**0.0231**	**0.181**	**0.146**	0.00150	0.00358	0.00137	0.00223	0.00250	<0.0025	0.00117
Barium	mg/L	2	0.265	0.0990	0.0767	1.49	**6.35**	0.0458	0.0382	0.179	1.68	1.12	0.800	**2.57**	0.233	0.0775
Beryllium	mg/L	0.004	<0.00013	<0.00013	0.0000687	0.0000952	0.0000775	<0.00013	0.0000718	0.0000904	0.0000738	0.0000692	<0.00013	<0.00013	<0.00013	0.0000678
Boron	mg/L	0.75	0.0177	0.00611	0.00584	0.0357	0.0187	0.00674	0.00756	0.00909	0.0515	0.0170	0.0739	0.0142	0.00673	0.00857
Cadmium	mg/L	0.00023	0.0000811	0.0000756	<0.00015	0.000100	0.0000753	<0.00015	0.0000887	0.0000849	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Chromium	mg/L	0.1	0.000596	0.000648	0.000485	0.000625	0.000510	<0.00062	0.000930	0.00119	0.000880	0.000490	0.000329	<0.00062	0.000508	0.000909
Cobalt	mg/L	0.05	0.000625	0.000622	<0.0012	<0.0012	0.000622	0.000628	0.00118	0.00115	0.000796	<0.0012	<0.0012	<0.0012	<0.0012	0.000808
Copper	mg/L	0.0077	0.000979	0.000374	0.00144	0.000776	0.000946	0.000285	0.000917	0.00631	0.00473	0.00272	0.000254	0.00224	0.000545	0.00209
Iron	mg/L	1	0.671	0.102	0.129	0.0756	**1.40**	**5.01**	**5.48**	**1.40**	0.879	0.739	0.059	0.0416	0.280	**1.16**
Lead	mg/L	0.0024	0.000495	0.000320	0.000446	0.000373	0.0000498	0.0000549	0.000111	0.00116	0.000510	0.000313	0.0000484	0.0000588	0.000172	0.000464
Lithium	mg/L	2.5	0.0250	0.00196	<0.0032	0.0314	0.00868	0.00284	0.00298	0.00489	0.0187	0.0187	0.0406	0.0235	<0.0031	<0.0031
Manganese	mg/L	0.05	**0.470**	0.0156	0.00817	0.0373	**0.509**	**0.250**	**0.231**	**0.234**	0.0382	**0.0827**	0.00880	**0.0641**	0.0441	**0.0514**
Mercury	mg/L	0.000012	0.00000342	0.00000217	0.00000192	0.000000546	0.000000395	**0.0000242**	0.00000387	**0.0000153**	0.00000166	0.00000518	0.000000393	0.000000433	0.00000168	**0.0000139**
Molybdenum	mg/L	0.01	0.00160	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	<0.0031	0.00164	<0.0031	<0.0031	0.00164
Nickel	mg/L	0.043	0.00109	0.000663	0.000508	0.000489	0.00176	0.00490	0.00379	0.00448	0.00196	0.00115	0.000680	0.000540	0.000723	0.00142
Selenium	mg/L	0.005	<0.0015	<0.0015	<0.0015	0.00100	0.000980	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	0.0008	<0.0015
Thallium	mg/L	0.0017	0.000174	0.000168	<0.00031	0.000170	<0.00031	0.000161	<0.00031	<0.00031	<0.00031	<0.00031	0.000162	0.000162	<0.00031	0.000162
Vanadium	mg/L	0.1	<0.0062	<0.0062	<0.0062	<0.0062	0.00322	<0.0062	0.00337	0.00329	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062	<0.0062
Zinc	mg/L	0.1	0.00428	0.00221	0.00195	0.0113	0.0501	0.0216	0.0336	0.0277	0.0469	0.0121	0.00627	0.00792	0.00306	0.00444

Notes:
Average concentrations calculated using one-half the method detection limit for non-detects
Data is from Q2-2005 through Q3-2013, as available for each well, primary and field duplicates are averaged, non-detects assigned a concentration of one-half the method detection limit
BOLD – concentration is above most stringent applicable AWQS

Table A-7 - Water Quality in Alluvial Wells, Average Concentrations

Parameter	Unit	AWQS	MW03-03	MW03-05	MW03-13	MW13-07
Filter Pack Interval, feet below ground surface			10-21	22-37	18-39	8.5-20.5*
Filter Pack Interval, meters below ground surface			3.05-6.4	6.71-11.3	5.49-11. 9	2.6-6.3*
Number of Sampling Events			30	28	30	3
Field Parameters and Anions/Cations						
DO, Field	mg/L	--	3.6	5.1	5.5	--
eH (ORP), Field	mV	--	-59	-36	-45	--
pH, Field	pH Units	6.5 to 8.5	7.0	7.2	6.6	--
Conductivity, Field	uS/cm	--	207	167	213	--
Total Alkalinity	mg $CaCO_3$/L	--	133	130	132	98.4
Hardness	mg $CaCO_3$/L	--	113	131	114	93.9
TDS	mg/L	500	164	160	171	168
Sulfate	mg/L	250	3.89	11.5	6.33	18.7
Fluoride F	mg/L	1	0.102	0.0384	0.0580	<0.031
Chloride Cl	mg/L	230	1.33	0.614	0.664	0.738
Nitrite-Nitrate (as N)	mg N/L	10	0.157	0.0757	0.202	<0.031
Ammonia	mg N/L	2.99	1.04	0.124	0.849	0.494
Cyanide (WAD)	mg/L	0.0052	0.00126	0.000955	0.00128	<0.0015
Carbonate (CO_3)	mg/L	--	<12.4	<12.4	<12.4	<3.1
Bicarbonate (HCO_3)	mg/L	--	133	130	132	98.4
Dissolved Metals						
Aluminum	mg/L	0.75	0.00614	<0.0062	0.208	<0.0062
Antimony	mg/L	0.006	<0.00031	<0.00031	<0.00155	<0.00031
Arsenic	mg/L	0.01	**0.218**	**0.0168**	**0.0466**	**0.126**
Barium	mg/L	2	0.347	0.403	1.21	0.291
Beryllium	mg/L	0.004	<0.00013	<0.00013	0.0000949	<0.00013
Boron	mg/L	0.75	0.0108	0.00735	0.00903	<0.015
Cadmium	mg/L	0.00023	<0.00015	<0.00015	<0.00075	<0.00015
Calcium	mg/L	--	26.0	41.3	37.3	22.1
Chromium	mg/L	0.1	0.000474	<0.00062	0.00144	<0.00062
Cobalt	mg/L	0.05	0.000913	<0.0012	0.00103	<0.0012
Copper	mg/L	0.0077	0.000163	0.000212	0.000333	<0.00031
Iron	mg/L	1	**40.4**	**6.01**	**34.4**	**32.9**
Lead	mg/L	0.0024	<0.000062	<0.000062	0.000514	0.000486
Lithium	mg/L	2.5	0.00211	<0.0031	0.00289	<0.0031
Magnesium	mg/L	--	10.2	6.58	4.90	9.39
Manganese	mg/L	0.05	**1.32**	**1.35**	**1.35**	**1.83**
Molybdenum	mg/L	0.01	<0.0031	<0.0031	<0.0155	<0.0031
Nickel	mg/L	0.043	0.000517	0.000775	0.000710	0.00118
Potassium	mg/L	--	0.907	0.632	0.902	0.753
Selenium	mg/L	0.005	<0.0015	<0.0015	<0.0075	<0.0015
Sodium	mg/L	--	11.0	4.37	6.22	7.62
Thallium	mg/L	0.0017	<0.00031	<0.00031	<0.00155	<0.00031
Vanadium	mg/L	0.1	<0.0062	<0.0062	<0.031	<0.0062
Zinc	mg/L	0.1	0.00257	0.00561	0.0107	0.0180

Table A-7 - Water Quality in Alluvial Wells, Average Concentrations (continued)

Parameter	Unit	AWQS	MW03-03	MW03-05	MW03-13	MW13-07
Filter Pack Interval, feet below ground surface			10-21	22-37	18-39	8.5-20.5*
Filter Pack Interval, meters below ground surface			3.05-6.4	6.71-11.3	5.49-11. 9	2.6-6.3*
Number of Sampling Events			30	28	30	3
Total Metals						
Aluminum	mg/L	0.75	0.212	0.00369	**1.74**	<0.0062
Antimony	mg/L	0.006	<0.00031	0.00123	0.000219	<0.00031
Arsenic	mg/L	0.01	**0.212**	**0.0166**	**0.0567**	**0.124**
Barium	mg/L	2	0.374	0.400	1.40	0.287
Beryllium	mg/L	0.004	0.0000671	<0.00013	0.000288	<0.00013
Boron	mg/L	0.75	0.0163	0.00747	0.0102	<0.015
Cadmium	mg/L	0.00023	0.0000762	0.0000727	0.000101	<0.00015
Chromium	mg/L	0.1	0.000650	0.000831	0.00277	<0.00062
Cobalt	mg/L	0.05	0.000649	<0.0012	0.000722	<0.0012
Copper	mg/L	0.0077	0.000418	0.00182	0.00161	<0.00031
Iron	mg/L	1	**37.5**	**6.13**	**42.2**	**33.0**
Lead	mg/L	0.0024	0.000403	0.0000586	0.00229	0.00247
Lithium	mg/L	2.5	0.00229	<0.0032	0.00343	<0.0031
Manganese	mg/L	0.05	**1.22**	**1.34**	**1.42**	**1.80**
Mercury	mg/L	0.000012	0.00000365	0.000000359	0.00000657	0.00000281
Molybdenum	mg/L	0.01	<0.0031	<0.0031	<0.0155	<0.0031
Nickel	mg/L	0.043	0.000880	0.000789	0.00186	0.00136
Selenium	mg/L	0.005	<0.0015	<0.0015	<0.0075	<0.0015
Thallium	mg/L	0.0017	<0.00031	<0.00031	<0.00155	<0.00031
Vanadium	mg/L	0.1	<0.0062	<0.0062	0.00470	<0.0062
Zinc	mg/L	0.1	0.00510	0.0270	0.0392	0.0349

Notes:

Average concentrations calculated using one-half the method detection limit for non-detects

* – denotes open interval from base of shale packer to bottom of drill hole, no artificial filter pack installed.

Data is from Q2-2005 through Q3-2013, as available for each well, primary and field duplicates are averaged, non-detects assigned a concentration of one-half the method detection limit

BOLD – concentration is above most stringent applicable AWQS

Appendix B
Water Balance, Numerical Hydrogeologic and Pit Lake Physical-Geochemical Models

B. Water Balance, Numerical Hydrogeologic, and Pit Lake Physical-Geochemical Models

B.1 Water Balance Models

Water management strategies for the construction, operations and closure phases were evaluated using both deterministic and stochastic water balance models (WBMs).

The analysis types, inputs, and results are summarized as follows (BGC 2011a).

B.1.1 Analysis Types

Deterministic Model Analysis

Deterministic water balance analysis for the construction and operations period of the project was based on a synthetic precipitation dataset generated for the period 1940-2010 (BGC 2011b). Three sequential 30-year strings were selected from this dataset to represent long-term average, dry, and wet conditions, as follows:

- below-average (dry) precipitation (1957-1986) 18.6 inches (472 mm)
- average precipitation (1941-1970) 19.8 inches (503 mm)
- greater than average (wet) precipitation (1981-2010) 20.8 inches (529 mm)

These three scenarios represent a deterministic analysis of site runoff and provide the best representation of possible precipitation trends expected at site during the construction and operations phases of the project (BGC 2011a). Each of the scenarios represents a consecutive 30-year period from the precipitation record. For example, the below average precipitation scenario spans the period 1957 to 1986. Maximum and minimum annual precipitation during this period is 29.6 inches (752 mm) and 13.0 inches (330 mm), respectively, but the 30-year average annual precipitation is 18.6 inches (472 mm).

The WBM analysis for the closure period spans a much longer period (200 years). The 1940-2010 dataset is looped to provide a longer, continuous record over this period.

The deterministic model described above accounts for two phases of periodicity. The precipitation data exhibit an annual cycle with wet summers (June through October) and drier winters (November through May). The data also exhibit a longer climatic cycle associated with changes in sea surface temperature (Pacific Decadal Oscillation), which has a wave length of 50 to 60 years (a period of increasing precipitation that lasts 25 to 30 years and a period of decreasing precipitation of similar length). While the model accounts for both of these cycles, the remainder of the variability is modeled as a random distribution with the mean centered on the deterministic value projected in the cycle at any given point in time. Because the projected mine life is significantly shorter than the wavelength of the longer cycle, it is valuable to model several scenarios of where the mine life falls within the longer cycle.

The weekly, monthly, and annual precipitation amounts predicted over the 65-year time scale of the deterministic model do not represent a prediction of precipitation in real time, and are intended only to represent the expected range of variation of the water balance model elements. Deviations from the projected values in any given week, month or year will likely be observed during the course of the project (BGC 2011a).

Stochastic Model Analysis

A feasibility-level WBM was developed for the construction and operations phases of the project and used to calculate runoff rates based on stochastic (probabilistic) water balance information. Stochastic modeling allows the effects of a greater range of meteorological conditions on critical areas of the project water balance to be considered than is possible using the three deterministic (specified) precipitation scenarios. Stochastic models permit calculation of the probability that a particular outcome will occur and can, therefore, be used to quantify the risk associated with potentially undesirable outcomes, e.g., the effect of a series of dry years early in the project life on available freshwater supply.

The software analytical tool @RISK®, which performs Monte Carlo simulation, was used to perform the stochastic analysis with the spreadsheet-based WBM. The Monte Carlo simulation randomly sampled values from the probability distributions for the uncertain variables and used these values as inputs to the WBM. The stochastic model for the proposed Donlin Gold project was set up using precipitation and temperature as uncertain variables. Temperature was included as a stochastic variable because it defines whether precipitation falls as rain or snow and the rate of snowmelt (BGC 2011a).

It should be noted that hydrologic data are rarely purely stochastic in nature. The data commonly have both a deterministic and random component. The deterministic component comes from regular cyclical behavior in time (e.g. the normal annual cycle or the longer decadal cycles affecting storm patterns discussed previously). For a probability distribution derived from any given dataset to be valid, it must be stationary (i.e. have no discernable trend). That means that the deterministic trend must be removed leaving only the random component varying around the deterministic curve. This is typically accomplished by breaking the time scale up into discrete intervals (weeks in the case of Donlin Creek) and assigning a mean that accounts for the deterministic trend along with a stochastically derived standard deviation to account for the stochastic scatter around the mean. The end result is that the long-term cycle of precipitation cannot be modeled with a stochastic analysis, making the deterministic model a valuable tool.

B.1.2 WBM Inputs

Precipitation

Average annual precipitation at Donlin Gold is estimated at 19.6 inches (499 mm) comprised of 13.58 inches (345 mm) rainfall (69%) and 6.06 inches (154 mm) snowfall (31%). However, annual precipitation is variable with a range of 12.9 to 34.3 inches (329 to 871 mm). Snow typically starts to accumulate in mid-October, while snowmelt occurs on average between early April and early May. Further details of the site hydrology are provided in BGC (2011b).

Groundwater Flows

Annual groundwater flows to the pit dewatering wells and horizontal drains are derived from the groundwater model. The flows for the base-case bedrock hydraulic conductivity, high conductivity, and low conductivity scenarios can be selected within the WBM.

Process Parameters

The following process parameters were input to the model:

- Process plant operational for 26.5 years
- Total ore resource of 556,458,900 st [505,811,000 t]
- Average process plant throughput of ore at 59,000* stpd (53,500 tpd)
- An additional 1.85% by weight of solids added to the tailings stream as process reagents (mostly gypsum)
- Tailings slurry at 35.9% solids by weight with a solids specific gravity of 2.76
- An average tailings settled dry density that varies from 0.690 st/yd^3 (0.820 t/m^3) at initial deposition to 1.051 st/yd^3 (1.249 t/m^3) at the end of mine life.

*Note: Calculated production average over life of mine, but the WBM accounts for a throughput that varies annually.

The WBM for operations assumes that when the tailings slurry is initially deposited in the TSF the settled dry density is 0.690 st/yd^3 (0.820 t/m^3), increasing to 1.032 st/yd^3 (1.225 t/m^3) by the end of operations. The model accounts for the concurrent, slow release of water from the tailings void space as the tailings load increases and pore pressures dissipate (consolidation). Another 52 years is required at closure for full consolidation of the tailings to a final settled density of 1.094 st/yd^3 (1.30 t/m^3). Loss of water to tailings voids is calculated according to the relationship:

(1/settled dry density) – (1/solid SG)] x 100%

Based on a total ore resource of 556.5 Mst (505.8 Mt), and accounting for an additional 10.29 Mst (9.33 Mt) of solids, such as gypsum, that become part of the tailings stream during processing, the average void loss is 4,266 gpm (969 m^3/h) during year 25 of operations (BGC 2016).

Surface Water Runoff

Runoff from undisturbed ground is calculated using the Vandewiele et al. (1992) model, as described in BGC 2011b. This runoff model was incorporated into the water balance model spreadsheets.

Runoff from disturbed ground, such as the plant site and pit sidewalls, is calculated as available water (snowmelt and/or rainfall) minus 20% of potential evaporation. Lake levels and inundated areas of the Lower and Upper contact water dams (CWDs), tailings storage facility (TSF), and reservoir dam are tracked weekly based on volume-area and volume-elevation curves. Direct runoff to these pond surfaces is assumed to equal available water minus shallow lake evaporation, which has an estimated annual total of 13.4 inches (340 mm).

Waste Rock Facility Seepage and Runoff

The size of the catchment area upstream of the Lower CWD is 3,435 acres (1,390 ha) at the start of operations, including 509 acres (206 ha) that reports to the Upper CWD starting in Year 2. The area covered by the waste rock facility (WRF) varies from 321 acres (130 ha) in Year 1 to approximately 2,273 acres (920 ha) at the end of mine life. The remaining area is undisturbed ground. Runoff from the barren waste rock or NAG rock is expected to occur as seepage predominantly. Net percolation into bare waste rock is estimated at 29% of annual precipitation. Some of this infiltration water is absorbed by the waste dump voids, but once the voids “wet-up”, matrix flow reports to the base of the WRF. A portion of the water that infiltrates the waste rock is also assumed to encounter a compacted surface, creating a seepage zone that reports to the Lower CWD as macro flow. Progressive reclamation of the WRF will occur during operations. Surface runoff and seepage from the reclaimed WRF are both estimated at about 16% of average annual precipitation.

TSF Seepage and Underdrain

Analyses were carried out to estimate seepage rates for the TSF under steady-state operational conditions using a finite-element groundwater flow model, Seep/W (Geo-Slope 2007). The Seepage rates are a function of tailings and pond elevations, permeability of the liner, and area of liner perforations. Seepage from the starter dam configuration was calculated to be 1.4 gpm (0.31 m^3/h) and seepage from the ultimate dam configuration was calculated to be 17.6 gpm (4.0 m^3/h). To evaluate the change in estimated seepage rate from the starter to the ultimate TSF configuration, analysis was done using a semi-empirical equation, producing the rates presented in Table B-1 (BGC 2016). Predicted seepage rates are considered to be generally conservative estimates because they do not account for decreasing seepage due to tailings consolidation.

Table B-1: Estimated TSF Seepage Rates

	Estimated Seepage Rate	
Year	(gpm)	(m^3/h)
2	1.8	0.41
5	3.7	0.84
10	6.9	1.6
15	10.7	2.4
20	13.2	3.0
25	16.4	3.7

Surface water and groundwater is expected to enter the underdrain beneath the TSF, at seasonal rates calculated to range from 399 to 1,032 gpm (91 to 234 m^3/h) (BGC 2016). The combined TSF underdrain and seepage report to the Seepage Recovery System (SRS) pond.

B.1.3 WBM Results

Construction Water Balance Model Results

Figure B-1 shows average annual flows for all components of the construction water balance system based on the deterministic model (average precipitation case). These values represent annual average totals only; there is considerable weekly, monthly, and annual variation.

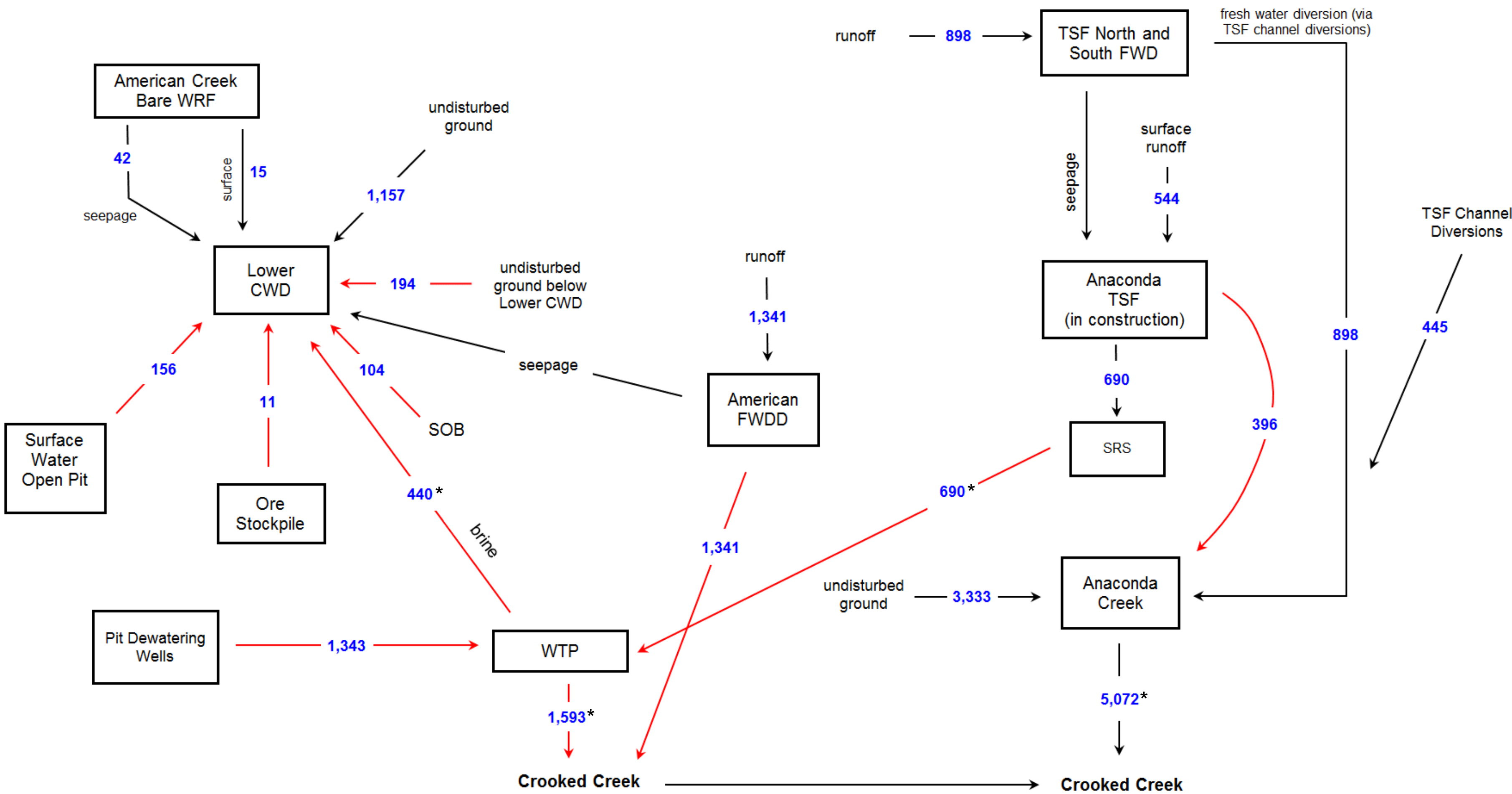
Total runoff to the Lower CWD, upstream freshwater diversion dam (FWDD), and TSF freshwater reservoirs for the final year of the construction period was evaluated with the stochastic model. Results are shown in Table B-2 for the 15-month period immediately prior to process plant start-up (start of Q2 Operations Year -1 to end of Q2 Operations Year 1).

The water captured in the Lower CWD will be the primary source of water to the process plant during the start-up period, when 2,513 acre-ft (3.1 Mm^3) of non-turbid water will be required. This volume is based on meeting process water requirements for the first month until the reclaim water system from the TSF is operating reliably.

Model runs indicate that if several dry years occurred in sequence, there is the potential for insufficient freshwater supply during the first few years of operation. This situation could arise if low-density tailings resulted in significant void losses and minimum TSF reclaim rates. To mitigate this potential deficit, the American FWDD will be allowed to accumulate water up to a maximum of 867 acre-ft (1.07 Mm^3) during the final year of construction. Runoff volumes in excess of this amount will be discharged into Crooked Creek. This diversion water along with the Snow Gulch freshwater reservoir will then be a source of supplementary fresh water in the event of an extended drought period coinciding with the start of operations.

Table B-2: Total Runoff Volumes to Dams during last 15 months of Construction

Duration Percentile	Lower CWD		American FWDD		TSF North and South FWDD	
	(acre-ft)	(Mm^3)	(acre-ft)	(Mm^3)	(acre-ft)	(Mm^3)
5%	1,952	2.41	1,781	2.20	1,392	1.72
10%	2,104	2.60	1,933	2.38	1,486	1.83
20%	2,315	2.85	2,088	2.58	1,643	2.03
30%	2,460	3.03	2,222	2.74	1,753	2.16
40%	2,623	3.23	2,343	2.89	1,829	2.26
50%	2,735	3.37	2,443	3.01	1,906	2.35
60%	2,889	3.56	2,563	3.16	1,988	2.45
70%	3,051	3.76	2,688	3.32	2,086	2.57
80%	3,230	3.98	2,826	3.49	2,208	2.72
90%	3,484	4.30	3,039	3.75	2,369	2.92
95%	3,715	4.58	3,232	3.99	2,533	3.12
99%	4,297	5.30	3,729	4.60	2,902	3.58



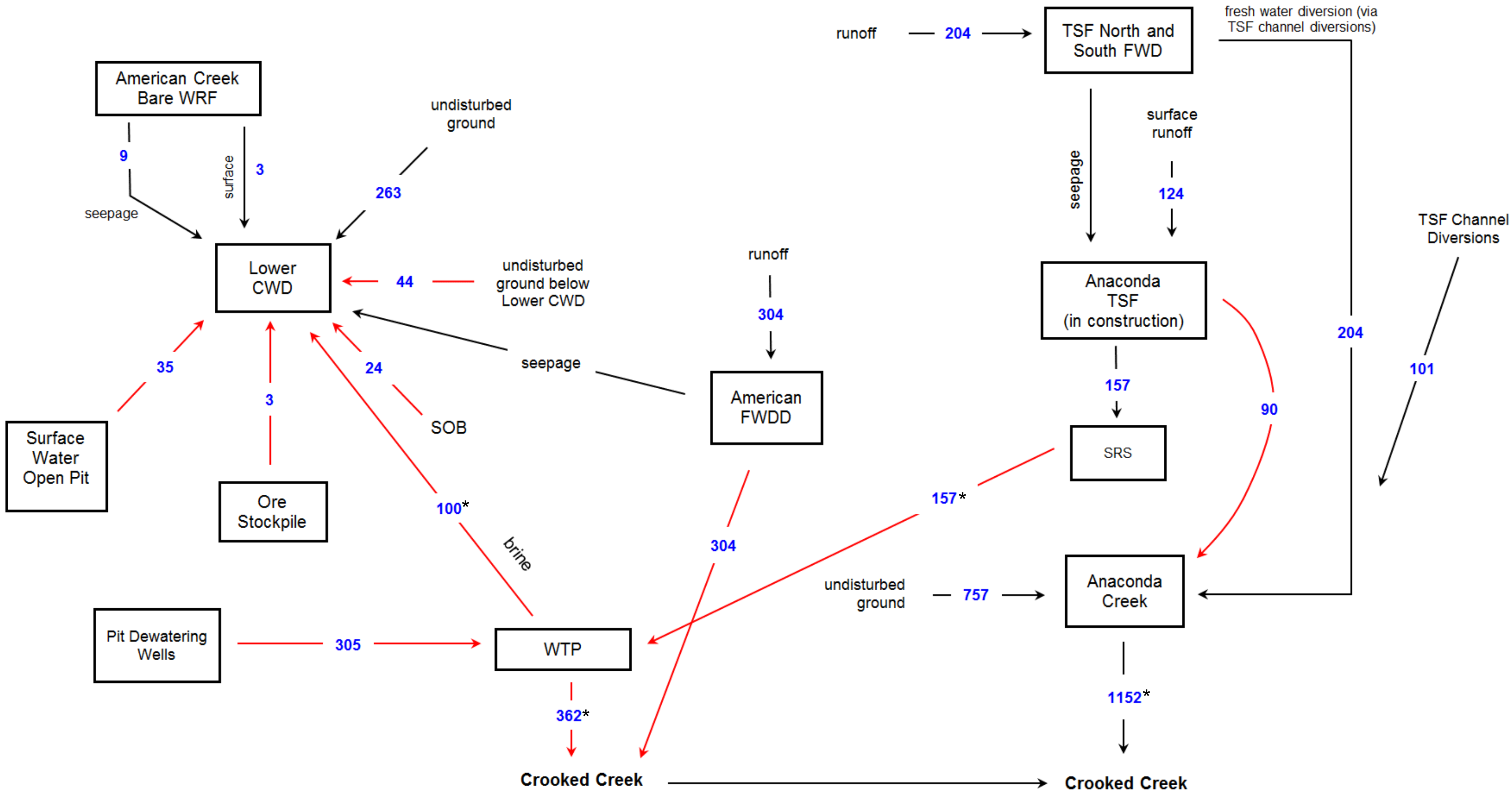
Note: Values shown are averaged over the simulation period and represent average precipitation conditions. Rates are in gpm.
Red arrows denote pumping routes.
All notes do not balance, in particular the contact water dams and fresh water dam depicted. These notes do not balance as the dams either start with or end with a surplus of water.
* - Assuming SRS water is treated. Treatment of SRS water as required based on water quality, refer to Section 3.12

DONLIN GOLD

SCHEMATIC WATER BALANCE
(US STANDARD)
CONSTRUCTION

DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	B-1a



Note: Values shown are averaged over the simulation period and represent average precipitation conditions. Rates are in m^3/h.
Red arrows denote pumping routes.
All notes do not balance, in particular the contact water dams and fresh water dam depicted. These notes do not balance as the dams either start with or end with a surplus of water.
*- Assuming SRS water is treated. Treatment of SRS water as required based on water quality, refer to Section 3.12

DONLIN GOLD

SCHEMATIC WATER BALANCE (METRIC) CONSTRUCTION

DONLIN GOLD PROJECT

SCALE:	FIGURE:
NA	B-1b

Operations Water Balance Model Results

Figure B-2 shows average annual flows for all components of the operations water balance system based on the deterministic model, average precipitation case. These values represent annual average totals, but there is considerable weekly, monthly, and annual variation. For comparison, Figure B-3 shows average annual flows for all components of the operations water balance system based on the deterministic model, above average precipitation case.

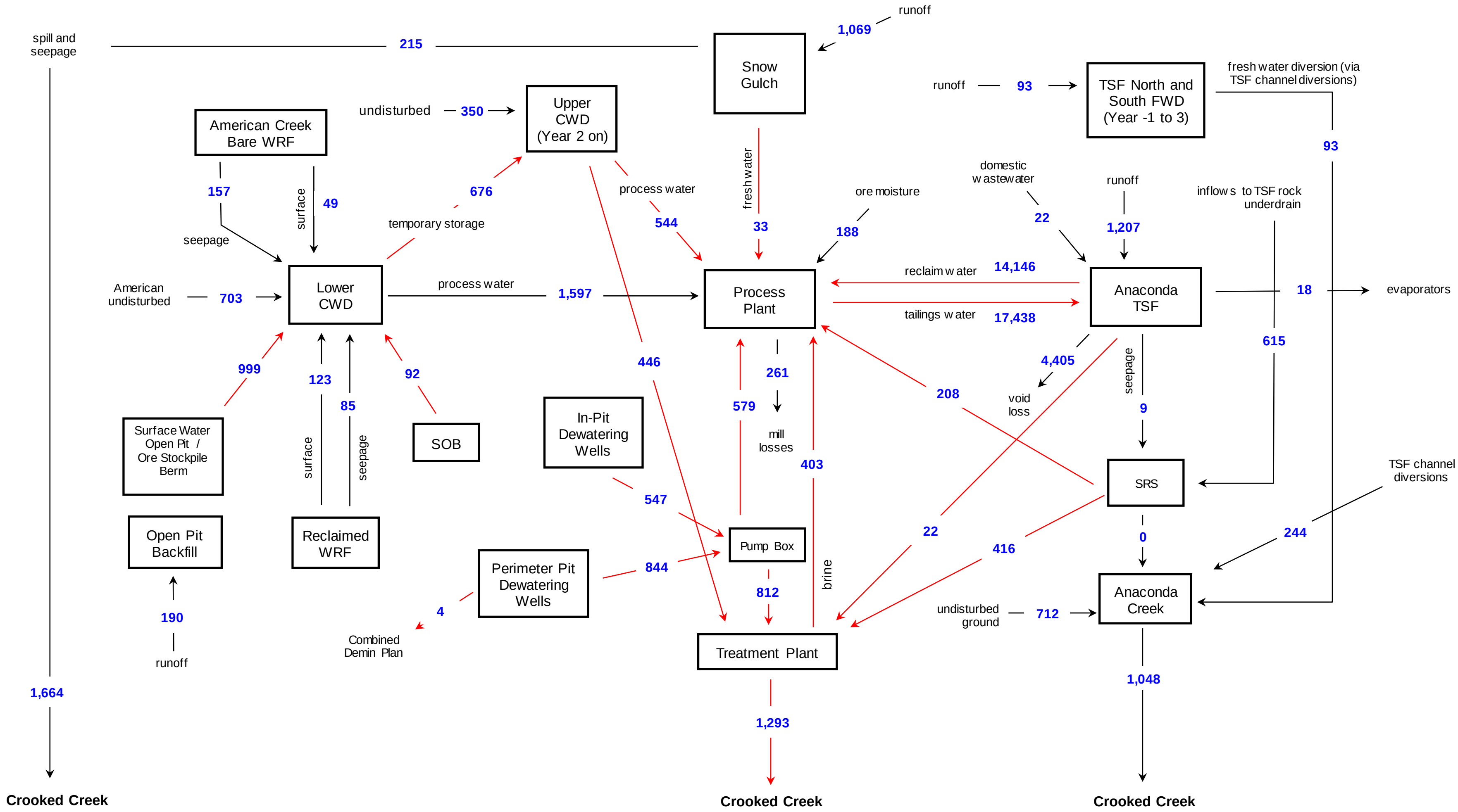
A summary of TSF Impoundment and treated water volume values based on the stochastic analysis is presented in Table B-3 (BGC 2016). More water is accumulated in the TSF and diverted when the wetter sequences of precipitation data are considered. Less water is sent to treatment and discharge in the drier scenario simulations, as this water is used in the plant. It is important to note that the build-up of water in the TSF is more sensitive to the frequency of very wet or very dry years, rather than the long-term average precipitation.

Table B-3: Summary of Stochastic Water Balance Model Results - End of Operations (U.S. Standard)

	Volume (acre-ft) for Selected Percentile Model Results							
Variable	**10%**	**30%**	**50%**	**70%**	**80%**	**90%**	**95%**	**99%**
TSF Impoundment Volume	6,660	7,450	8,140	8,850	9,760	10,600	11,710	13,020
Treated Water	61,460	63,740	65,350	66,590	67,770	68,860	70,290	71,660

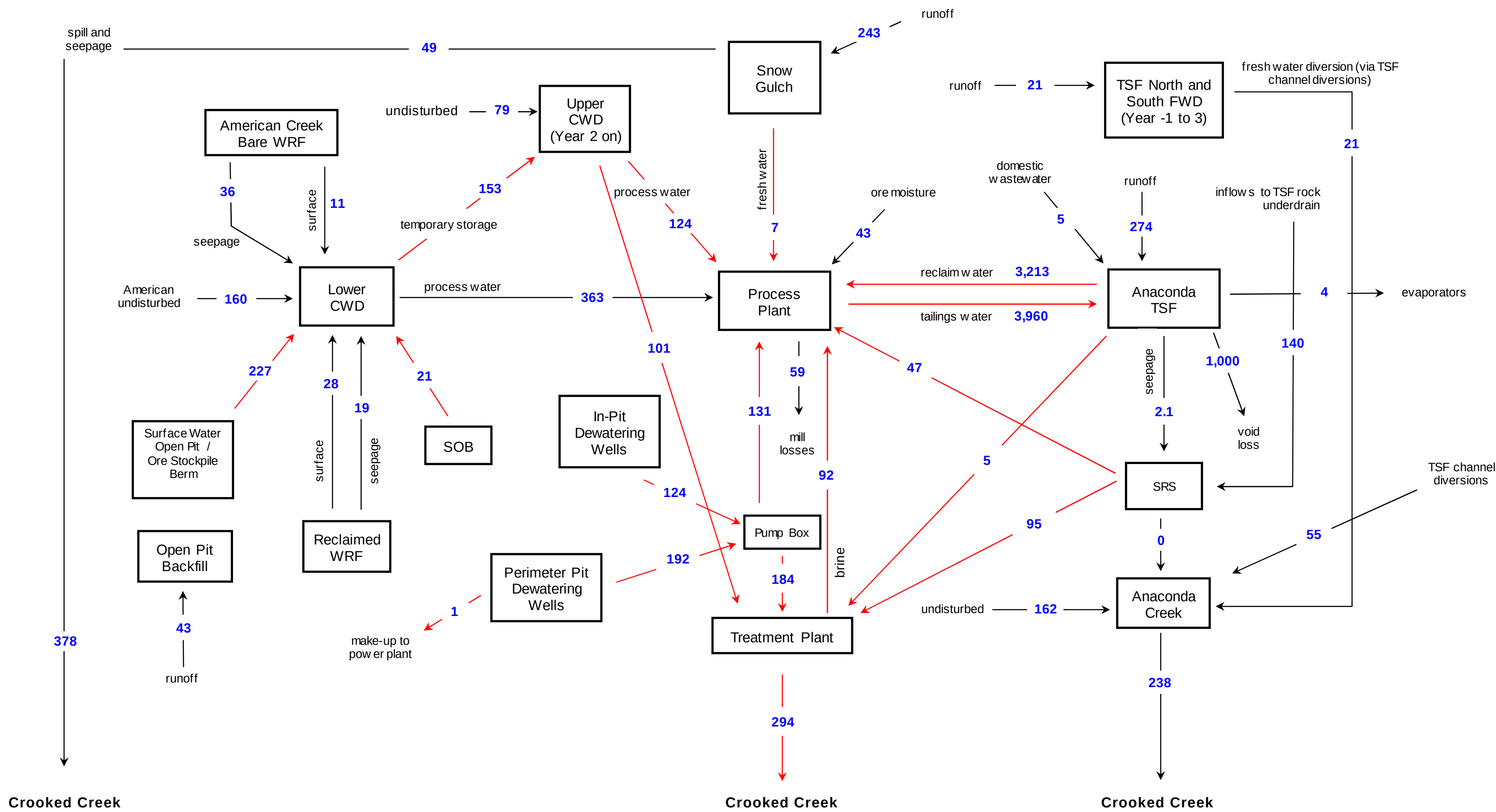
Table B-3: Summary of Stochastic Water Balance Model Results - End of Operations (Metric)

	Volume (Mm^3) for Selected Percentile Model Results							
Variable	**10%**	**30%**	**50%**	**70%**	**80%**	**90%**	**95%**	**99%**
TSF Impoundment Volume	8.22	9.19	10.04	10.92	12.03	13.08	14.44	16.06
Treated Pit Dewatering Groundwater	75.81	78.62	80.61	82.13	83.60	84.94	86.70	88.39



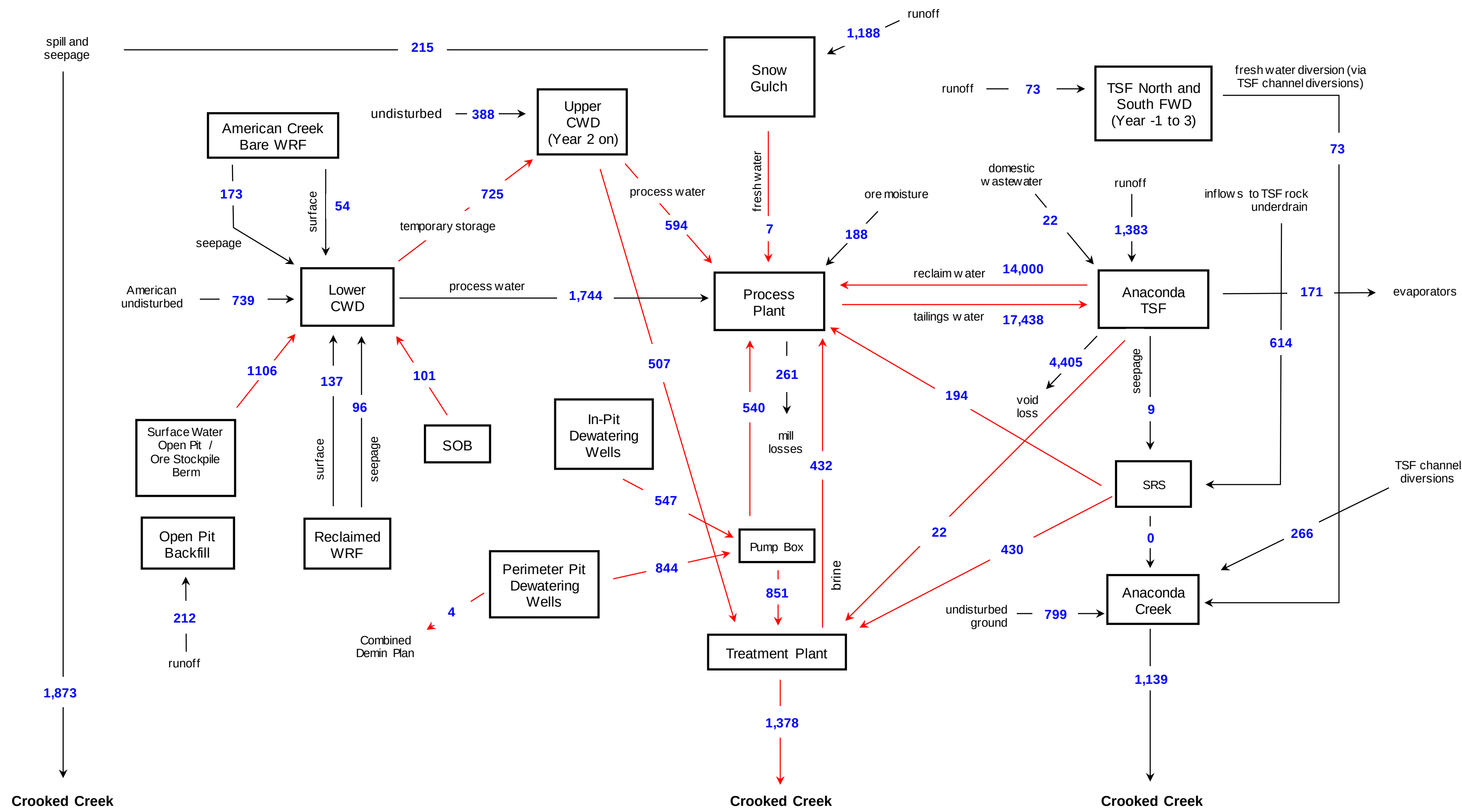
Note:
Red arrows denote pumping routes. Depicted values are in gpm.
All nodes do not balance, in particular the contact water dams and fresh water dams depicted. These nodes do not balance as the dams either start or end with a surplus of water.

(Year 2 to Year 27)	SCALE: N/A	DONLIN GOLD	SCHEMATIC WATER BALANCE (US STANDARD) OPERATIONS DONLIN GOLD PROJECT	FIGURE: **B-2a**



Note:
Red arrows denote pumping routes. Depicted values are in m³/h.
All nodes do not balance, in particular the contact water dams and fresh water dams depicted. These nodes do not balance as the dams either start or end with a surplus of water.

(Year 2 to Year 27)	SCALE: N/A	DONLIN GOLD	SCHEMATIC WATER BALANCE (METRIC) OPERATIONS DONLIN GOLD PROJECT	FIGURE: **B-2b**



Note: Red arrows denote pumping routes. Values shown are in gpm.
Note that all nodes do not balance, in particular the contact water dams and fresh water dam. These nodes do not balance as the dams either start with or end with a surplus of water.

SCALE:

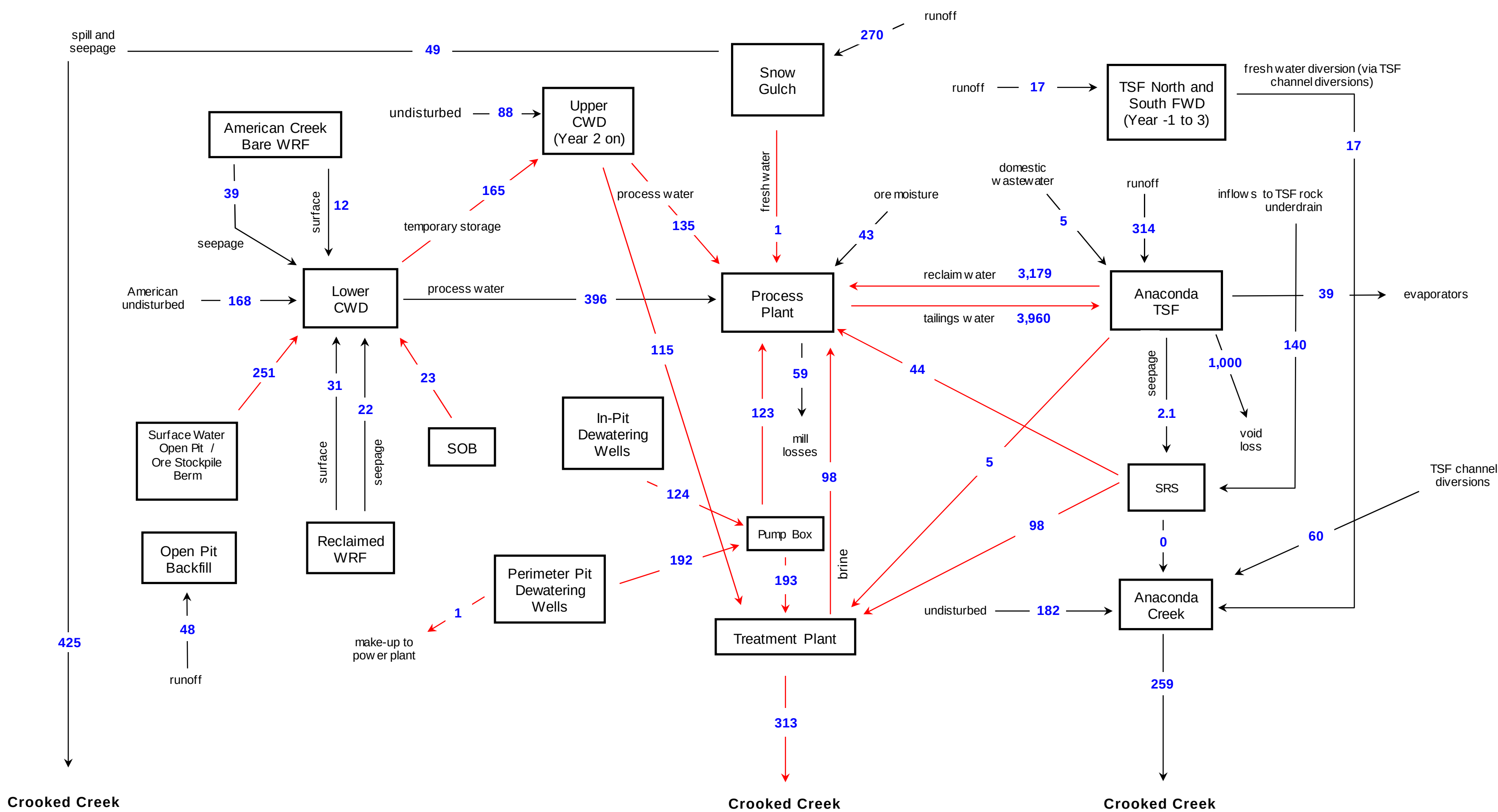
DONLIN GOLD

SCHEMATIC WATER BALANCE OPERATIONS (LOM YEARS 2 to 27) ABOVE AVERAGE PRECIPITATION (U.S. STANDARD)

DONLIN GOLD PROJECT

FIGURE:

B-3a



Note: Red arrows denote pumping routes. Values shown are in m^3/h.

Note that all nodes do not balance, in particular the contact water dams and fresh water dam. These nodes no not balance as the dams either start with or end with a surplus of water.

SCALE:	DONLIN GOLD	SCHEMATIC WATER BALANCE OPERATIONS (LOM YEARS 2 to 27) ABOVE AVERAGE PRECIPITATION (METRIC) DONLIN GOLD PROJECT	FIGURE: B-3b

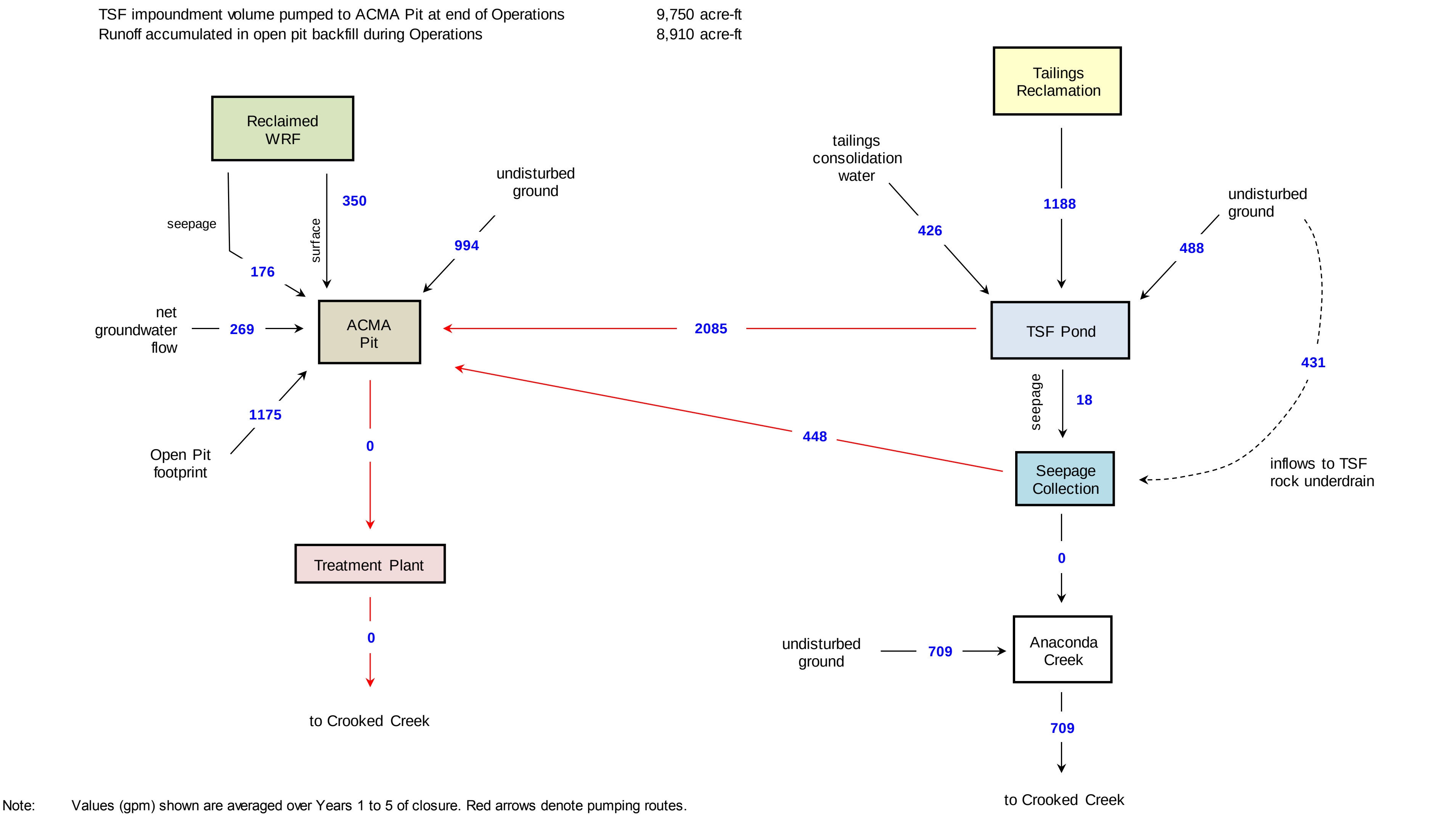
Closure Water Balance Model Results

Figures B-4 through B-7 show average annual flows for all components of the closure water balance based on the average precipitation dataset, as well as information derived from the operations WBM and numerical hydrogeological model. It should be stressed that these values represent annual average totals, but there are considerable year-to-year variations in the values shown (BGC 2016).

Key aspects of closure conditions include:

- Under average conditions, 9,750 acre-ft (12.0 Mm^3) of TSF water will accumulate in the TSF pond by the end of operations, which will be pumped to the pit at closure. Also 8,910 acre-ft (10.99 Mm^3) of runoff will accumulate in the base of ACMA pit by the end of operations.
- During reclamation (Years 1 to 5), surface runoff to the TSF and water from tailings consolidation needs to be pumped to the ACMA pit. This volume is approximately 16,816 acre-ft (20.7 Mm^3) over the 5-year period.
- Tailings consolidation starts in Year 1 of operations and full consolidation is not reached until the end of Year 52 of closure. During the closure period, 13,023 acre-ft (16.1 Mm^3) of void water will be released to the capillary break (NAG rockfill layer) below the cover and above the tailings surface and pumped to the pit. Because of the potential for a depression generating in the middle of the TSF as the tails consolidate, rock fill may need to be placed in the center of the pond to achieve the desired surface drainage gradient to the southeast corner of the TSF for reclamation.
- After the cover is placed, the consolidation water will mix with water that infiltrates through the cover (Years 6 to 52). This mixed water is assumed to be unacceptable for discharge and must be pumped to ACMA pit. The total infiltration water over the approximately 46-year period is 26,860 acre-ft (33.0 Mm^3).The total volume of water pumped from the rockfill layer to the pit over the same period, consisting of combined consolidation water and cover infiltration, is 36,448 acre-ft (44.9 Mm^3).
- Once the TSF consolidation is complete and cover infiltration water is suitable for discharge to the environment without treatment, the average discharge to Crevice Creek from the TSF is estimated at 1,157 gpm (263 m^3/h) from Year 52 of closure on.
- The pit lake will reach its managed elevation of 328 ft (100 m) amsl approximately 51 years after closure. The average annual flow of treated pit lake water to Crooked Creek from Year 52 on would be 2,916 gpm (662 m^3/h).

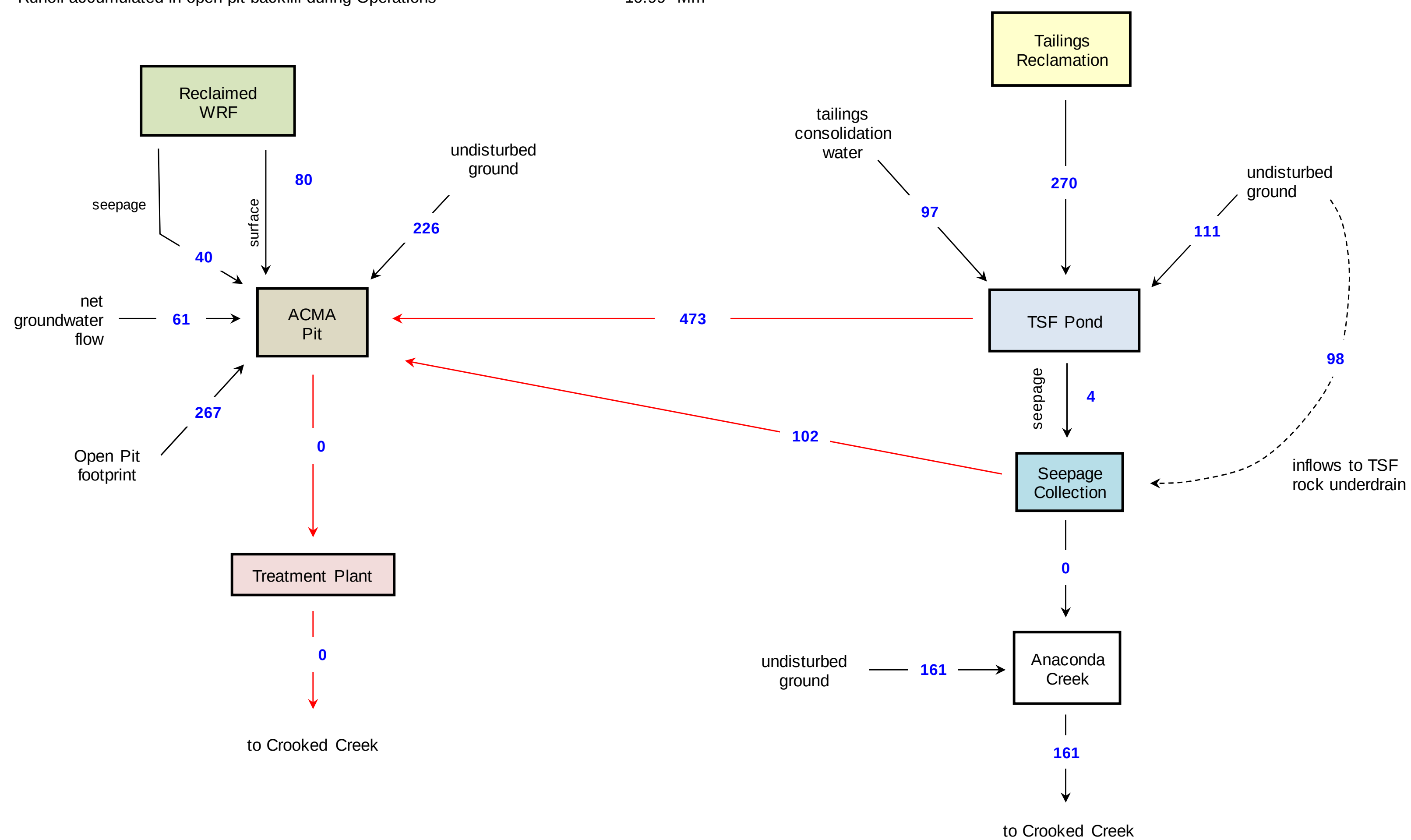
The SRS will be maintained after closure and the captured water will be pumped to the pit lake. Average flow to the SRS pond at closure is estimated at 448 gpm (102 m^3/h). It is currently assumed that after Year 51 SRS water will be consistent with natural conditions and suitable for discharge. Monitoring to demonstrate seepage water quality would continue for both the SRS pond and collection wells until analytical results indicate acceptable chemistry for discharge. If the seepage water is not suitable for discharge, it would continue to be pumped to the pit lake.



Note: Values (gpm) shown are averaged over Years 1 to 5 of closure. Red arrows denote pumping routes.

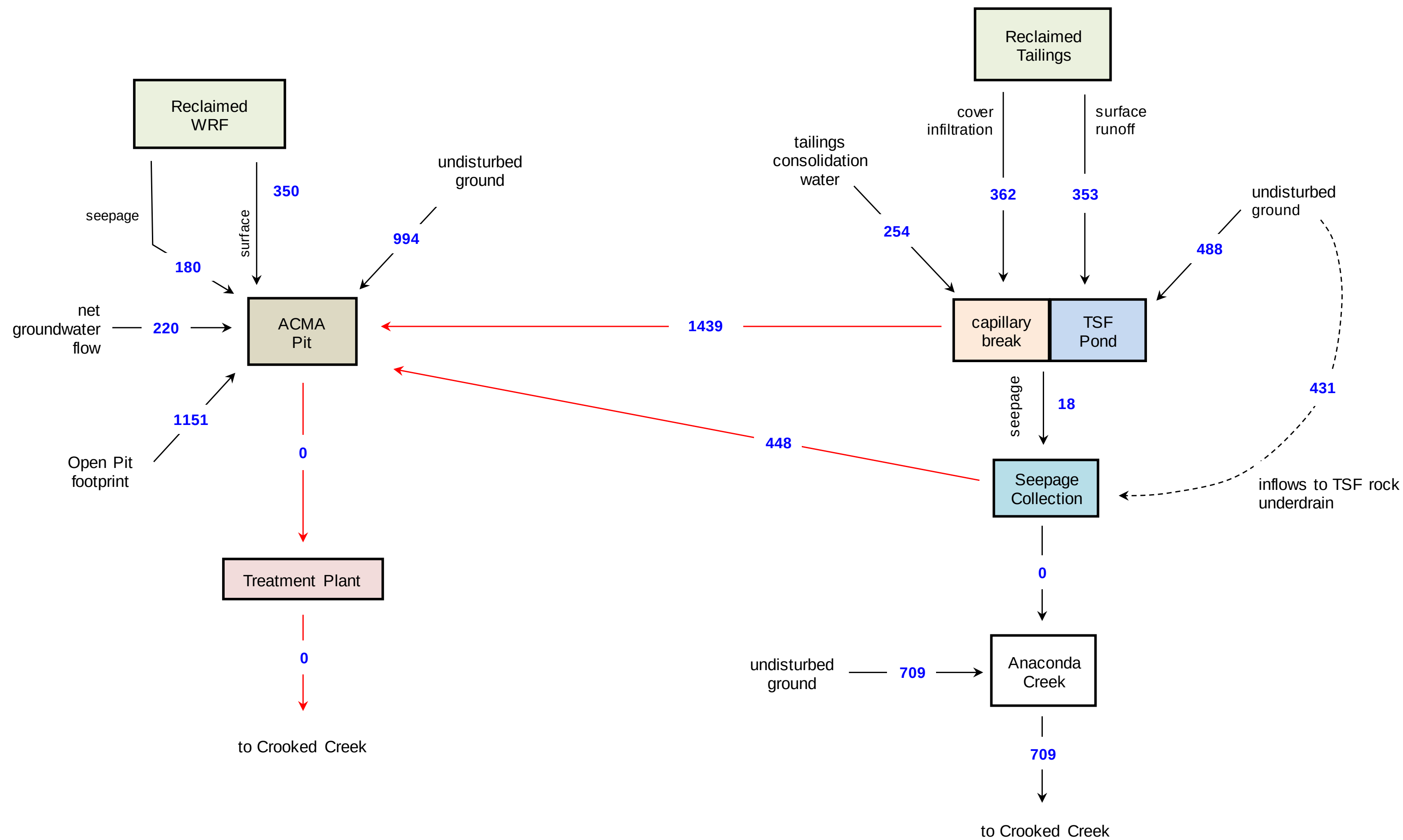
SCALE:		ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 1 to 5 (U.S. STANDARD)	FIGURE:
N/A	DONLIN GOLD	DONLIN GOLD PROJECT	B-4a

TSF impoundment volume pumped to ACMA Pit at end of Operations 12.03 Mm^3
Runoff accumulated in open pit backfill during Operations 10.99 Mm^3



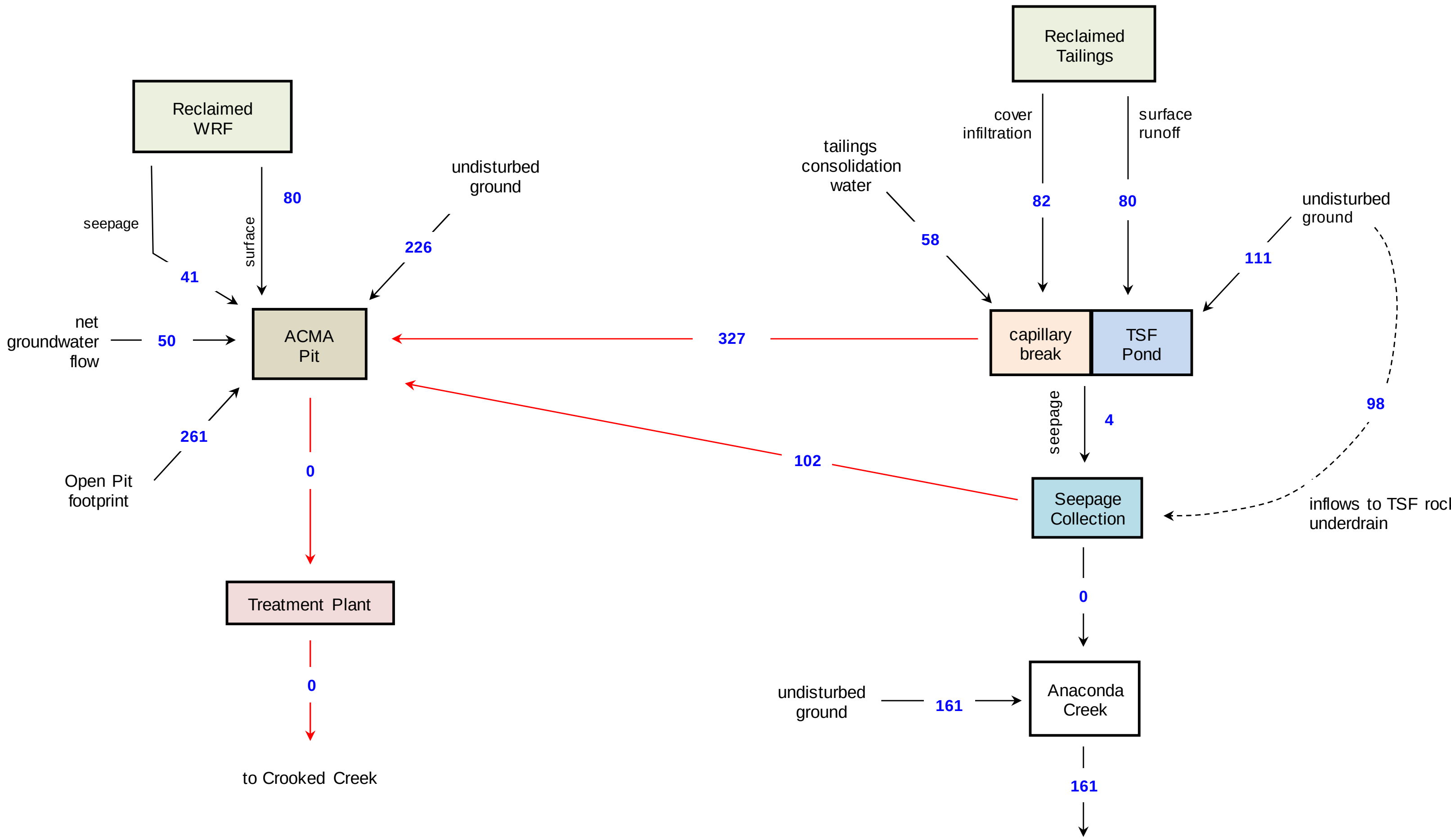
Note: Values (m^3/h) shown are averaged over Years 1 to 5 of closure. Red arrows denote pumping routes.

SCALE:		ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 1 to 5 (METRIC)	FIGURE:
N/A	DONLIN GOLD	DONLIN GOLD PROJECT	B-4b



Note: Values (gpm) shown are averaged over Years 6 to 10 of closure (the TSF pond monitoring period). Red arrows denote pumping routes.

SCALE:			FIGURE:
N/A	DONLIN GOLD	**ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 6 to 10 (U.S. STANDARD)** DONLIN GOLD PROJECT	**B-5a**



Note: Values (m^3/h) shown are averaged over Years 6 to 10 of closure (the TSF pond monitoring period). Red arrows denote pumping routes.

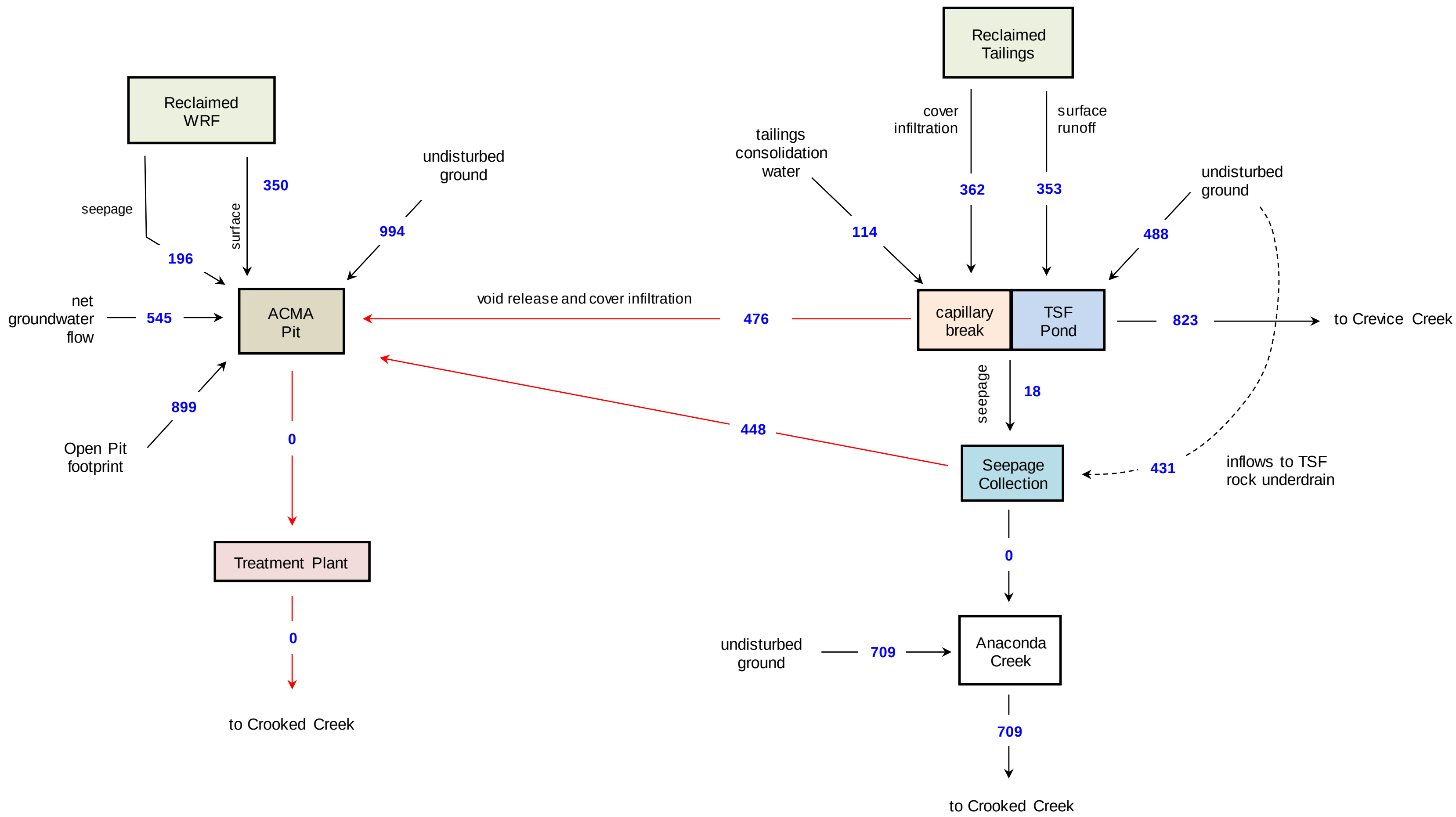
SCALE: N/A

DONLIN GOLD

ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 6 to 10 (METRIC)

DONLIN GOLD PROJECT

FIGURE: **B-5b**



Note: Values (gpm) shown are averaged over Years 11 to 51 of closure (tailings consolidation water and TSF seepage water continue to be collected and pumped to ACMA Pit). Red arrows denote pumping routes.

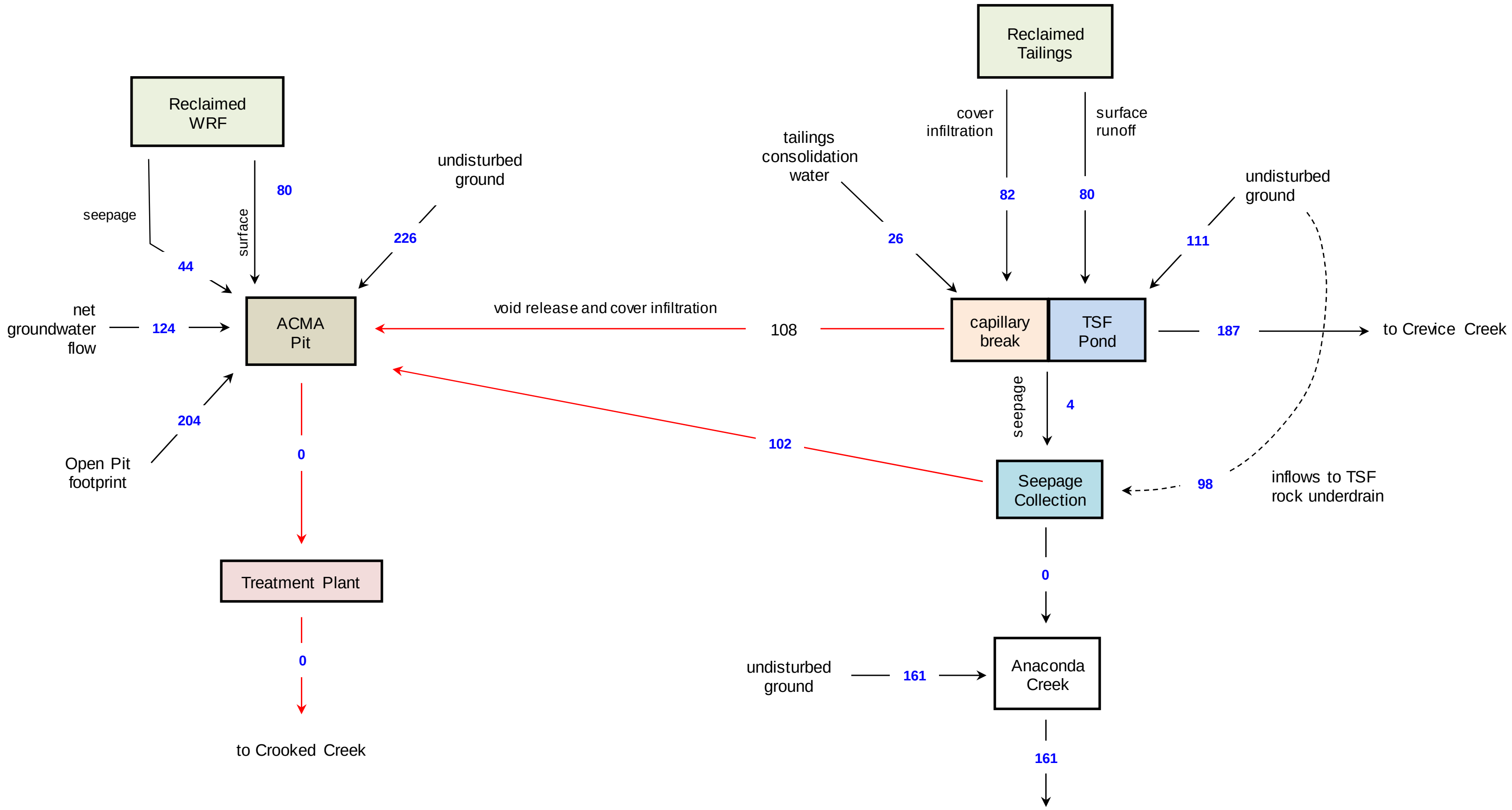
SCALE: N/A

DONLIN GOLD

ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 11 to 51 (U.S. STANDARD)

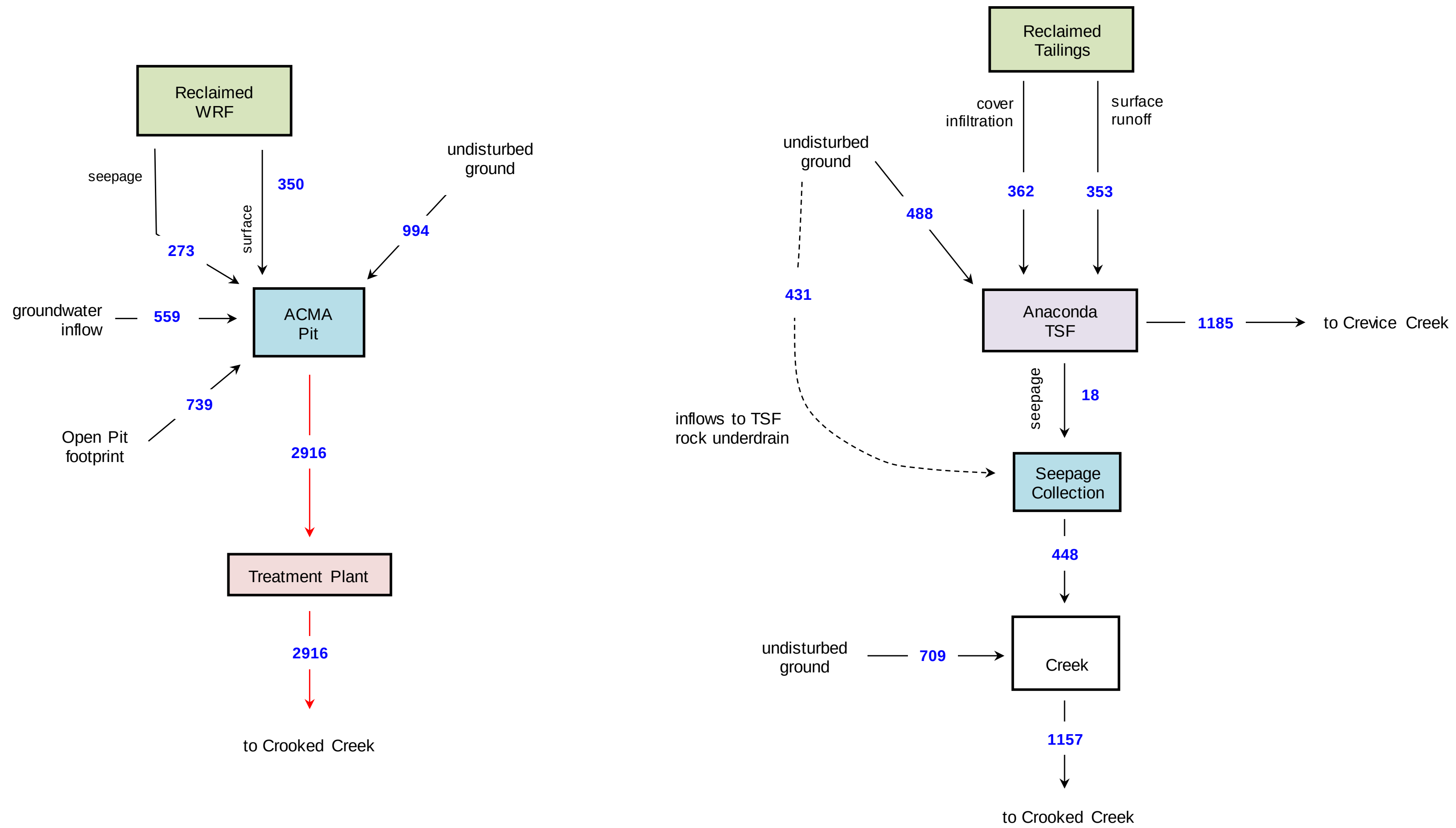
DONLIN GOLD PROJECT

FIGURE: **B-6a**



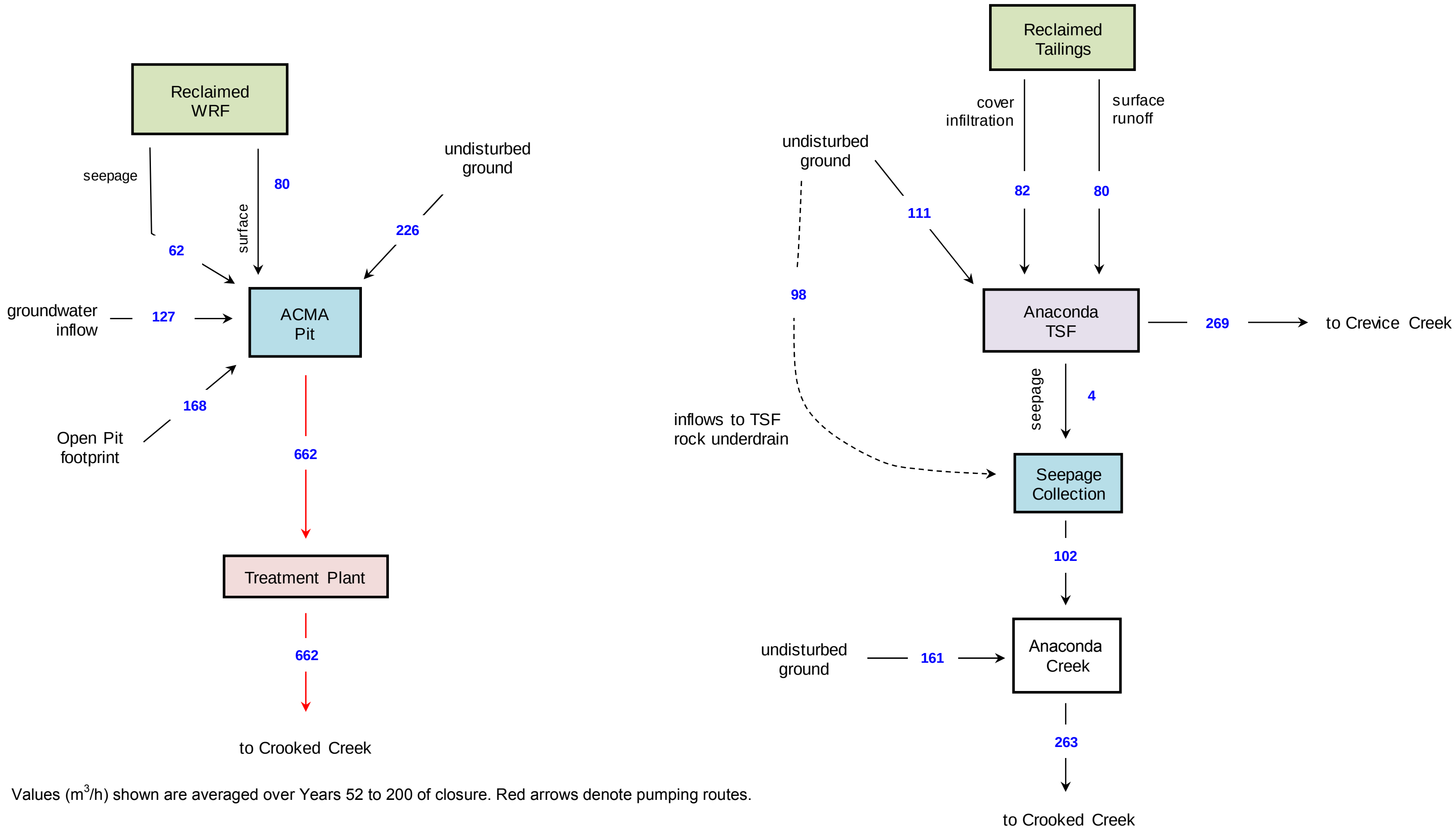
Note: Values (m^3/h) shown are averaged over Years 11 to 51 of closure (tailings consolidation water and TSF seepage water continue to be collected and pumped to ACMA Pit). Red arrows denote pumping routes.

	SCALE:			FIGURE:
	N/A	DONLIN GOLD	**ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 11 to 51 (METRIC)** DONLIN GOLD PROJECT	**B-6b**



Note: Values (gpm) shown are averaged over Years 52 to 200 of closure. Red arrows denote pumping routes.

SCALE:			FIGURE:
N/A	DONLIN GOLD	**ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM CLOSURE YEAR 52 ON (U.S. STANDARD)** DONLIN GOLD PROJECT	**B-7a**



Note: Values (m^3/h) shown are averaged over Years 52 to 200 of closure. Red arrows denote pumping routes.

SCALE:			FIGURE:
N/A	DONLIN GOLD	**ANNUAL AVERAGE FLOW FOR DETERMINISTIC CLOSURE WBM YEAR 52 ON (METRIC)** DONLIN GOLD PROJECT	**B-7b**

Modeling of the pit lake geochemistry indicates that treatment is required before ACMA pit lake water can be discharged to Crooked Creek (Lorax 2015). The treatment plant will begin to operate when pit lake levels are approximately 31 ft (9.5 m) below the spillway invert. This water level provides sufficient freeboard for upset flood events and also prevents a groundwater gradient developing from the pit lake toward Crooked Creek.

B.2 Numerical Hydrological Model

A numerical groundwater flow model was developed to assist with the design of the open pit dewatering system, to estimate the associated impacts to water resources, and to provide input to the site-wide water balance model (BGC 2014b). Specific model objectives included:

- Simulate baseline groundwater flow directions in the project area.
- Quantify groundwater pumping rates required to depressurize the pit slopes.
- Evaluate impacts to surface water flow in Crooked Creek in the vicinity of mining operations.
- Predict changes to the regional groundwater flow regime due to storage of tailings in Anaconda Valley.
- Estimate the rate of pit lake formation and the groundwater flow regime at the completion of mining operations.

The numerical groundwater flow model was developed using MODFLOW-SURFACT, an industry standard 3D model based on the MODFLOW flow model developed by the U.S. Geological Survey (USGS) (McDonald and Harbaugh 1988; Harbaugh et al., 2000) and augmented by HydroGeoLogic, Inc. The model covers an area of approximately 58 sq miles (149 km^2).

The Groundwater Model and the WBM are somewhat interrelated. The WBM provides inputs to and outputs from the Groundwater Model from sources including runoff (to the streams), groundwater recharge from rainfall and snowmelt, evaporation rates from creeks and the pit lake at closure, and ET rates from the subsurface. In return, the Groundwater Model provides predictive inputs to the WBM, including groundwater pumping rates required to depressurize the pit slopes, groundwater flows to the TSF underdrain, and groundwater inflow rates to the pit lake after closure.

Transient predictive simulations were performed using a calibrated MODFLOW-SURFACT groundwater flow model, together with open pit shells. The goal of the simulations was to evaluate the degree of effort required to depressurize the pits and to estimate the required groundwater pumping rates and pit wall pore water pressures.

B.2.1 Pit Dewatering

Dewatering will begin at least 6 months before the start of pre-stripping and continue through to the end of mine operations (BGC 2014a, 2014b). The total groundwater extraction rate, which comprises flows from vertical perimeter wells, in-pit wells, and horizontal drain flows, is predicted to increase from approximately 1,500 gpm (341 m^3/h) when the system is turned on in Year -2, to approximately 2,400 gpm (545 m^3/h) in Year 12 and averages 1,391 gpm (316 m^3/h) for operations Years 2 through 27. After Year 19, the total average annual dewatering rate is predicted to generally decrease to approximately

1,100 gpm (250 m^3/h) as the perimeter wells surrounding the pits are progressively turned off during pit backfilling activities.

B.2.2 Pit Lake Filling

Groundwater inflows and outflows to the pit lake were calculated using the MODFLOW-SURFACT model for a scenario that assumes the tailings pond water will be pumped from the TSF to the pit lake immediately upon end of operations. These flows were then input into the water balance model as a function of lake stage. The simulated flow components included runoff from the pit walls, surface flows from American Creek, and precipitation and evaporation from the pit lake (BGC 2015).

During the initial years after closure, pit lake water is predicted to flow out of the lake and fill the pore space of the waste rock placed as backfill within the pit. Predicted annual lake net outflow (the difference between the rate of groundwater discharging to the lake and the rate of pit lake water seeping to groundwater) during this period declines from a high of approximately 1,100 gpm (250 m^3/h) in closure Year 3, to zero net groundwater outflow after year 16. Groundwater seepage from the lake stops after the lake reaches its managed level approximately 50 years after cessation of operations. It is important to note that hydraulic containment of the lake water is not lost because the water table is always higher on the perimeter of the pit (BGC 2015).

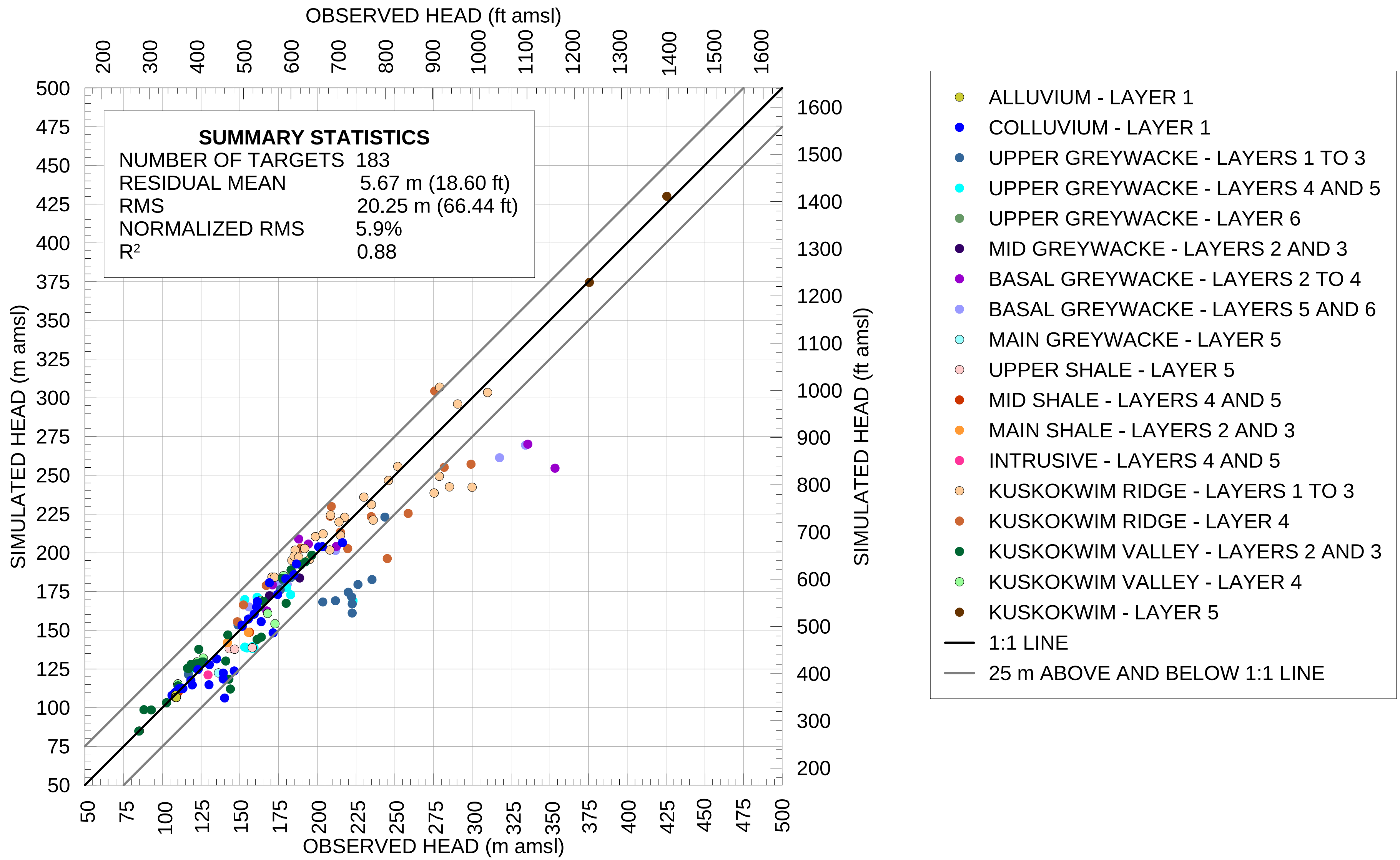
Net groundwater inflows to the pit lake are predicted to decline from an average of approximately 571 gpm (130 m^3/h) from 11 to 51 years after closure, to a constant annual average of approximately 55 gpm (126 m^3/h) after the pit lake has reached its managed level (BGC 2015).

B.2.3 Streamflows in the Numerical Hydrogeologic Model

Stream flow measurements used for calibration of the numerical hydrogeologic model (BGC 2014b) include periods of continuous flow measurements available for stations AMER, ANDA, CCBO, CCAC, and CCBA between 1996 and 2013. These data are primarily limited to the summer period when creeks were not frozen. An average value was taken over the measurement period for the calibration target. The remainder of stream flow measurements recorded at other stations are limited to single manual measurements that were generally taken quarterly. These measurements may have been influenced by the daily distribution of precipitation (i.e., storms) and may not be representative of average conditions. Therefore, these values were not used for calibration.

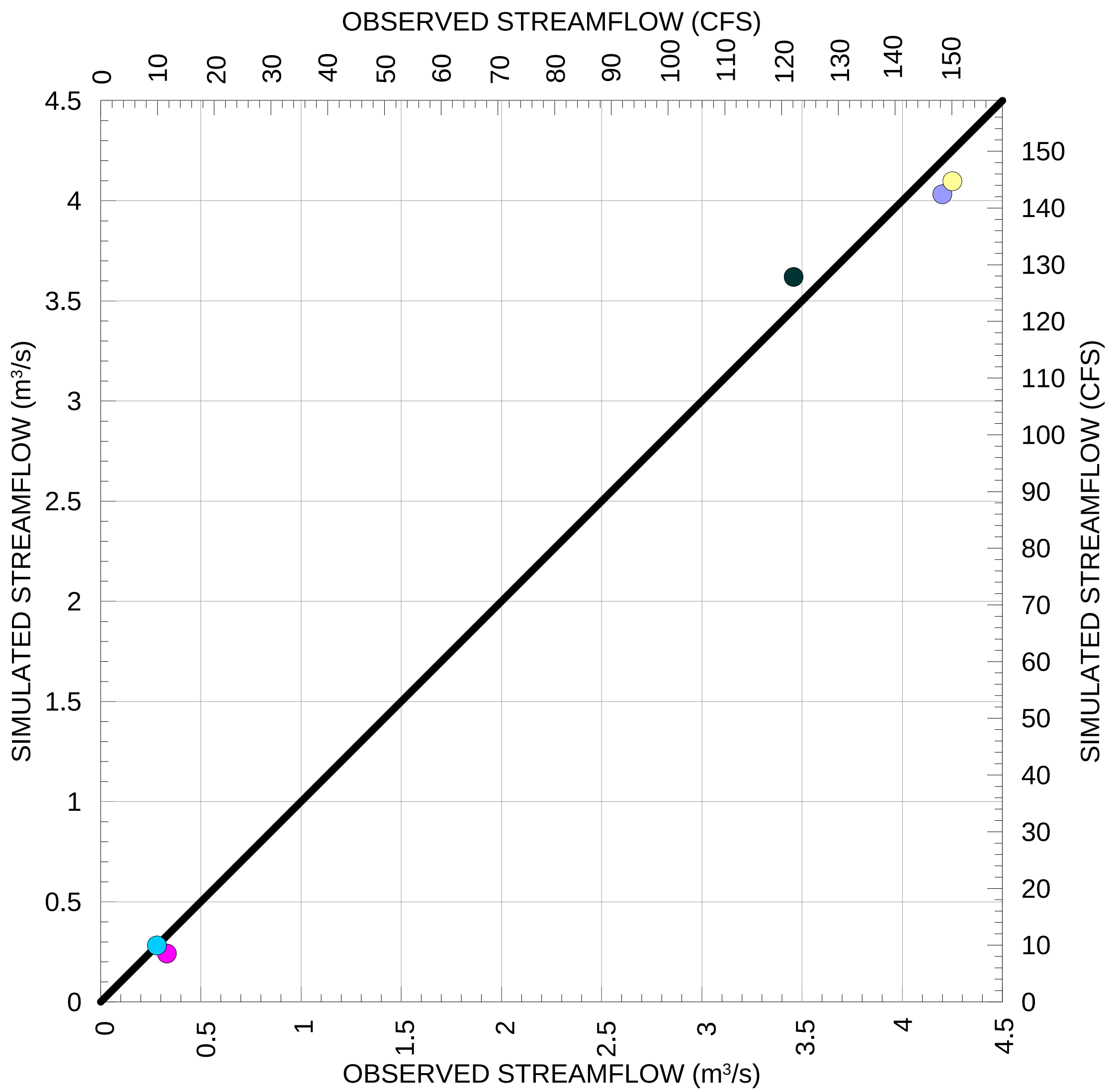
Simulated versus observed groundwater hydraulic heads for the calibrated groundwater model are shown on the scatterplot in Figure B-8. A normalized root mean square (NRMS) of 10% is generally suggested as a guideline for the maximum difference between simulated and measured target (observed) values. The NRMS of this calibration is 5.9%, indicating a good match was achieved (BGC 2014b).

Simulated and observed stream flows at the measurement stations listed above are provided in Figure B-9. The NRMS for stream flows of the calibration is also less than 10%, with a value of 3.3% (BGC 2014b). Considering the small amount of stream flow data available for calibration (i.e., five points), the match to measured data is considered adequate. A summary of the simulated water balance derived from the numerical hydrogeologic model for each watershed is provided in Table B-4A (summer) and Table B-4B (winter).



SOURCE: BGC 2014 Numerical Hydrogeological Model Development and Calibration Report	SCALE: N/A	DONLIN GOLD	**MEAN ANNUAL HYDRAULIC HEADS: SIMULATED vs. OBSERVED VALUES** DONLIN GOLD PROJECT	FIGURE: **B-8**

DG: PER0118.mxd, 01/26/16, R03



SUMMARY STATISTICS

RESIDUAL MEAN	0.05 m^3/s (1.74 CFS)
RMS	0.13 m^3/s (4.62 CFS)
NORMALIZED RMS	3.30%
R^2	0.99

1:1 LINE
AMER
ANDA
CCBO
CCBA
CCAC

SOURCE: BGC 2014 Numerical Hydrogeological Model Development and Calibration Report

SCALE:

N/A

DONLIN GOLD

SUMMER STREAM FLOWS: SIMULATED vs. OBSERVED VALUES

DONLIN GOLD PROJECT

FIGURE:

B-9

DG: PER0119.mxd, 01/26/16, R02

Table B-4: Simulated Water Budget by Watershed

A. Winter

Watershed	Stream													
	Inflows								Outflows					
	Flow from Upstream Segments		Direct Precipitation to Stream		Runoff		Baseflow		Streambed Leakage		Stream Evaporation		Flow to Downstream Segment	
	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d
Crooked	6,480	228,700	0	0	0	0	50,150	1,770,300	42,385	1,496,190	0	0	44,636	1,575,660
Anaconda	0	0	0	0	0	0	5,428	191,610	57	2,030	0	0	5,371	189,590
Unnamed SE1	0	0	0	0	0	0	280	9,870	12	410	0	0	268	9,470
Omega	0	0	0	0	0	0	443	15,630	7	240	0	0	436	15,390
Lewis	0	0	0	0	0	0	447	15,780	0.2	10	0	0	447	15,770
Queen	0	0	0	0	0	0	880	31,060	18	640	0	0	861	30,380
Snow	0	0	0	0	0	0	2,456	86,690	35	1,250	0	0	2,421	85,450
American	0	0	0	0	0	0	4,264	150,510	7	250	0	0	4,257	150,260
Dome	0	0	0	0	0	0	4,393	155,080	0.4	15	0	0	4,449	157,040
Flat	2,590	91,400	--	--	--	--	--	--	--	--	--	--	2,590	91,430
Quartz	0	0	0	0	0	0	1,519	53,620	1,271	44,870	0	0	295	10,420
Unnamed NE1	0	0	0	0	0	0	111	3,900	0	0	0	0	111	3,900
Unnamed SW2	0	0	0	0	0	0	316	11,150	30	1,040	0	0	286	10,110
Unnamed SW1	0	0	0	0	0	0	107	3,780	5	190	0	0	102	3,610
Grouse	0	0	0	0	0	0	6,898	243,500	33	1,150	0	0	6,865	242,320
Unnamed	0	0	0	0	0	0	3,160	111,530	65	2,290	0	0	3,095	109,240

Watershed	Aquifer															
	Inflows								Outflows							
	Groundwater Recharge		Streambed Leakage		Storage		Net Flow From Adjacent Watersheds		Evapotranspiration		Baseflow		Storage		Net Flow To Adjacent Watersheds	
	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d
Crooked	0	0	42,385	1,496,190	5,222	184,330	7,328	258,670	0	0	50,147	1,770,200	67	2,360	4,711	166,310
Anaconda	0	0	57	2,030	5,381	189,960	559	19,740	0	0	5,428	191,600	82	2,890	489	17,270
Unnamed SE1	0	0	11.5	410	514	18,130	204	7,200	0	0	280	9,900	6.9	240	442	15,610
Omega	0	0	7	240	630	22,250	421	14,870	0	0	443	15,600	9.2	320	608	21,450
Lewis	0	0	0.2	10	530	18,710	643	22,710	0	0	447	15,800	12.2	430	715	25,230
Queen	0	0	18	640	618	21,830	1,150	40,590	0	0	880	31,100	13.5	480	890	31,430
Snow	0	0	35	1,250	2,421	85,460	887	31,310	0	0	2,456	86,700	48	1,680	840	29,640
American	0	0	7	250	4,946	174,580	703	24,810	0	0	4,264	150,500	101	3,570	1,295	45,700
Dome	0	0	0.4	15	3,976	140,350	633	22,350	0	0	4,393	155,100	76	2,690	141	4,980
Flat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Quartz	0	0	1,519	44,870	980	34,600	148	5,220	0	0	1,271	44,900	17	610	1,358	47,940
Unnamed NE1	0	0	0	0	393	13,860	24	840	0	0	111	3,900	5.4	190	300	10,600
Unnamed SW2	0	0	30	1,040	708	24,990	311	10,980	0	0	316	11,100	9.9	350	723	25,530
Unnamed SW1	0	0	5	190	456	16,110	376	13,280	0	0	107	3,800	4.9	170	726	25,630
Grouse	0	0	33	1,150	7,434	262,410	255	9,000	0	0	6,898	243,500	90	3,180	730	25,790
Unnamed	0	0	65	2,290	3,586	126,590	383	13,530	0	0	3,160	111,500	52	1,820	822	29,020

(BGC 2014b, NHM Report)

Notes:

1. Upstream flow defined as surface water flow (streamflow) entering creeks within the modeled area from outside of the model domain at DCBO and Flat Creek.
2. Watershed areas used for budget calculations presented above are shown on Drawing 3. Note that the area used for Crooked Creek is not a closed watershed but rather small section along the creek, so inflows do not equal outflows. Flat Creek is a stream inflow location only

Table B-4 (Continued): Simulated Water Budget by Watershed

B. Summer

Watershed	Stream													
	Inflows								Outflows					
	Flow from Upstream Segments		Direct Precipitation to Stream		Runoff		Baseflow		Streambed Leakage		Stream Evaporation		Flow to Downstream Segment	
	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d
Crooked	145,200	5,125,600	570	20,100	24,307	858,000	53,200	1,878,000	40,153	1,417,400	502	17,700	354,000	12,496,200
Anaconda	0	0	205	7,200	19,311	681,700	4,800	169,400	93	3,300	181	6,400	24,087	850,300
Unnamed SE1	0	0	18	600	1,733	61,200	330	11,600	10	300	16	600	2,057	72,600
Omega	0	0	11	400	2,125	75,000	570	20,100	5	200	10	300	2,688	94,900
Lewis	0	0	4.1	100	1,490	52,600	430	15,200	10	400	4	100	1,910	67,400
Queen	0	0	7.0	200	1,848	65,200	1,020	36,000	27	1,000	6	200	2,841	100,300
Snow	0	0	62.8	2,200	8,320	293,700	2,300	81,200	33	1,200	55	2,000	10,578	373,400
American	0	0	68.0	2,400	16,705	589,700	4,100	144,700	6	200	60	2,100	20,807	734,500
Dome	0	0	138	4,900	17,461	616,400	3,600	127,100	55	1,900	122	4,300	21,093	744,600
Flat	21,600	762,500	--	--	--	--	--	--	--	--	--	--	21,600	762,500
Quartz	0	0	12	400	2,976	105,100	1,330	46,900	1,489	52,600	11	400	2,818	99,500
Unnamed NE1	0	0	4.3	200	553	19,500	100	3,500	37	1,300	4	100	618	21,800
Unnamed SW2	0	0	8.0	300	2,409	85,000	360	12,700	34	1,200	7	300	2,736	96,600
Unnamed SW1	0	0	5.1	200	1,215	42,900	150	5,300	11	400	5	200	1,333	47,000
Grouse	0	0	155	5,500	29,564	1,043,600	5,900	208,300	49	1,700	137	4,800	35,471	1,252,100
Unnamed	0	0	42.2	1,500	16,021	565,600	2,000	70,600	59	2,100	37	1,300	17,973	634,400

Watershed	Aquifer															
	Inflows								Outflows							
	Groundwater Recharge		Streambed Leakage		Storage		Net Flow From Adjacent Watersheds		Evapotranspiration		Baseflow		Storage		Net Flow To Adjacent Watersheds	
	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	$m^3/dm^3/d$	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d	m^3/d	ft^3/d
Crooked	17,911	632,250	40,153	1,417,400	66	2,340	7,703	271,910	2,145	75,720	53,250	1,879,710	5,190	183,200	5,263	185,780
Anaconda	13,474	475,640	93	3,300	77	2,710	581	20,520	3,481	122,880	4,842	170,910	5,276	186,260	622	21,970
Unnamed SE1	1,143	40,330	9.7	340	6	220	309	10,920	198	6,980	326	11,520	503.7	17,780	440	15,540
Omega	1,547	54,610	5	190	9	310	472	16,650	201	7,080	569	20,070	622.9	21,990	640	22,600
Lewis	1,072	37,840	10	370	12	430	718	25,340	190	6,720	430	15,160	522.7	18,450	668	23,600
Queen	1,381	48,760	27	960	14	480	1,243	43,880	115	4,080	1,015	35,850	611.3	21,580	909	32,080
Snow	5,779	204,000	33	1,180	45	1,590	933	32,930	1,247	44,000	2,288	80,770	2,377	83,890	874	30,850
American	11,662	411,660	6	200	98	3,460	810	28,590	2,326	82,120	4,096	144,600	4,864	171,700	1,275	45,020
Dome	10,209	360,370	55	1,940	76	2,680	694	24,510	3,428	121,020	3,586	126,570	3,876	136,840	138	4,860
Flat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Quartz	2,213	78,110	1,489	52,560	16	580	194	6,860	287	10,140	1,329	46,910	965	34,070	1,330	46,960
Unnamed NE1	821	28,980	37	1,290	7	250	50	1,770	66	2,320	101	3,560	390.0	13,770	358	12,640
Unnamed SW2	1,686	59,530	34	1,210	9	320	287	10,130	135	4,750	359	12,680	701.8	24,770	820	28,940
Unnamed SW1	992	35,030	11	390	5	160	425	15,000	77	2,700	149	5,250	452.7	15,980	755	26,650
Grouse	19,648	693,580	49	1,740	93	3,270	270	9,520	6,176	218,010	5,936	209,530	7,143	252,140	790	27,890
Unnamed	9,508	335,650	59	2,070	51	1,820	399	14,100	3,612	127,510	1,999	70,560	3,447	121,670	953	33,640

(BGC 2014b, NHM Report)

Notes:

1. Upstream flow defined as surface water flow (streamflow) entering creeks within the modeled area from outside of the model domain at DCBO and Flat Creek.
2. Watershed areas used for budget calculations presented above are shown on Drawing 3. Note that the area used for Crooked Creek is not a closed watershed but rather small section along the creek, so inflows do not equal outflows. Flat Creek is a stream inflow location only.

B.3 Pit Lake Physical-Geochemical Model

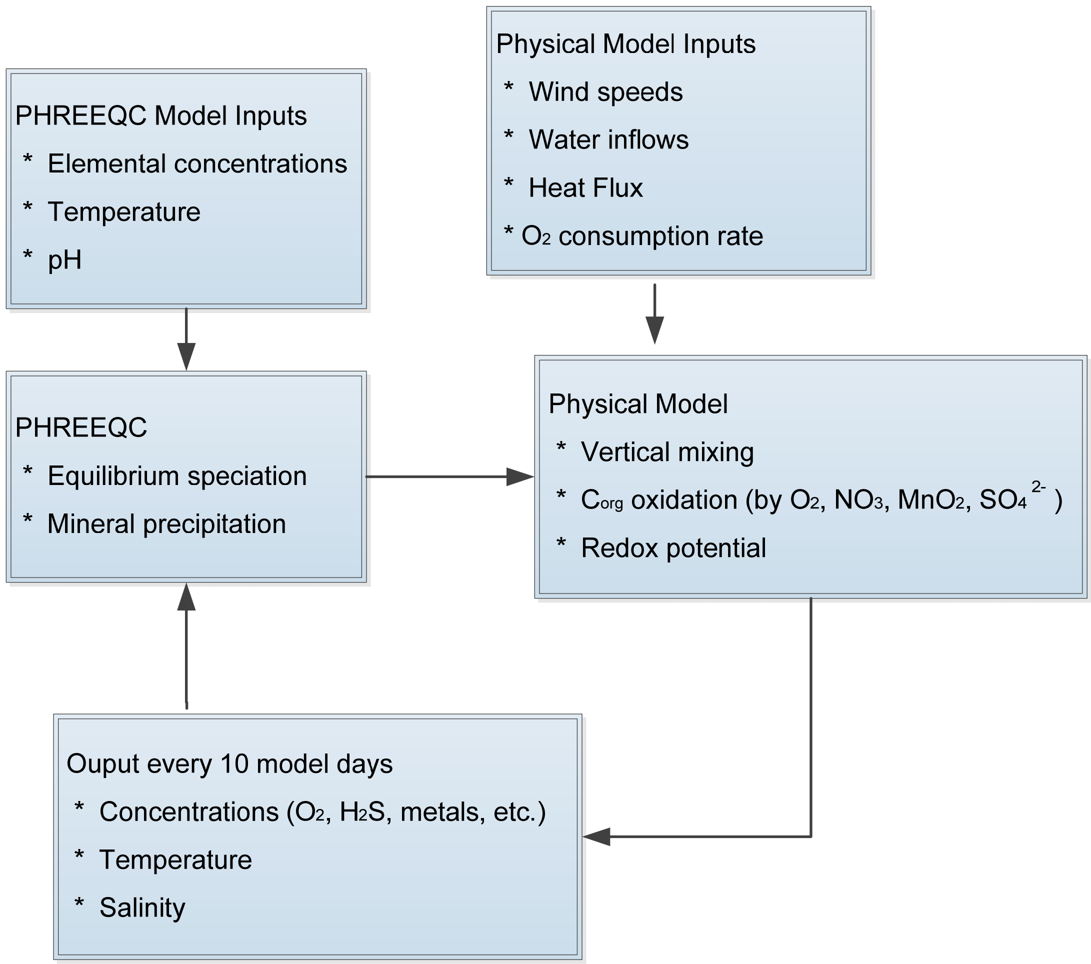
A post-mining pit lake is expected to form in the ACMA pit at the cessation of mining. Lorax Environmental Services Ltd. (Lorax 2011, 2012, 2015) was commissioned to model the closure water management scenario with respect to the Donlin pit lake. The purpose of the pit lake modeling was to assess pit lake filling, physics, and geochemistry with the objective of predicting the quality of water that would eventually be discharged from the ACMA pit lake into the Crooked Creek drainage. A coupled physical-geochemical pit lake model, PitMod, was utilized to accomplish this task.

The principal physical and hydrodynamic processes simulated by the model include:

- Solar heating of the lake surface
- Wind mixing
- Vertical mixing as a function of the density structure of the water column
- Convective mixing due to heating and cooling of the lake water
- Oxygen (oxidant) consumption in the water column and sediments.

PitMod couples the hydrodynamic model, which simulates physical mixing processes and contaminant additions, to a customized version of PHREEQC, a geochemical model originally produced by the USGS (Parkhurst and Appelo 1999). PHREEQC is capable of a wide variety of aqueous geochemical calculations, including speciation and saturation index calculations, mineral and gas equilibria, surface complexation (adsorption) reactions, ion exchange reactions, and redox reactions. The PHREEQC model was utilized in conjunction with the physical model, primarily because it is well established and has been rigorously validated. Furthermore, PHREEQC's treatment of aqueous solution chemistry is valid from very fresh water through to high ionic strength media often observed in pit lake systems. A diagram of this model is presented as Figure B-10.

Figure B-10: Water Quality Inflows from the Eight Waste Rock Categories



Running PHREEQC requires a comprehensive set of chemical input data to characterize the water; for a typical model run on mine-affected waters this would include: pH, temperature, the controlling redox couple, and the concentrations of oxygen, secondary oxidants (e.g., nitrate, sulfate, etc.), major cations, major anions, and trace metals. The various inputs of source water are integrated together and PHREEQC predicts the likelihood of all possible reactions among chemical species in that body of water. The predictions are based on thermodynamic principles and a database that includes hundreds of chemical species. The output of PHREEQC is the equilibrium concentration and speciation of all aqueous species, as well as the equilibrium concentrations of all minerals. Water quality is, therefore, predicted for each model layer as a function of time, providing vertical profiles of relevant parameters in the pit lake.

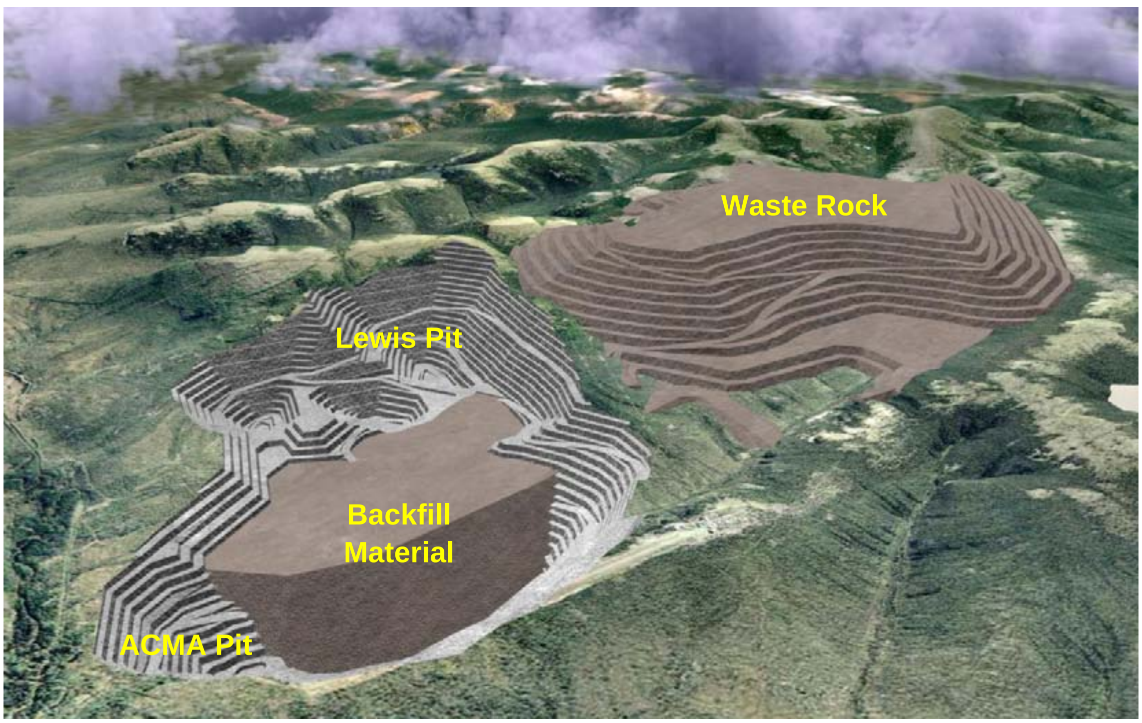
PitMod is driven by many types of data, depending on availability of information. Data sources for the pit lake model include:

- CAD files of the final pit geometry
- High temporal resolution meteorological data – wind speed, direction, precipitation (rain/snow), evaporation, relative humidity, incoming and out-going radiation, percent cloud cover - used to create a 200-year synthetic database

- The water balance for the backfilled Donlin pit void, which is a combination of ACMA and Lewis pits
- Areas of exposed pit-wall geology including ARD characteristics and predicted drainage chemistry from the eight categories of rock units including overburden as previously defined
- Flow volumes and water chemistry of inflows and outflows, including both surface runoff, waste dump seepage, tailings reclamation runoff and consolidation water and groundwater.

At the cessation of operations, the ACMA pit and areas within the Lewis pit would be backfilled with waste rock to approximately 111.5 ft amsl (34 m amsl), as shown in Figure B-11. During the backfill process, some parts of the pit would no longer be dewatered, and a total of 10,291 acre-ft (12.69 Mm^3) of in-pit runoff would infiltrate into the backfill by the end of operations.

Figure B-11: Illustration of ACMA and Lewis Pits with Backfill at the End of Mine Operations



At closure, the pit would also receive inflows from excess water that would accumulate in the TSF. This water would be delivered to the bottom of the ACMA pit and combined with the accumulated groundwater and pit wall runoff; the total volume of water in the pit lake following discharge of excess TSF water would be approximately 8,190 acre-ft (10.1 Mm^3). During filling of the pit lake, the primary flows delivered to the pit would include tailings beach runoff, tailings consolidation water and cover infiltration water, pit highwall runoff, and NAG and PAG seepage from waste rock in the American Creek watershed. Also groundwater, surface runoff from the waste rock facilities and from the undisturbed areas within the pit watershed, and direct precipitation on the lake surface would contribute to the pit lake.

The volume of flow for each source term would be driven by the closure water balance for the pit (BGC 2011a, 2015). The pit backfill would be assumed to contain approximately 50,670 acre-ft (62.5 Mm^3) of voids, which would be occupied by the following sources prior to establishment of the lake over the backfill:

- 8,970 acre-ft (11.06 Mm^3) of pit runoff that accumulates during placement of the backfill
- 8,190 acre-ft (10.1 Mm^3) of excess tailings water delivered to the pit at closure
- During reclamation (Years 1 to 5) surface runoff to the TSF would be pumped to the ACMA pit; the volume is approximately 17,684 acre-ft (21.8 Mm^3) over the 5-year period.

The water in the backfill voids was assumed for modeling to be isolated from the overlying lake and therefore did not influence pit lake physics, geochemistry, or water column chemistry. The pit lake modeling also assumed that all flows from the TSF, and NAG and PAG seepage flow from waste rock in American watershed, are captured and directed to the bottom of the pit lake. Clean runoff would be directed to the pit lake surface waters.

The pit lake would fill, if not managed, to the emergency spillway invert overflow elevation of about 359 ft (109.5 m) over a period of approximately 52 years. The presence of the partial waste rock backfill in the ACMA pit and the Lewis pit, results in the development of a portion of the pit lake in the ACMA pit to an approximate managed depth of 1,024 ft (312 m), and a large portion of the Lewis pit lake relatively shallow at approximately 216.5 ft (66 m) deep. It is relevant to note that a minor discrepancy in pit filling rate exists between PitMod results and water balance results provided by BGC. The difference arises because PitMod includes an ice module for determining ice on and ice off conditions that is driven by the heat budget. The timing of ice formation and ice melting influences evaporation rates and PitMod is calculating slightly higher evaporation rates due to the calculated timing of ice conditions versus those prescribed in the pit water balance. The result, compounded over several years, is a slightly slower pit filling rate estimated by PitMod. This difference in physical filling rate has no influence on predicted pit geochemical or hydrodynamic behavior.

References

The following studies were used as the basis for this Appendix.

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BGC Engineering Inc., 2011b. Donlin Creek Gold Project Feasibility Study Update II, Hydro-Meteorological Data: Synthesis and Analysis, Final Report

BGC Engineering Inc., 2014a. Donlin Creek Gold Project, Conceptual Hydrogeologic Model, Final Report

BGC Engineering Inc., 2014b. Donlin Creek Gold Project, Numerical Hydrogeologic Model, Final Report

BGC Engineering Inc., 2014c. Donlin Creek Gold Project, Water Resources Management Plan Interim Update, July 2014 – Revision 1. EN-0011178.0040

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Appendix C
Leaching Analysis of Site Material

C. LEACHING ANALYSIS OF SITE MATERIAL

Geochemical characterization of waste rock (which includes the pit wall rock), overburden, and tailings solids was used to predict water quality from the various materials. The geochemical characterization programs utilized the following testing methodologies:

- Mineralogy, including optical and quantitative (Rietveld method) x-ray diffraction mineralogy and microprobe analysis of carbonate mineral grains
- Acid-base accounting (ABA) including paste pH, total sulfur analysis using a Leco sulfur analyzer, neutralization potential testing by titration using the standard Sobek method (Sobek et al. 1978)
- Sequential Meteoric Water Mobility Procedure (MWMP) with geochemical analysis of the leachate for specific constituents
- Kinetic testing using standard humidity cell test procedures designed to simulate water-rock interactions and predict the rate of reaction for acid generation and metals mobility.

The results of these characterization programs are presented in *Waste Rock Metal Leaching and Acid Rock Drainage Assessment for Feasibility Study* (SRK 2007a).

C.1 Waste Rock and Pit Wall Rock

The Donlin Gold deposit is hosted by rhyodacitic sills and dikes intruded into a sedimentary package consisting of calcareous and non-calcareous shales and greywackes. The sedimentary host rocks contain diagenetic iron sulfide mineralization, as well as iron, arsenic, antimony, and mercury sulfide minerals introduced with the gold mineralization. The intrusive rocks contain the same sulfide minerals introduced by mineralizing processes. Mineralogical analyses show that carbonate minerals occur variably in both rock type groups and are dominated by magnesium and iron enriched varieties such as dolomite, ankerite, and siderite, rather than pure calcium carbonates such as calcite.

Waste rock geochemical characterization in the form of long-term kinetic testing is ongoing to evaluate the distribution of sulfide and carbonate minerals and the potential for ARD and ML. ARD occurs when sulfide minerals are oxidized by reaction with oxygen and the resulting acid is not completely neutralized by reaction with acid-consuming minerals or dissolved alkalinity in the leaching waters. The related process of ML occurs when metals and other contaminants are released either by oxidation of sulfide minerals or by dissolution of other minerals caused by acid leaching or other weathering processes. At the proposed Donlin Gold project site, arsenic, antimony, and mercury occur as traces of their sulfide minerals (arsenopyrite, and stibnite, respectively) and as components of more abundant sulfides (iron pyrite) and have the potential to leach, regardless of whether acidic conditions develop.

ARD/ML potential has been characterized in several phases and is ongoing in the form of long-term kinetic testing. In 2004, an initial suite of 769 widely spaced core samples were collected from 162 drillholes and analyzed for ABA to evaluate potential for ARD. ABA is a static test method that measures the potential for a rock sample to generate ARD (acid generating potential [AP]) and the potential for the same sample to neutralize acid (neutralization potential [NP]). Generally, AP indicates the presence of acid-generating sulfide minerals, principally pyrite, while NP is associated with carbonate and other acid-neutralizing minerals. ABA also includes analysis of sulfur forms (sulfide and sulfate) and carbonate.

Sixteen samples from this 2004 suite were selected for kinetic testing using humidity cells to evaluate both ARD and ML potential. The same samples were submitted for detailed mineralogical characterization. After this work, an additional set of 360 samples from 12 holes was selected to fill gaps in the initial characterization. The samples were obtained from continuous intervals to evaluate “mining block-scale” geochemical variations and were analyzed for similar parameters as the initial suite.

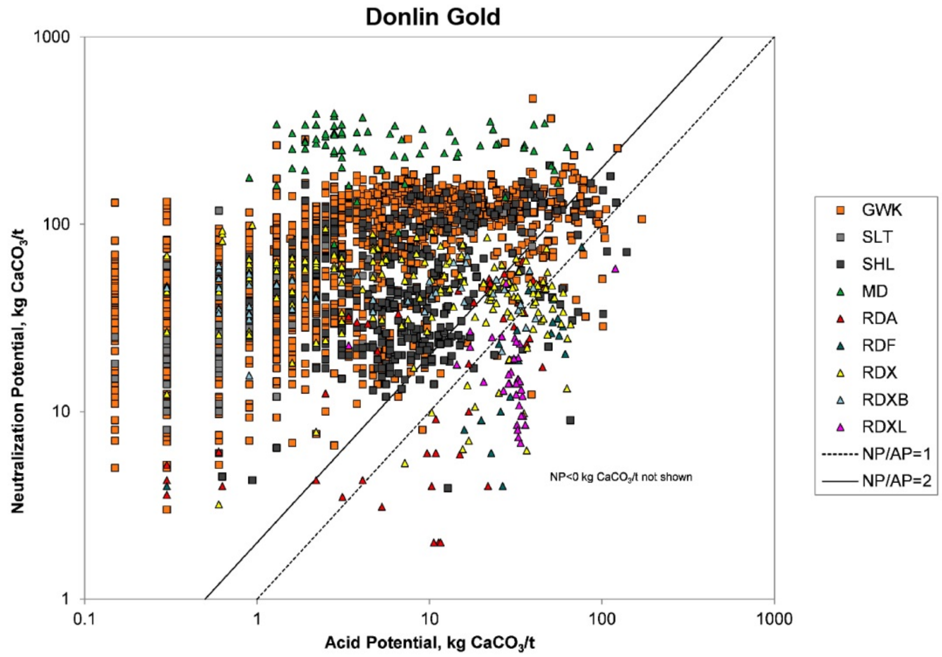
Both the initial and second suites of ABA samples were drawn largely from rock defined as waste, but in the vicinity of the mineralization. This was found to be biasing the assessment toward higher potentials for ARD and ML. During 2006, five holes were drilled near the proposed final pit walls and 483 additional samples were analyzed for ABA. Additional samples were selected from waste areas outside of the highly mineralized areas to enable block-modeling of ARD/ML and to quantify volumes of rock with different ARD/ML characteristics. At the same time, eight large composite samples were prepared from drill core to fill large columns or barrels holding approximately 660 lb (300 kg) for onsite testing designed to evaluate leaching under site conditions. The samples represent typical and elevated sulfur and arsenic concentrations in both sedimentary and intrusive rocks.

Between 2004 and 2006 more than 2,400 samples were analyzed for ABA. During the first and second quarters of 2007, 20 composite samples containing different concentrations (%) of sulfur and arsenic were tested using a modification of the Nevada Department of Environmental Protection’s MWMP. The modification involves re-application of leachate from a single step of the MWMP to a new sample to evaluate the accumulation of contaminants that can occur along flow paths; the actual procedure involved six steps with full analysis of leachate at each step. The method gives a more reliable indication of contaminant solubility than indicated by the conventional MWMP, the results, discussed *(*SRK 2007a), were factored into predictions of water chemistry for full-scale waste rock dumps and pit walls.

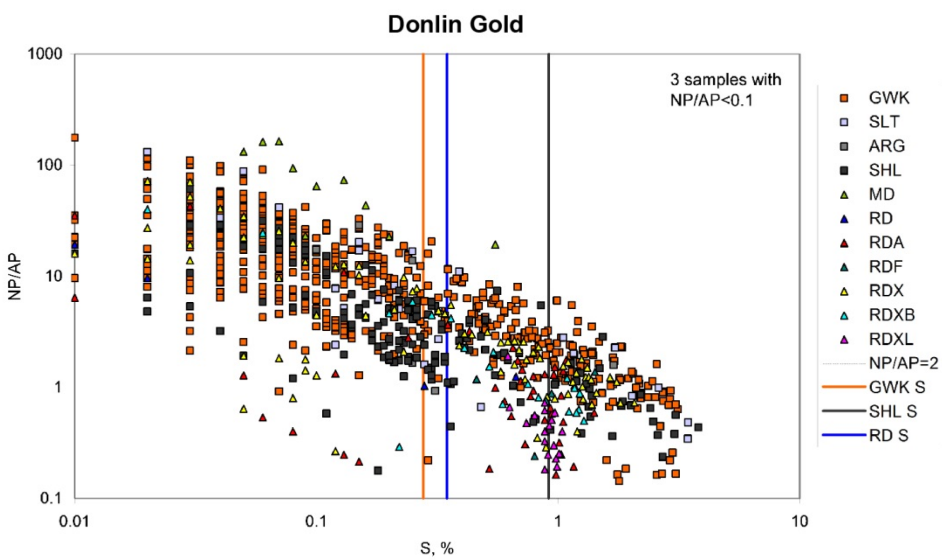
Interpretation of the initial database of sulfur concentrations showed the major rock types (shales, greywackes, and rhyodacites) contained bimodally distributed sulfur concentrations. The higher sulfur mode was greater for shales (17% of samples, averaging 1.64% sulfur) compared to greywackes (30% of samples, averaging 0.83% sulfur). The sulfide sulfur concentration equals the total sulfur concentration for these materials. In contrast, the low sulfur population for the rhyodacites was smaller than the higher sulfur population (35%, averaging 0.07% sulfur). For greywacke 99% of samples containing sulfur concentrations in the lower concentration population, the ratio of NP to AP was greater than 2:1 indicating that greywacke, the dominant sedimentary rock type, is expected to have a low potential for acid generation. Shale and rhyodacite showed variable potential for acid generation for sulfur concentrations in the lower sulfur population. Overall, therefore, acid generation potential was found to be controlled to some degree by rock type, but the over-printing effect of sulfide mineralizing processes resulted in variable sulfur content and variable potential for ARD in all rock types. Figure C-1 presents the NP vs. AP and sulfur vs. NP/AP for the waste rock samples.

Figure C-1: NP vs. Ap and Sulfur vs. NP/AP

Lines in the lower diagram refer to thresholds derived from probability plots.



P:\01_SITES\Donlin_Creek\1CB018.000_Geochem\Analysis\2010-11_ABA_Database\[ScatterPlots_1CB018.000_rev00_LD.xlsx]



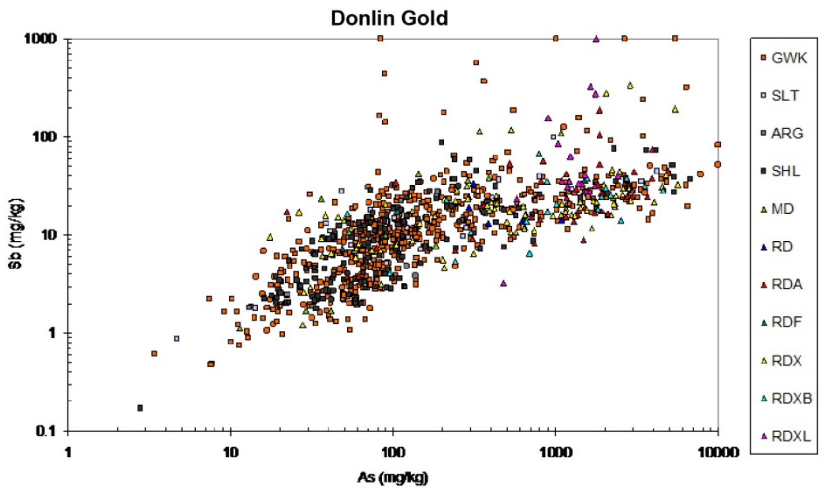
Concentrations of arsenic, antimony, and mercury were well above global crustal averages due to the introduction of these elements during mineralization. Arsenic concentrations spanned a wide range from 1 to 10,000 mg/kg (1% by weight) and were weakly correlated with sulfur concentrations. Like sulfur, arsenic concentrations were bimodally distributed, with average arsenic concentrations of 80 mg/kg in all three major rock types. The lower arsenic population accounted for 83%, 85%, and 25% of shales, greywackes, and rhyodacites, respectively. The overall distribution of arsenic was, therefore, similar to sulfur as shown in Figure C-2. Section C.3.1 presents a description of waste rock classification, projected tonnages, and handling.

Results from continuous samples in 25 holes showed that geochemical characteristics tended to show uniform NP/AP and arsenic concentrations over intervals spanning tens of feet, indicating that waste segregation may be feasible based on ARD/ML characteristics. Further evaluation of potential segregation and blending of development waste rock would continue to refine the waste rock management plan as discussed below.

Kinetic tests have shown that rates of sulfide mineral oxidation are strongly and positively correlated with sulfur and arsenic leaching and with the arsenic content of the rock as shown in Figure C-3. This indicated bulk rock characteristics can be related to leaching behavior; therefore, segregation based on characteristics such as sulfur and arsenic content should result in the production of different water qualities in drainage flows. Kinetic testwork has shown that rock with NP/AP below 1.3 defines PAG rock. The delay to onset of acidic conditions for PAG rock was found to vary from many decades for rock near the NP/AP criterion, to a few years for rock with NP/AP near 0.1, the lowest level indicated by kinetic testwork. Humidity cells containing NP/AP at these levels produced low pH as soon as the test started due to operation at room temperature and unavoidable oxidation of the sample in storage prior to testing.

Figure C-2: Comparison of Arsenic & Sulfur, Arsenic & Antimony; and Arsenic & Mercury Concentrations

Rock types indicated in the legend are GWK = Greywacke. SLT = Siltstone, ARG = Argillite, SHL = Shale, MD = Mafic Dike, RD = Rhyodacite. The qualifiers on RD are textural and compositional variants.



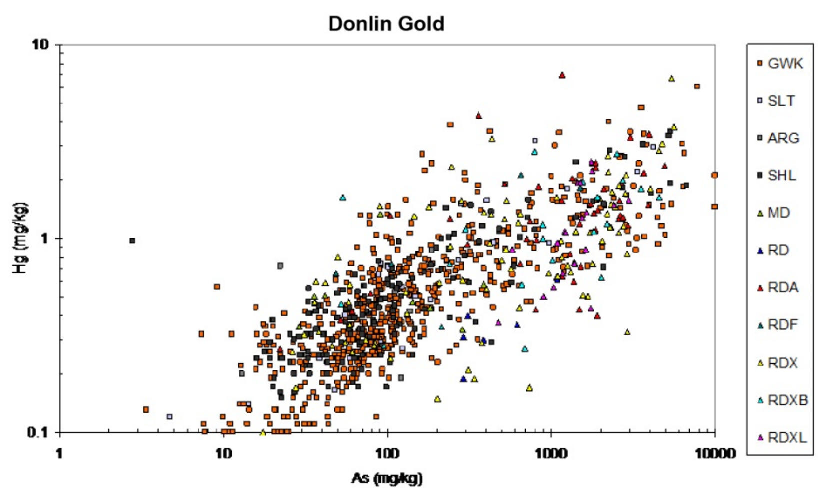
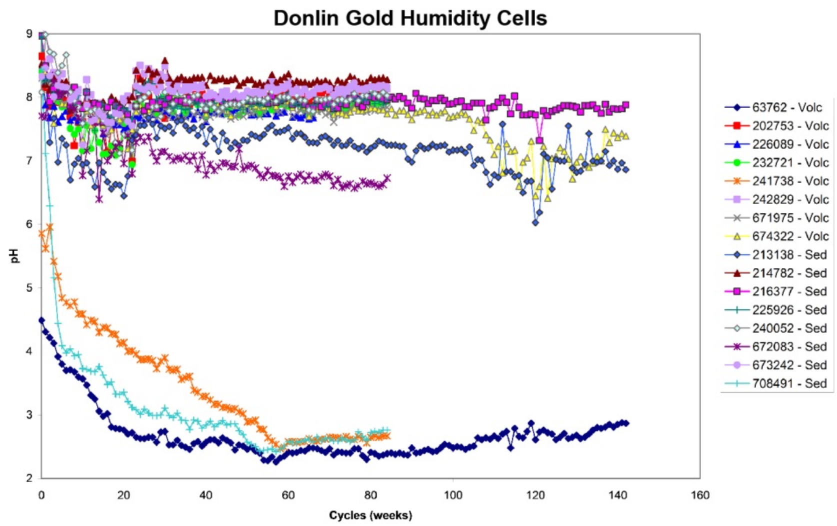
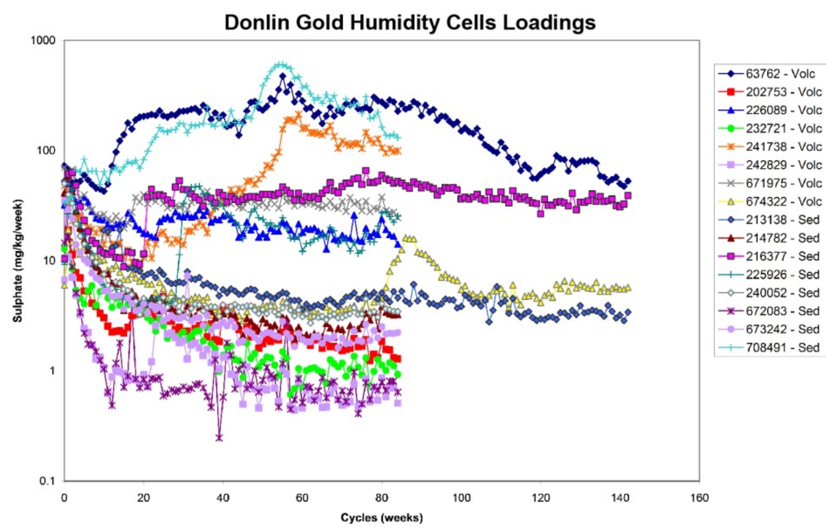
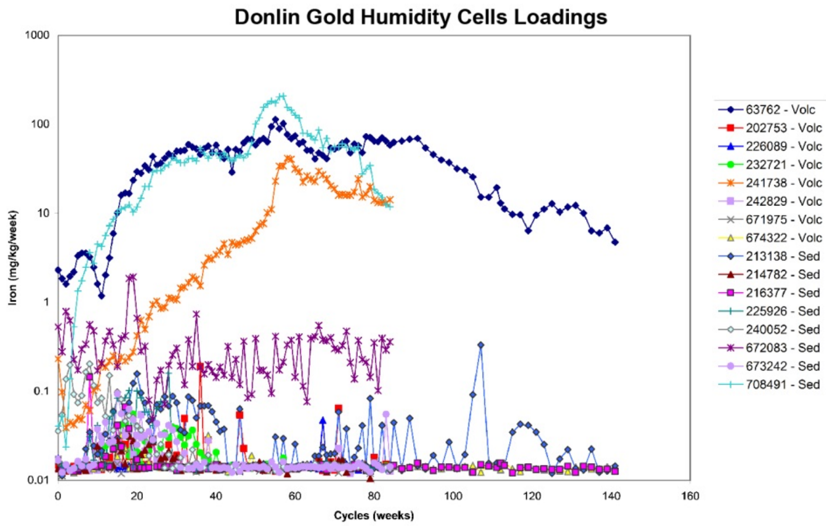


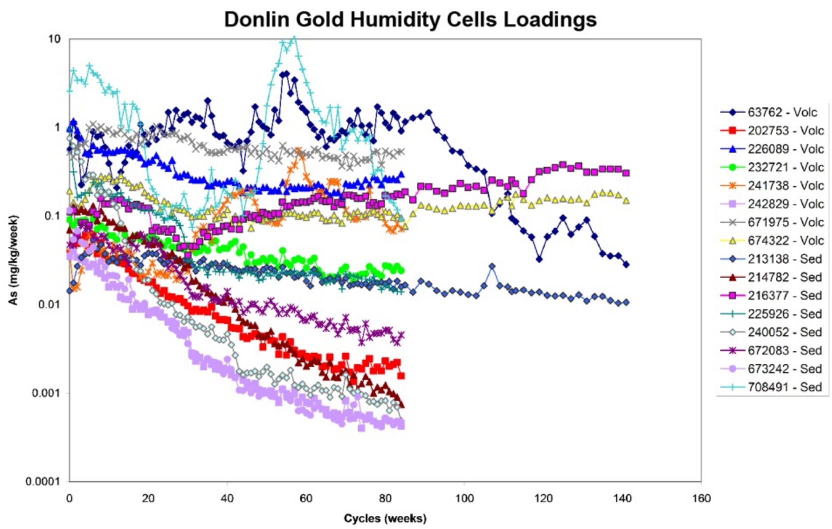
Figure C-3: Humidity Cell Results

Humidity cell results are grouped according to major geochemically distinctive rock types. “Volc” indicates volcanic or intrusive rocks, which are rhyodacites “Sed” indicates sedimentary rocks which include greywacke, siltstone, argillite and shale.






Donlin Gold Humidity Cells Loadings
Iron (mg/kg/week)
Cycles (weeks)
63762 - Volc
202753 - Volc
226089 - Volc
232721 - Volc
241738 - Volc
242829 - Volc
671975 - Volc
674322 - Volc
213138 - Sed
214782 - Sed
216377 - Sed
225926 - Sed
240052 - Sed
672083 - Sed
673242 - Sed
708491 - Sed


Donlin Gold Humidity Cells Loadings
As (mg/kg/week)
Cycles (weeks)
63762 - Volc
202753 - Volc
226089 - Volc
232721 - Volc
241738 - Volc
242829 - Volc
671975 - Volc
674322 - Volc
213138 - Sed
214782 - Sed
216377 - Sed
225926 - Sed
240052 - Sed
672083 - Sed
673242 - Sed
708491 - Sed

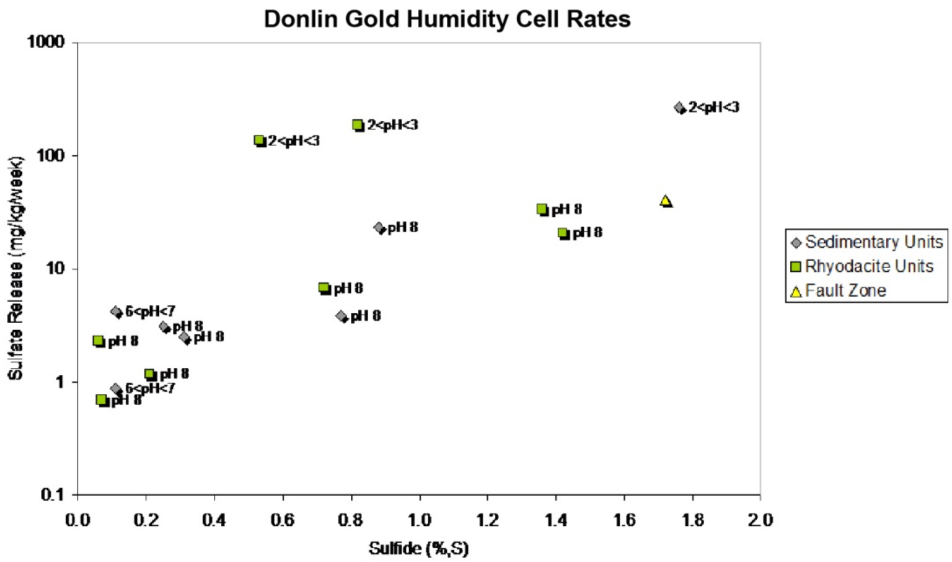
Elevated levels of arsenic and antimony leaching have been demonstrated in both field and laboratory kinetic tests as shown in Figure C-4. Rock containing arsenic concentrations corresponding to the upper mode of concentration has been shown to leach arsenic at concentrations up to 25 mg/L under non-acidic conditions in the field tests. Rock with lower arsenic concentrations leached arsenic in the 1 to 3 mg/L range. Antimony concentrations varied from 0.2 to 7.5 mg/L. Mercury concentrations were typically very low (in the tens of nanograms per liter).

In summary, ARD/ML characterization to date has shown that most of the rock at the proposed project has a low potential for ARD and segregation of rock based on ABA characteristics could potentially reduce the volume requiring management to prevent ARD. Current mine planning allows for this segregation. Other long-term management strategies such as blending and encapsulation are incorporated into the waste rock management strategy.

Arsenic leaching is potentially significant for all waste rock, owing to widespread elevated concentrations in the rock and leachability indicated by testwork. Concurrent reclamation of overburden and waste rock dumps to minimize stormwater contact with the rock could result in lower arsenic content in drainage from rock. However, the water chemistry predictions do not, as yet, support the concept of segregation to reduce concentrations in drainage.

Using these findings, seven waste rock management categories were initially developed based on the material neutralization potential as carbonate (NP_{CO3})/acid generating potential (AP) range as well as the ratio of arsenic/sulfur (As/S). Waste rock would be classified in the block model so that disposal locations can be determined. Table C-1 presents the updated waste rock management category definitions used for the segregation of waste rock by the NP_{CO3}/AP range. These definitions were based on interpretation of the occurrence of the reactive sulfide and carbonated minerals and evaluation of kinetic test data (SRK 2011).

Figure C-4: Humidity Cell Release Rate Comparisons Sulfate and Arsenic



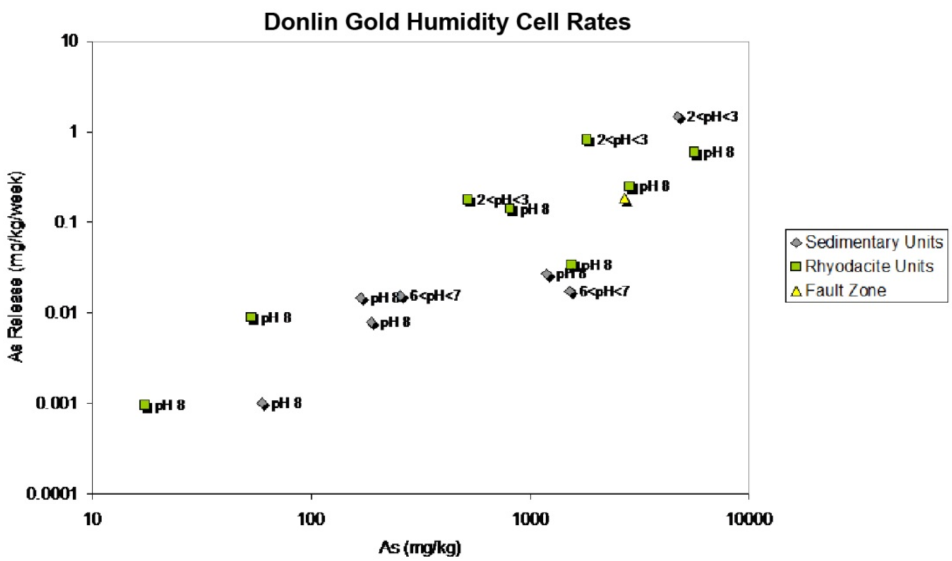


Table C-1: Waste Rock Management Category Definitions

NP_{CO3}/AP	Waste Rock Management Category	Description	Delay to Onset of ARD
>1.3	NAG 1-4	Non-acid generating	--
1.0 < NP_{CO3}/AP ≤ 1.3	PAG 5	Potentially acid generating	Several decades
0.2 < NP_{CO3}/AP ≤ 1.0	PAG 6	Potentially acid generating	Less than a decade
NP/AP ≤ 0.2	PAG 7	Potentially acid generating	Less than a few years

Source: Table 3-4, *Waste Rock Management Plan, Donlin Gold Project (*SRK 2016)
--: N/A

C.2 Tailings

To provide samples that are reasonably representative of both the complete metallurgical processes, and also the ore, testing the combined pilot-plant tailings was selected as the preferred testing method. The final tailings from Donlin Gold consisted of a blend of detoxified carbon-in-leach (CIL) tails (cyanide-leached autoclave and hot cure product) and neutralized autoclave acidic liquor using the flotation tails stream.

The key environmental considerations and characteristics of the process plant are described in the following sections. The most stringent Alaska water quality standard (AWQS) presented for each parameter in subsequent tables are for reference only in analyzing the process tailings. The purpose of the analysis is to better understand the potential long-term properties of the process tailings so appropriate control measures can be implemented to manage these specific products.

Three sets of detailed analysis were available from a set of final tails generated from the 2006 Donlin Gold pilot testwork program using a composite of the feed samples from the 2007 Phase 1 pilot testwork program, and also from the 2007 Phase 2 pilot testwork program.

Table C-2 shows the final tailings solids phase analyses from both the 2006 and 2007 Phase 1 and 2 pilot-plant test programs. The tailings solids are notably enriched in arsenic (910 to 3,400 parts per million [ppm]), antimony (120 to 250 ppm), and lead (15 to 26 ppm).

Table C-2: Final Plant Tailings Solids Analysis*

Parameter	Unit	Feasibility Pilot (Phase 2) Final Tailings Filtrate 2007	Feasibility Pilot (Phase 1) Final Tailings Filtrate Feb 2007	Pre-Feasibility Pilot Final Tailings Filtrate Oct 2006
Ag	g/t	0.68	0.95	1.1
Al	g/t	63,000	69,000	71,000
As	g/t	910	2,900	3,400
B	g/t	2	<3	5
Ba	g/t	640	520	520
Be	g/t	2.2	2.0	2.1
Bi	g/t	0.13	0.16	0.22
Ca	g/t	12,000	8,200	11,000
Cd	g/t	0.2	0.6	0.24
Ce	g/t	33	52	41
Cl	%	<0.01	<0.01	<0.01
Co	g/t	3.7	8.0	8.2
Cr	g/t	180	210	300
Cs	g/t	7.0	7.5	7.9
Cu	g/t	60	60	77
F	%	0.01	0.01	<0.01
Fe	g/t	16,000	20,000	23,000
Ga	g/t	18	18	21
Ge	g/t	<0.4	<2	<0.5
Hf	g/t	2.5	5.1	2.7
Hg	g/t	0.7	1.0	2.0
In	g/t	<0.01	0.06	0.05
K	g/t	23,000	23,000	22,000
La	g/t	16	25	20
Li	g/t	56	38	35
Mg	g/t	6,000	3,800	5,000
Mn	g/t	380	380	450
Mo	g/t	2.4	7.1	14
Na	g/t	2,600	1,900	1,500
Nb	g/t	6.7	5.6	4.0
Ni	g/t	21	70	170
Pb	g/t	15	15	26
Rb	g/t	98	140	130
Re	g/t	<0.02	< 0.02	0.04
Sb	g/t	120	230	250
Se	g/t	<0.7	1	<1
Si	g/t	309,000	330,000	-
Sn	g/t	3.1	12	3.0
Sr	g/t	98	62	64

Table C-2 (Continued): Final Plant Tailings Solids Analysis*

Parameter	Unit	Feasibility Pilot (Phase 2) Final Tailings Filtrate 2007	Feasibility Pilot (Phase 1) Final Tailings Filtrate Feb 2007	Pre-Feasibility Pilot Final Tailings Filtrate Oct 2006
Ta	g/t	0.72	0.71	0.86
Te	g/t	<0.4	<0.4	<0.4
Th	g/t	11	23	10
Ti	g/t	1,000	790	390
Tl	g/t	0.9	0.9	1.0
U	g/t	2.7	2.7	2.7
V	g/t	49	42	46
W	g/t	5.8	12	6.0
Y	g/t	8.4	10	8.6
Zn	g/t	100	96	66
Zr	g/t	-	71	44

*See List of Elements and Compounds in the contents
--: N/A

C.2.1 MWMP Tests on Final Tailings Samples

MWMP testing results are shown in Table C-3 and for the pilot-plant final tailings samples generated in 2006 and 2007 (Tables C-4, C-5 and C-6). The data provided for the first deionized water (DI) rinse is the standard MWMP result. However, additional rinses were applied to the standard MWMP testing process to simulate further rinsing of the tailings with natural precipitation (rainfall, snowmelt). Species reporting to the first rinse MWMP solutions that are above current drinking and aquatic life criteria are mercury, manganese, molybdenum, antimony, sulfate, and chlorine. By the fourth DI rinse, sulfate and molybdenum are below these limits.

Table C-5 shows the MWMP results from testing on the 2007 Phase 2 pilot-plant transitional final tailings. Those species showing elevations above drinking and aquatic life criteria in the first MWMP rinse are sulfate, fluoride, chloride, arsenic, manganese, antimony, and molybdenum. By the third MWMP rinse, molybdenum and fluorine are below the aquatic life (chronic) criteria.

Table C-3: 2006 Pilot Plant Final Tailings Solids MWMP Species Results

Parameter	Units	[1]AWQS	World Bank	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
TSS*	mg/L	--	50	11	197	58	100	106
pH	units	--	6 to 9	7.06	6.68	6.17	6.54	6.54
Alkalinity	mg/L as $CaCO_3$	[4] 20	--	10	4	<2	3	3
Conductivity	µS/cm	--	--	3,450	641	858	600	406
Carbonate	mg/L as $CaCO_3$	--	--	<2	<2	<2	<2	<2
HCO_3	mg/L as $CaCO_3$	--	--	10	4	<2	3	3
OH	mg/L as $CaCO_3$	--	--	<2	<2	<2	<2	<2
TDS	mg/L	500	--	NSS	500	700	400	300
F	mg/L	[2] 4.0	--	0.65	0.09	0.12	0.09	0.07
Cl	mg/L	[4] 0.23	--	9.8	0.7	1.0	0.6	0.4
SO_4	mg/L	250	--	2400	290	420	290	180
NO_2	as N mg/L	[2] 1	--	<0.06	<0.06	<0.06	<0.06	<0.06
NO_3	as N mg/L	[2] 10	--	2.38	0.20	0.19	0.11	0.05
$NH_3{}^+NH_4$	as N mg/L	[8]pH dependent	--	6.4	0.5	0.8	0.4	0.3
CN(T)	mg/L	[3] 0.7	1.0	0.005	<0.1	<0.1	<0.1	<0.1
CN_{WAD}	mg/L	[2] 0.2 ([4 + 5] 0.005)	0.5	<0.01	<0.1	<0.1	<0.1	<0.1
CN(F)	mg/L	[2] 0.2 ([4 + 5] 0.005)	--	<0.02	--	--	--	--
CNO	mg/L	--	--	<1	--	--	--	--
CNS	mg/L	--	--	13	--	--	--	--

* See List of Elements and Compounds in the TOC
[1]Alaska water quality standards
[2]Drinking water primary maximum contaminant levels
[3]Human health criteria for non-carcinogens (for consumption of water + aquatic organisms)
[4]Aquatic life criteria for fresh waters (chronic)
[5]Aquatic life criteria for free cyanide shall be measured as WAD cyanide or equivalent
[6]Stockwater + irrigation water criteria
[7]Acute, freshwater ammonia criteria based on pH - criteria not available for pHs <6.5
--: N/A

Table C-4: 2006 Pilot Plant Final Tailings MWMP Dissolved Metals Results

Parameter	Unit	[1]AWQS	World Bank	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
Ag	mg/L	--	--	<0.00005	<0.00003	<0.00003	<0.00003	<0.00003
Al	mg/L	--	--	<0.01	<0.01	<0.01	<0.01	<0.01
As	mg/L	[2] 0.01	0.1	0.162	0.0294	0.0632	0.0390	0.0273
B	mg/L	--	--	0.151	0.015	0.022	0.015	0.009
Ba	mg/L	[2] 2	--	0.0108	0.0078	0.0079	0.0067	0.0060
Be	mg/L	[2] 0.004	--	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Ca	mg/L	--	--	521	78.5	114	75.0	49.0
Cd	mg/L	[2] 0.005	0.1	0.00017	<0.00006	<0.00006	<0.00006	<0.00006
Ce	mg/L	--	--	<0.00009	<0.00009	<0.00009	<0.00009	<0.00009
Co	mg/L	[6] 0.050	--	0.0135	0.0029	0.0023	0.0016	0.0010
Cr	mg/L	[2] 0.1	--	0.0014	0.0007	0.0003	0.0008	0.0005
Cs	mg/L	--	--	0.0018	0.0002	0.0003	0.0002	0.0001
Cu	mg/L	[6] 0.20	0.5	0.0106	0.0022	0.0018	0.0011	0.0005
Fe	mg/L	[4] 1	3.5	0.02	<0.01	<0.01	<0.01	<0.01
Ga	mg/L	--	--	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
Ge	mg/L	--	--	<0.005	<0.0001	<0.0001	<0.0001	<0.0001
Hf	mg/L	--	-	<0.00008	<0.00003	<0.00003	<0.00003	<0.00003
Hg	mg/L	[3] 0.00005	0.01	0.001050	0.000512	0.000293	0.000416	0.000338
In	mg/L	--	--	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
K	mg/L	--	--	25.2	2.22	3.24	2.06	1.14
La	mg/L	--	--	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Li	mg/L	[6] 2.5	--	0.070	<0.002	0.002	<0.002	<0.002
Mg	mg/L	--	--	188	23.3	33.7	21.4	11.3
Mn	mg/L	[3] 0.05	--	5.25	0.610	0.822	0.561	0.329
Mo	mg/L	[6] 0.010	--	0.120	0.0116	0.0175	0.0123	0.0069
Na	mg/L	--	--	49.9	4.05	5.61	3.46	1.79
Nb	mg/L	--	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ni	mg/L	[2] 0.1	0.5	0.0282	0.0061	0.0059	0.0043	0.0032
Pb	mg/L	[6] 0.05	0.1	0.00029	0.00091	0.00010	0.00023	<0.00002
Rb	mg/L	--	--	0.0362	0.0041	0.0062	0.0039	0.0023
Re	mg/L	--	--	0.00033	<0.00003	0.00004	0.00003	0.00004
Sb	mg/L	[2] 0.006	--	0.130	0.0178	0.0273	0.0198	0.0124
Se	mg/L	[4] 0.005	--	0.005	<0.003	<0.003	<0.003	<0.003
Sr	mg/L	--	--	1.36	0.213	0.310	0.212	0.139
Ta	mg/L	--	--	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
Te	mg/L	--	--	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Th	mg/L	--	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tl	mg/L	[3] 0.0017	--	0.0005	<0.0001	<0.0001	<0.0001	<0.0001
U	mg/L	--	--	<0.002	0.00265	0.00063	0.00025	<0.00002
V	mg/L	[6] 0.10	--	0.00008	<0.00006	<0.00006	<0.00006	<0.00006

Table C-4 (Continued): 2006 Pilot Plant Final Tailings MWMP Dissolved Metals Results

Parameter	Unit	[1]AWQS	World Bank	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
Y	mg/L	--	--	0.00002	0.000011	0.000036	0.000011	<0.000005
Zn	mg/L	[6] 2.0	2.0	0.0279	0.0238	0.0116	0.0098	0.0047
Zr	mg/L	--	--	0.0001	<0.00006	<0.00006	<0.00006	<0.00006

[1]Alaska water quality standards
[2]Drinking water primary maximum contaminant levels
[3]Human health criteria for non-carcinogens (for consumption of water + aquatic organisms)
[4]Aquatic life criteria for fresh waters (chronic)
[5]Aquatic life criteria for free cyanide shall be measured as WAD cyanide or equivalent
[6]Stockwater + irrigation water criteria
[7]Acute, freshwater ammonia criteria based on pH - criteria not available for pHs <6.5
--: N/A

Table C-5: 2007 Phase 2 Pilot Plant Transitional Tailings Solids MWMP Species Results

Parameter	Unit	[1]AWQS	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
TSS	mg/L	--	5	3	2	3	2
TDS	mg/L	--	2,900	2,820	2,370	1,160	1,440
pH	units	--	6.85	6.86	6.83	6.65	7.06
Alkalinity	mg/L as $CaCO_3$	--	28	32	35	20	27
Acidity	mg/L as $CaCO_3$	--	<2	<2	<2	<2	<2
Conductivity	μS/cm	--	2,960	2,770	2,350	1,390	1,440
Carbonate	mg/L as $CaCO_3$	--	<2	<2	<2	<2	<2
HCO_3	mg/L as $CaCO_3$	--	28	32	35	20	27
OH	mg/L as $CaCO_3$	--	<2	<2	<2	<2	<2
F	mg/L	[2] 4.0	0.45	0.50	0.47	0.30	0.27
$NH_3{}^+NH_4$	as N mg/L	--	0.8	0.4	0.1	<0.1	0.2
CN(T)	mg/L	--	0.04	0.012	0.014	0.018	0.031
CN(F)	mg/L	--	--	--	--	--	--
CNWAD	mg/L	--	<0.01	<0.005	<0.005	<0.005	0.007
CNO	mg/L	--	--	--	--	--	--
CNS	mg/L	--	--	--	--	--	--
Cl	mg/L	[3] 0.23	3.2	<2	<2	<2	<2
SO_4	mg/L	250	2000	1900	1500	850	1600
NO_2	as N mg/L	--	8.63	3.54	1.27	0.38	1.84
NO_3	as N mg/L	--	<0.5	<0.5	<0.5	<0.05	0.16

[1]Alaska water quality standards
[2]Drinking water primary maximum contaminant levels
[3]Aquatic life criteria for fresh waters (chronic)
--: N/A

Table C-6: 2007 Phase 2 Pilot Plant Final Transitional Tailings Solids MWMP Dissolved Metals Results

Parameter	Unit	[1]AWQS	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
Ag	mg/L	--	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Al	mg/L	--	<0.01	<0.01	0.02	0.02	0.01
As	mg/L	[2] 0.01	0.463	0.506	0.500	0.412	0.402
B	mg/L	--	0.160	0.158	0.0736	0.0207	0.0316
Ba	mg/L	[2] 2	0.0160	0.0185	0.0189	0.0131	0.0428
Be	mg/L	[2] 0.004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Bi	mg/L	--	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Ca	mg/L	--	528	512	555	326	378
Cd	mg/L	[2] 0.005	0.000083	0.000061	0.000043	0.000017	0.000045
Ce	mg/L	--	<0.00007	<0.00007	<0.00007	<0.00007	<0.00007
Co	mg/L	[6] 0.050	0.00665	0.00584	0.00362	0.00150	0.00189
Cr	mg/L	[2] 0.1	<0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Cs	mg/L	--	0.0004	0.0003	0.0002	<0.0001	<0.0001
Cu	mg/L	[6] 0.20	0.0078	0.0052	<0.003	0.0015	0.0036
Fe	mg/L	[4] 1	0.03	0.05	0.02	<0.01	0.03
Ga	mg/L	--	0.00002	0.00005	0.00004	0.00005	0.00006
Ge	mg/L	--	0.00015	0.00015	0.00008	0.00004	0.00005
Hf	mg/L	--	0.000098	0.0000048	0.000061	0.000018	0.00002
Hg	mg/L	[3] 0.00005	0.00001	0.00001	0.000007	0.000005	0.000003
In	mg/L	--	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
K	mg/L	--	17.2	15.9	11.5	5.16	4.70
La	mg/L	--	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Li	mg/L	[6] 2.5	<0.002	<0.002	<0.002	<0.002	<0.002
Mg	mg/L	--	140	122	52.9	8.72	5.58
Mn	mg/L	[3] 0.05	3.27	3.14	2.06	0.870	0.966
Mo	mg/L	[6] 0.010	0.0368	0.0309	0.0115	0.00268	0.00477
Na	mg/L	--	85.5	38.5	1.76	0.34	0.69
Nb	mg/L	--	0.000002	0.000006	<0.000001	<0.000001	<0.000001
Ni	mg/L	[2] 0.1	0.0142	0.0122	0.0073	0.0033	0.0185
Pb	mg/L	[6] 0.05	0.00022	0.0003	0.0008	0.00056	0.0002
Rb	mg/L	--	0.00933	0.00795	0.00484	0.00239	0.00186
Re	mg/L	--	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Sb	mg/L	[2] 0.006	0.0393	0.0448	0.0431	0.0239	0.0222
Se	mg/L	[4] 0.005	0.004	0.003	<0.001	<0.001	<0.001
Si	mg/L	--	2.87	3.56	3.52	1.83	2.03
Sn	mg/L	--	0.00014	0.00032	0.00035	0.00035	0.00045
Sr	mg/L	--	1.90	1.86	1.82	0.0941	0.0003
Ta	mg/L	--	0.000013	0.000008	0.00001	0.00004	0.000001
Te	mg/L	--	<0.00003	<0.00006	<0.00003	<0.00003	<0.00003
Th	mg/L	--	0.000841	0.000519	0.000634	0.000042	0.00149

Table C-6 (Continued): 2007 Phase 2 Pilot Plant Final Transitional Tailings Solids MWMP Dissolved Metals Results

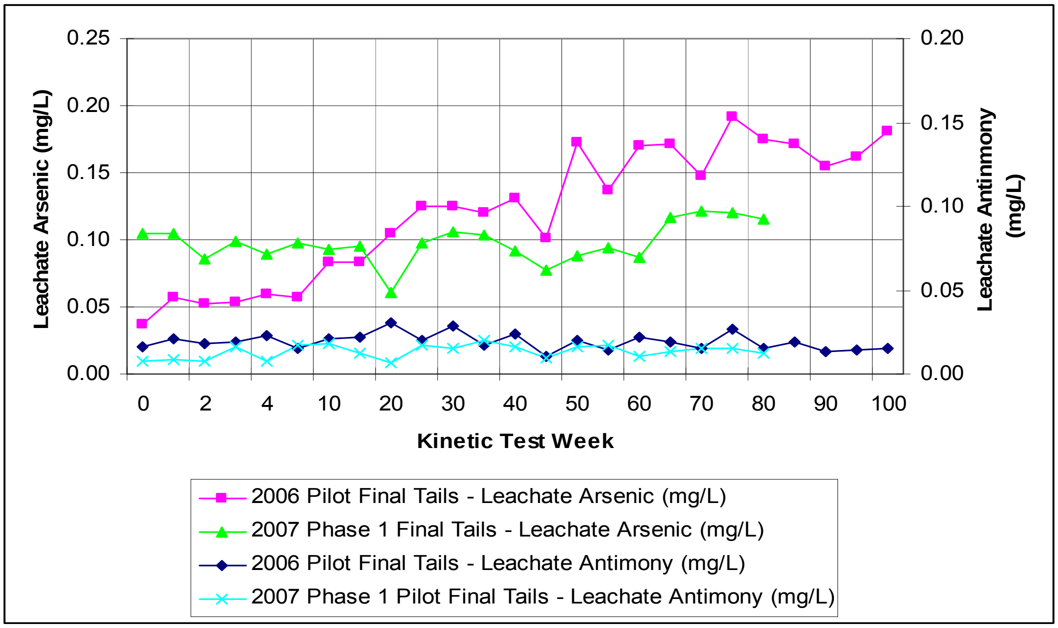
Parameter	Unit	[1]AWQS	Leachate	1st DI Rinse	2nd DI Rinse	3rd DI Rinse	4th DI Rinse
Ti	mg/L	--	0.0003	0.0006	0.0003	0.0003	0.0003
Tl	mg/L	[3] 0.0017	0.000058	0.000046	0.00002	0.000004	0.00001
U	mg/L	--	0.00119	0.00177	0.000978	0.000565	0.000956
V	mg/L	[6] 0.10	0.00025	0.00041	0.00030	0.0006	0.00059
W	mg/L	--	0.00019	0.00024	0.00023	0.00011	0.00016
Y	mg/L	--	0.000010	0.000013	0.000008	0.000005	0.000009
Zn	mg/L	[6] 2.0	0.008	0.007	0.004	0.003	0.010
Zr	mg/L	--	0.00014	0.00007	0.00032	0.00023	0.00003

[1]Alaska water quality criteria
[2]Drinking water primary maximum contaminant levels
[3]Human health criteria for non-carcinogens (for consumption of water + aquatic organisms)
[4]Aquatic life criteria for fresh waters (chronic)
[5]Aquatic life criteria for free cyanide shall be measured as WAD cyanide or equivalent
[6]Stockwater + irrigation water criteria
[7]Acute, freshwater ammonia criteria based on pH - criteria not available for pHs <6.5
--: N/A

No adverse trends regarding acid generation are yet evident, and the test data available indicate that generation of excess acid from the tailings as the test proceeds to completion is not indicated. Figure C-5 shows the trends of arsenic and antimony dissolution from the two final tailings samples. The arsenic release rate from the 2006 pilot final tailings sample shows an increasing release rate; however, after 50 weeks, it appears to have stabilized in the 0.15 to 0.20 mg/L range. The 2007 Phase 1 final tailings appear to have stabilized in the 0.10 to 0.15 mg/L range at 65 weeks. Antimony release for both samples is steady.

Metal leaching concentrations of selenium, lead, and mercury are very low or below analysis detection limits. These kinetic tests will continue to be conducted through to practical completion to provide additional information for the environmental permitting stage of the proposed project, to confirm arsenic leachability, and to demonstrate the non-acid generating properties of the final tails samples.

Figure C-5: Kinetic Cell Testing Profiles (As, Sb) of Two Final Tailings Samples

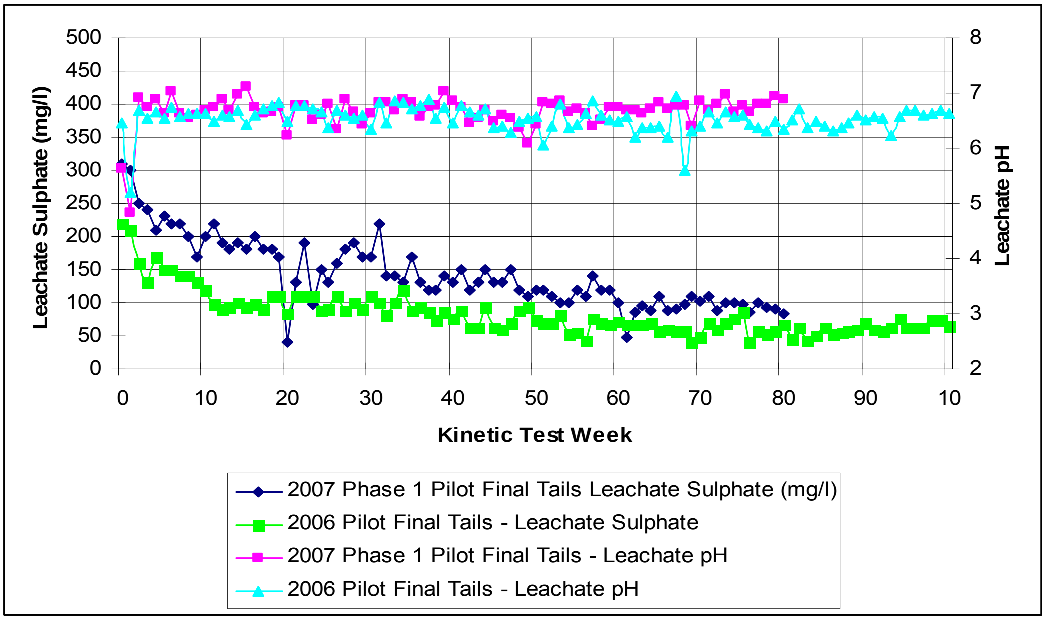


C.2.2 Kinetic Testing of Final Plant Tailings

Analytical data from two sets of humidity cells (kinetic testing) for both the 2006 pilot plant final tailings and the 2007 Phase 1 pilot-plant final tailings were used to evaluate the long-term geochemical characteristics. Both samples used are the actual residue solids from the MWMP testing, where four DI washes have been applied prior to kinetic testing as part of the MWMP test procedure. MWMP washed solids are being used for kinetic testing due to sample mass limitations, and their use for this purpose is considered appropriate as the MWMP test simulates environmental conditions that would be encountered. A summary of the kinetic tests leachate analysis is shown in Tables A-3 and A-4 in Appendix A.

Figure C-6 shows the sulfate production and pH profiles of the leachates from the kinetic cell tests. The pH profiles of both samples show an initial dip, and then stabilize to a pH of 6.5 to 7.0. Sulfate production for both samples show a steady declining and then stabilizing trend.

Figure C-6: Kinetic Cell Testing Profiles (pH, sulfate) of Two Final Tailings Samples



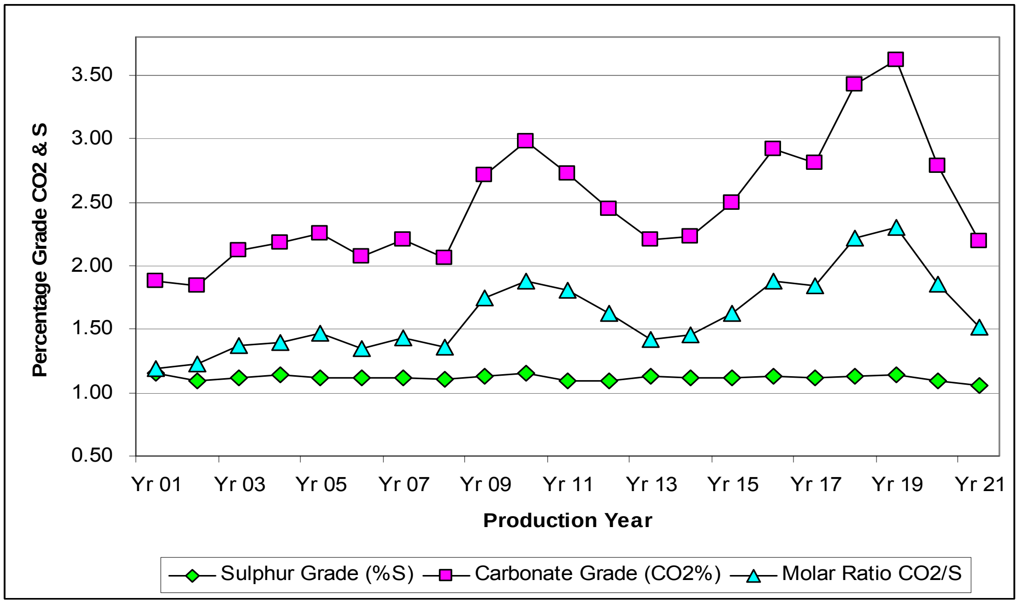
C.2.3 ABA Analysis of Final Plant Tails

The metallurgical process adopted for Donlin Gold would be favorable for the establishment of tailings that would not be acid producing as a result of near complete sulfide sulfur oxidation.

The average process plant feed grade would be approximately 1.12% sulfur, with no significant sulfate sulfur present. The process plant feed averages 2.51% carbonate as carbon dioxide (CO_2), which would be a molar excess of 37% to the contained sulfur in the process plant feed after the second year of operations, meaning that the ore would have excess carbonate content to sulfur content.

Figure C-7 shows the study of the process plant feed production schedule of sulfur and carbonate and calculated molar ratio of CO_2/S. It can be seen that the molar ratio (CO_2/S) varies from 1.2 to 2.3 and molar content of carbonate always remains in excess of sulfur.

Figure C-7: Production Plan for Sulfur, Carbonate, and Molar Ratio (Carbonate/Sulfur)



Ore fed to the process plant would be passed through a relatively large flotation circuit, where approximately 98% of the contained sulfur in the ore is floated to a pyritic concentrate, leaving the flotation tails barren of sulfur with about 0.01% to 0.03% sulfur remaining.

The concentrate from the flotation circuit would be pre-acidified using dilute autoclave acidic liquor, and then fed in entirety to a pressure oxidation circuit. In the autoclave slurry temperature would be autonomously raised to 220°C to 225°C and oxygen sparged throughout under high pressure, to near completely (approximately 98% oxidation extent) oxidizing the contained sulfide in the concentrates, producing sulfuric acid and sulfate precipitates. Products from the autoclave also would be essentially significantly depleted in sulfide sulfur content.

A hot-curing stage follows the autoclave, which promotes dissolution of sulfate-based precipitates (i.e., basic iron sulfate) into soluble iron sulfate form, which would then be susceptible to neutralization and precipitation as iron hydroxides.

The acidic liquor and soluble metal sulfates generated from the hot-cure circuit would be separated and washed from the solids through a four-stage CCD wash circuit, and directed to a neutralization circuit.

In the neutralization circuit, flotation tails and lime would be added to the acidic liquor (with air-sparging) to provide a final tail with neutral pH and the majority of the metal sulfates precipitated as hydroxides, with the notable exception of magnesium, which remains soluble at neutral pH. Table C-7 shows the reported ABA test results testing undertaken on the 2006 and 2007 Phase 1 and 2 pilot-plant final tails samples.

Table C-7: ABA Testing Results on Pilot Plant Final Tails Samples

Parameter	Unit	Pre-Feasibility Pilot Final Tailings Solids Oct 2006	Feasibility Pilot (Phase 1) Final Tailings Solids Feb 2007	Feasibility Pilot (Phase 2) Final Tailings Solids Oct 2008
Paste pH	units	7.80	7.39	8.07
Fizz Rate	-	1	1	1
Sample	weight(g)	1.97	1.96	1.98
HCl added	mL	20.00	20.00	30.20
HCl	Normality	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10
NaOH to	pH=8.3 mL	11.30	15.35	18.90
Final pH	units	1.95	1.71	1.55
NP	t $CaCO_3$/1000 t	22.1	11.9	28.5
AP	t $CaCO_3$/1000 t	6.2	3.4	2.28
Net NP	t $CaCO_3$/1000 t	15.9	8.5	26.2
NP/AP	ratio	3.6	3.5	12.5
S	%	0.75	0.578	0.474
SO_4^-S	%	0.55	0.47	0.40
Sulfide-S	%	0.20	0.11	0.07
C	%	0.59	0.413	0.627
Carbonate	$\%CO_3$	1.09	0.753	1.40

Jarosite is known to form (precipitate) within either the autoclave or hot-cure circuits; this precipitate can generate acid in tails stored under certain conditions for an extended period of time.

Analysis of mineralogy indicates that up to 23% of the sulfate sulfur in the 2006 pilot final tailings sample is in the form of jarosite with 7% in the 2007 Phase 1 pilot plant final tails and 8% in the 2007 Phase 2 pilot-plant final tails. Modifying the calculated ABA parameters, assuming that jarosite is an acid-forming component of the sulfate, indicates that the tailings would still contain an excess of neutralization capacity. Subsequent testing using modified ABA with siderite correction indicated a sample of “Final Tails 2” had an NP/AP ratio of 99.3 indicating considerable NP compared to AP.

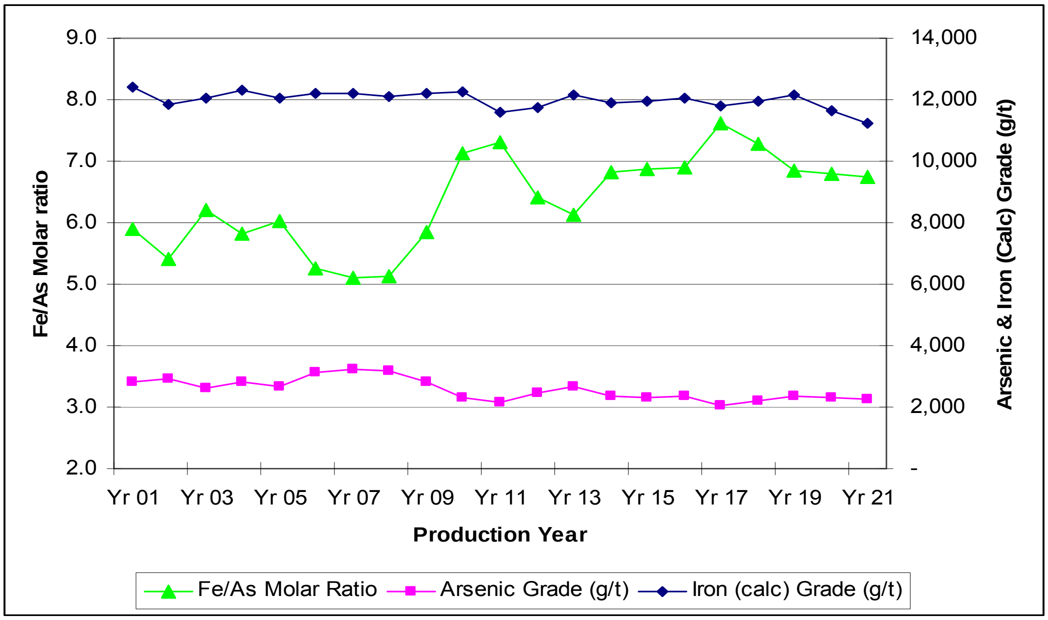
Monitoring would be established on the actual plant final tailings stream, including appropriate mineralogy, to establish the acid producing potential incorporating acid loads from jarosite precipitates formed either in the hot cure or autoclave processes.

C.2.4 Arsenic Stability in Final Plant Tailings

Pressure oxidation (POX) of arsenopyrite in the presence of excess iron is generally considered a best-practice process for generation of stable arsenic precipitates, in forms such as scorodite, for disposal into a tailings storage facility. Promoting the formation of stable precipitates is particularly favored when molecular ratio of iron to arsenic in the applicable process solutions exceeds four.

Within the plant feed for Donlin Gold, there would be sufficient iron to provide the recommended molar ratio of 4:1 iron to arsenic. Figure C-8 shows the production trends of arsenic and iron content (calculated from arsenopyrite and pyrite iron contents only) within the process plant feed schedule, along with the calculated molar ratio of arsenic to iron.

Figure C-8: Production Plan for Arsenic, Iron (calculated with Arsenopyrite and Pyrite), and Molar Ratio of Iron/Arsenic



The actual assay grade of iron typically is double the iron content that is accounted for by arsenopyrite and pyrite alone and is more typically at grades of 15,000 to 40,000 ppm. This additional iron present in the ore is as carbonates, mainly in ferroan dolomite and minor siderite. As iron dissolves from the ferroan dolomites and siderite in the pre-acidification, POX, and acidic liquor neutralization processes, this iron would then also become available for complexing with arsenic, to further increase the iron/arsenic (Fe/As) ratio in process solutions beyond that indicated in Figure C-8.

Experimental arsenic speciation mineralogy was carried out by Canadian Light Source on the various key pilot test streams, including both the detoxified CIL tails, and the neutralized tails. This experimental mineralogy indicated the significant proportion of arsenic in the tailings streams occurs as scorodite-based compounds.

C.2.5 Mercury Precipitation

The cyanide within the CIL circuit dissolves a portion of the mercury in the solids feed to the circuit. A portion of this dissolved mercury in the CIL circuit would be adsorbed onto the circuit carbon, and would then be recovered from the carbon via stripping and carbon regeneration. However, the capacity of the circuit carbon to completely adsorb the mercury is limited; therefore, a component of the soluble mercury would remain in the CIL tails solution. This remaining soluble mercury would then be blended with the detoxified CIL tails into the neutralization circuit, which then reports to the TSF.

Reductions in soluble mercury content in recirculating plant waters would be achieved by addition of mercury precipitation reagents, by conversion of soluble mercury to a stable mercury sulfide (HgS) product. This is currently practiced using the Cherokee Chemical

University of Nevada-Reno (UNR) reagent suite at operating mine sites in the U.S. and Dominican Republic.

To confirm the applicability of the UNR mercury precipitation reagents, a set of tests were undertaken. Leach tailings liquor was generated by cyanidation of available 2007 Phase 2 pilot autoclave product, with the leach tailings then cyanide detoxified. No carbon was used in the leach test to ensure adequate mercury levels were maintained in the leach tailings filtrate, which measured 876 parts per billion (ppb) Hg. Three UNR reagents were tested on both the leach slurry and leach tailings filtrate, at varying dosages.

Figure C-9: Mercury Precipitation Tests on Detoxified Leach Tails Filtrate

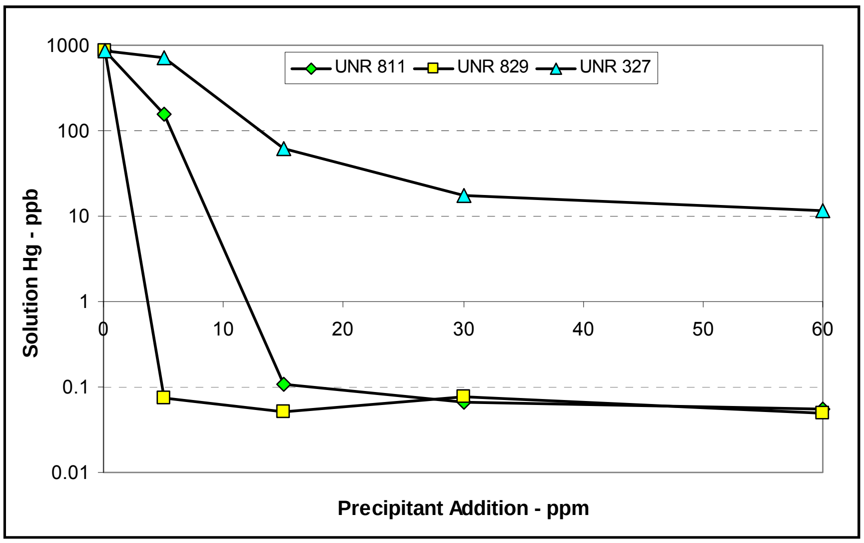
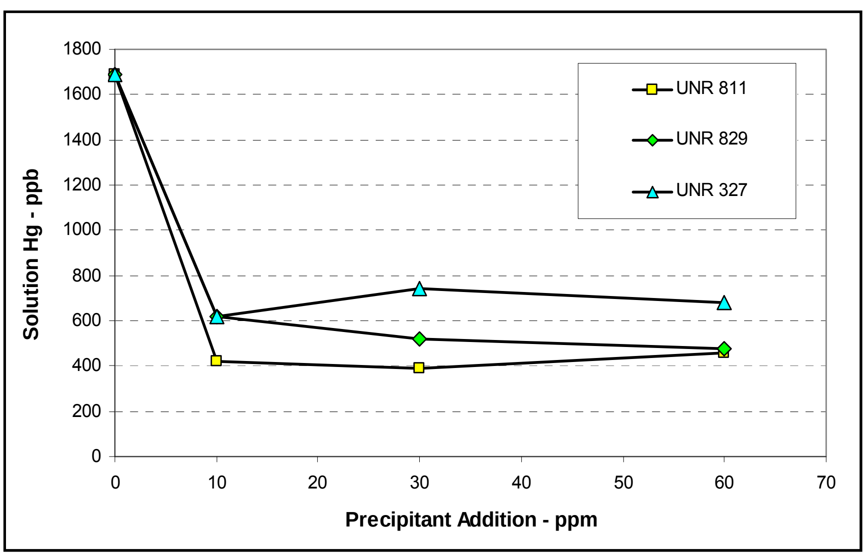


Figure C-10: Mercury Precipitation Tests on Detoxified Leach Tails Slurry



The results of precipitation testing on the detoxified tailings slurry did not result in the anticipated reductions of soluble mercury, with 400 to 800 ppb Hg remaining in solution up to dosages of 60 ppm UNR reagents (Figure C-10). However, precipitation tests undertaken on the leach tailings filtrate were comparatively successful, with UNR 829 reducing mercury concentration in solution to below 0.1 ppm with less than 5 ppm reagent addition (Figure C-9). Within the plant, mercury treatment can be carried out on the tailings decant return water, either through treating the water returning to the process plant, or treatment of a recirculating flow on the decant pond itself which would be located on the lined TSF impoundment.

Based on the testwork completed, the process plant design would include a dosage facility to add Cherokee UNR reagent to a recirculating water stream. This will promote precipitation of mercury in solution into a stable HgS solid. The use of other mercury control reagents would be explored with the goal of reducing the level of soluble mercury in solution and rendering the mercury into a stable compound that would be co-mingled with the tailings solids within the TSF.

C.3 Overburden Characterization

Six samples of overburden were collected by Barrick as part of the feasibility study investigations primarily as an input into predictions of water chemistry for runoff from final covers placed on completed waste rock pile. The samples were subjected to Meteoric Water Mobility Procedure (MWMP) (SRK 2007b).

C.4 Water Quality Predictions

The results of the static, kinetic, and MWMP testing were used to predict the water quality from the WRFs, pit wall rock, the overburden dumps, and the tailings solids (beach and buried tailings), the long-term tailings solution chemistry, and the pit lake.

C.4.1 Process Pond Water and Buried Tailings Pore Water Quality Predictions

Process Pond

The process pond water quality was estimated based on the tailings filtrate water quality adjusted as follows (SRK 2007, 2015d):

- Process pond input water chemistry (Table C-2, Feasibility Pilot (2007 Phase 2), Final Tailings Filtrate) was multiplied by a re-cycle factor of 3.
- The resulting chemistry was then modeled with Geochemist's Workbench (GWB) to determine whether the concentrations of any ions would be affected by reaching the solubility of minerals. The equilibrated chemistry was obtained assuming these minerals precipitate.
- Finally, the interaction of the equilibrated process pond water chemistry with tailings under the sub-oxic conditions resulting from consumption of oxygen by dissolved organic carbon was evaluated using GWB.

All resulting solutions were checked for ion balances.

The effect of re-cycling affects the major ions by causing limited precipitation of calcium and sulfate (as gypsum), and alkalinity and calcium (as carbonates). Other minor effects included precipitation of barium (as barite), copper (as copper carbonate), aluminum (as aluminum hydroxide), iron (as iron hydroxide) and fluoride (as fluorite). For all other ions, concentrations are simply three times the process water concentration.

Results are provided in Table C-8. These results can be applied more generally as follows to any input chemistry. Concentrations controlled by secondary mineral solubility are noted in the table. The concentrations of other elements are three times the input chemistry.

The effects on cyanide and its degradation by-products (cyanate, thiocyanate, ammonia and nitrate) were not modeled. Significant seasonal variations can be expected due to lower temperature, reduced sunlight and ice cover in the winter. Degradation may be more appropriately evaluated based on operational experience.

Buried Tailings Pore Water

The short term pore water chemistry calculation assumes that reducing conditions could develop in the saturated buried tailings as the impoundment is constructed. The reductants were assumed to be residual process reagents (MIBC, PAX) or dissolved organic carbon (DOC) from shale components of the tailings indicated by leaching testwork (SRK 2007). As oxygen is consumed, other reducing reactions can occur such as de-nitrification of nitrate and eventually reduction of iron. The latter increases the mobility of arsenic (SRK 2015d).

The predicted deep burial pore water quality is shown in Table C-8. The ion balance was -7% which is considered within acceptable tolerance given the number of minerals involved and shift in redox conditions modelled.

Outcomes for Eh, pH, sulfate, alkalinity, arsenic, antimony, calcium, magnesium and potassium are controlled by mineral solubility. The following specific effects occur:

- pH decreases due to accumulation of CO_2 from oxidation of DOC. This also causes alkalinity to increase.
- The decrease in pH also increases the solubility of carbonates in the tailings resulting in net dissolution of dolomite.
- The tailings contain gypsum and further gypsum precipitates causing calcium to be removed from solution. No similar mechanism removes Mg due to the high solubility of $MgSO_4$ minerals and as a result Mg increases relative to calcium.
- The pore water is effectively at equilibrium with jarosite resulting in no net dissolution as shown by unchanged K.
- Ferric arsenate represented by scorodite is dissolved due to reductive dissolution.
- Iron released by dissolution of various minerals is partially re-precipitated as ferric hydroxide.

The effect of suboxic conditions on cyanide and its degradation by products could not be modelled. Qualitatively, degradation is expected to occur to bicarbonate, sulfate and nitrogen.

Table C-8: Predicted Process Pond and Buried Tailings Pore Water Quality (dissolved)

Parameter	Unit	Solubility Constrained	Process Pond	Buried Tailings Process DOC
Eh	mV			300
pH	s.u.	X	7.7	5.5
Sulfate	mg/L	X	5800	4400
NH_4	mgN/L		29	29
Alkalinity	mg/L		25	530
Al	mg/L	X	0.013	0.0056
Sb	mg/L	X	0.022	1.1
As	mg/L	X	3.3	15
Ba	mg/L	X	0.011	0.011
Be	mg/L		<0.00006	<0.00006
B	mg/L		0.59	0.59
Cd	mg/L		0.00073	0.00073
Cl	mg/L		26	25
Ca	mg/L	X	610	1000
Cr	mg/L		0.012	0.012
Co	mg/L		0.019	0.019
Cu	mg/L	X	0.018	0.018
Fe	mg/L	X	0.0044	98
F	mg/L	X	2	2
Pb	mg/L		0.003	0.003
Li	mg/L		<0.006	<0.006
Mg	mg/L	X	440	1000
Mn	mg/L	X	2	2
Hg[1]	mg/L		0.073	0.073
Mo	mg/L		0.23	0.23
Ni	mg/L		0.062	0.062
K	mg/L	X	120	120
Se	mg/L		0.042	0.042
Si	mg/L		7	7
Na	mg/L		1100	1100
Sr	mg/L		7.9	7.9
Tl	mg/L		0.00041	0.00041
V	mg/L		0.0048	0.0048
Zn	mg/L		0.033	0.033

Source: Table 1 (SRK 2015b)
Note 1: Hg concentration is derived from geochemical modeling. Actual pore water and pond concentrations are anticipated to be <0.010 mg/L based on reductions observed at a Barrick facility using UNR reagent.

C.4.2 Overburden

Six samples of overburden were collected as part of the feasibility study investigations primarily as an input into predictions of water chemistry for runoff from final covers placed on completed waste rock pile. The samples were subjected to MWMP testing, which indicated low concentrations of regulated parameters. Overburden is classified as Category 8 in the waste rock characterization matrix (SRK 2007a). The analytical results are presented in Table C-9.

C.4.3 Waste Rock Water Quality Predictions

The waste rock pore water chemistry was predicted based on placement of NAG and PAG material as described in *Waste Rock Management Plan Volume IIIB* (SRK 2016). Waste rock predictions are provided for the NAG and PAG dumps based on laboratory tests scaled up to full scale waste rock dumps which incorporate the quantities in each Waste Rock Management Category (WRMC) and water flow. These waste rock pore water predictions are for water that does not runoff but would report to the foundation and emerge as seepage or discharge to groundwater (SRK 2007b).

Waste rock predictions are provided for the NAG and PAG dumps. The predictions are based on laboratory tests scaled up to full scale waste rock dumps which incorporate the quantities in each Waste Rock Management Category (WRMC) and water flow.

All waste rock predictions assume that the dumps are fully oxygenated. This is a conservative assumption that probably significantly affects the calculation of drainage chemistry under acidic conditions.

Since both NAG and PAG dumps will contain mixtures of two or more WRMCs, there is a need to assess the effect of mixing at different scales. Two methods were used to estimate water quality (SRK 2007a):

- Case 1: Well-Mixed Waste Rock. The WRMCs were assumed to be completely mixed such that they affectively function as a homogeneous mineral mixture. Under these conditions, acidity is generated at the grain scale but is immediately mitigated by contact with nearby carbonate minerals. Acidic pore water does not occur beyond the grain scale.
- Case 2: Poorly Mixed Waste Rock: The WRMCs are assumed to generate acidic and non-acidic waters separately. The waters then mix. In this case, acidity from the PAG components is only mitigated by reaction with dissolved alkalinity. This is a worst case because it does not allow for direct reaction between acidic waters and carbonate minerals. This reaction tends to be an inefficient use of solid alkalinity because precipitates coat the carbonate minerals.

The 50^{th}, 75^{th}, and 95^{th} percentile predictions are presented in Tables C-10a, b, and c, respectively (SRK 2015a).

C.4.4 Pit Walls Water Quality Predictions

The method to determine pit wall rock runoff water quality is the same as that for the waste rock. The concentrations were calculated on a per square meter basis for the wall assuming a reacting thickness of 6.6 ft (2 m). This thickness was selected to represent the typical depth of overblast that results in a fractured zone in the pit walls. This thickness was assumed to be 6.6 ft (2 m). The following refinements were incorporated into the method to address depletion of leachable components from the pit walls.

Table C-9: Selected MWMP Results for Overburden Samples

Parameter	Unit	Colluvium Coarse	Colluvium Medium	Colluvium Fine	Terrace Gravels Coarse	Terrace Gravels Medium	Terrace Gravels Fine
						Mineralized Area	Mineralized Area
pH	pH Units	6.76	6.26	6.57	6.4	6.48	6.36
Aluminum, Dissolved	mg/L	0.49	0.23	0.8	4.2	<0.045	<0.045
Antimony, Dissolved	mg/L	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Arsenic, Dissolved	mg/L	0.011	<0.005	<0.005	<0.005	0.006	0.012
Barium, Dissolved	mg/L	0.013	0.38	0.058	0.057	<0.01	<0.01
Beryllium, Dissolved	mg/L	<0.001	<0. 001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium, Dissolved	mg/L	0.94	39	9.5	1.2	1.2	<0.5
Chloride	mg/L	1.9	4.6	3.1	1.9	<1	<1
Copper, Dissolved	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride	mg/L	0.34	0.22	0.17	0.19	0.33	0.23
Iron, Dissolved	mg/L	0.46	0.28	1.2	5.9	0.017	0.045
Lead, Dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium, Dissolved	mg/L	<0.5	4.4	1.3	0.71	<0.5	<0.5
Manganese, Dissolved	mg/L	0.019	0.48	0.086	0.12	<0.005	0.0063
Nickel, Dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Potassium, Dissolved	mg/L	<0.5	4.2	0.72	0.68	<0.5	<0.5
Selenium, Dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium, Dissolved	mg/L	3.2	11	8.8	5.9	2.2	1.7
Sulfate	mg/L	3.4	67	11	3.2	<1	<1
Total Alkalinity	mg/L as $CaCO_3$	6	20	22	4	10	4
Zinc, Dissolved	mg/L	<0.01	0.014	0.019	0.049	<0.01	<0.01

Source: Table 4-1 (SRK 2007a) and SRK 2015c

Table C-10a: Waste Rock Pore Water Concentration Estimates, 50th Percentile

		Dump Sector	NAG	NAG	NAG	NAG	NAG	NAG	PAG	PAG	PAG	PAG
		Time	LOM Year 13	LOM Year 13	LOM Year 19	LOM Year 19	LOM Year 22	LOM Year 19	LOM Year 10	LOM Year 10	Closure Year 9	Closure Year 9
Parameter	Unit	Case	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed
pH	s.u.		7.7	7.7	7.7	7.7	7.7	7.6	7.7	7.6	6.4	3.5
Sulfate	mg/L		2000	1900	2000	2000	2000	3900	2000	2600	42000	180000
Acidity	mg/L		0.17	0.17	0.17	0.17	0.17	8.8	0.009	0.17	0.028	190000
Alkalinity	mg/L		23	23	23	22	24	17	24	20	2.8	0.78
Al	mg/L		0.029	0.029	0.029	0.029	0.029	1.6	0.0006	0.00048	0.00072	32000
Sb	mg/L		3.1	3.1	3.1	3.1	3.1	3	3.1	3.1	3.1	2.8
As	mg/L		21	10	21	19	21	21	21	20	21	27
Ba	mg/L		0.0047	0.0046	0.0047	0.0046	0.0047	0.0043	0.0047	0.0045	0.0033	0.0032
Be	mg/L		0.00068	0.00068	0.00068	0.00068	0.00068	0.021	0.00068	0.00068	0.00068	0.074
B	mg/L		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cd	mg/L		0.0013	0.0013	0.0013	0.0013	0.0013	0.0047	0.0013	0.0013	0.0005	0.065
Ca	mg/L		710	680	710	690	710	610	710	660	390	400
Cr	mg/L		0.031	0.031	0.031	0.031	0.031	0.058	0.031	0.031	0.031	0.13
Co	mg/L		0.24	0.21	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1.1
Cu	mg/L		0.025	0.025	0.025	0.025	0.025	0.024	0.025	0.026	13	33
F	mg/L		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Fe	mg/L		0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0089	710
Pb	mg/L		0.3	0.3	0.81	0.79	0.96	0.92	0.9	4.5	1	0.36
Li	mg/L		0.07	0.07	0.07	0.07	0.07	0.52	0.07	0.07	1.5	0.0000000037
Mg	mg/L		64	70	64	86	64	610	64	240	7500	1500
Mn	mg/L		7.5	7.3	8.8	9	8.8	8.5	8.8	9.6	370	170
Hg	mg/L		0.00019	0.00019	0.00019	0.00019	0.00019	0.00018	0.00019	0.00019	0.00019	0.00018
Mo	mg/L		0.82	0.82	0.82	0.82	0.82	0.79	0.82	0.82	0.82	0.72
Ni	mg/L		1.6	1.4	1.6	1.5	1.6	1.6	1.6	1.6	1.6	2.3
P	mg/L		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
K	mg/L		27	27	27	27	27	200	27	27	590	0.0000014
Se	mg/L		0.86	0.85	0.86	0.88	0.86	1.7	0.86	1.1	18	80
Si	mg/L		31	31	31	31	31	31	31	31	31	31
Ag	mg/L		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.0018
Na	mg/L		0	0	0	0	0	0	0	0	4400	0.01
Sr	mg/L		6.2	5.9	6.2	6	6.2	5.3	6.2	5.8	3.4	3.5
Tl	mg/L		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0011
V	mg/L		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Zn	mg/L		1.9	1.8	5.1	4.9	6	5.8	5.9	28	400	190
TDS	mg/L		2800	2700	2800	2800	2800	5100	2800	3500	55000	220000
NO_3	mgN/L		36	36	23	23	0	0	14	14	0	0
NH_4	mgN/L		3.9	3.9	2.5	2.5	0	0	1.6	1.6	0	0
NO_2	mgN/L		0.12	0.12	0.076	0.076	0	0	0.048	0.048	0	0

Source: SRK 2015a

Table C-10b: Waste Rock Pore Water Concentration Estimates, 75th Percentile

		Dump Sector	NAG	NAG	NAG	NAG	NAG	NAG	PAG	PAG	PAG	PAG
		Time	LOM Year 13	LOM Year 13	LOM Year 19	LOM Year 19	LOM Year 22	LOM Year 19	LOM Year 10	LOM Year 10	Closure Year 9	Closure Year 9
Parameter	**Unit**	**Case**	**Well Mixed**	**Poorly Mixed**	**Well Mixed**	**Poorly Mixed**	**Well Mixed**	**Poorly Mixed**	**Well Mixed**	**Poorly Mixed**	**Well Mixed**	**Poorly Mixed**
pH	s.u.		7.7	7.6	7.7	7.6	7.7	7.5	7.7	7.6	6.7	3.5
Sulfate	mg/L		2000	2000	2000	2700	2000	5300	2000	2500	52000	180000
Acidity	mg/L		0.17	0.17	0.17	0.17	0.17	23	0.17	0.17	0.18	190000
Alkalinity	mg/L		23	20	24	18	24	17	23	19	5.1	0.78
Al	mg/L		0.029	0.029	0.029	0.029	0.029	4.2	0.029	0.029	0.029	30000
Sb	mg/L		3.1	3.1	3.1	3.1	3.1	3	3.1	3.1	3.1	2.8
As	mg/L		21	15	21	20	21	22	21	20	21	27
Ba	mg/L		0.0047	0.0045	0.0047	0.0045	0.0047	0.0041	0.0047	0.0045	0.0031	0.0032
Be	mg/L		0.00068	0.00068	0.00068	0.00068	0.00068	0.021	0.00068	0.00068	0.00068	0.074
B	mg/L		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cd	mg/L		0.0013	0.0013	0.0013	0.0013	0.0013	0.0069	0.0013	0.0013	0.0005	0.065
Ca	mg/L		710	670	710	650	710	570	710	660	370	400
Cr	mg/L		0.031	0.031	0.031	0.031	0.031	0.058	0.031	0.031	0.031	0.13
Co	mg/L		0.24	0.24	0.24	0.24	0.24	0.28	0.24	0.24	0.24	1.1
Cu	mg/L		0.025	0.028	0.025	0.029	0.025	0.031	0.025	0.029	3.2	33
F	mg/L		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Fe	mg/L		0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0051	710
Pb	mg/L		0.42	0.41	1.1	1.1	1.3	1.3	0.64	0.7	2.8	0.46
Li	mg/L		0.07	0.07	0.07	0.07	0.07	0.53	0.07	0.07	0.07	0.0000000037
Mg	mg/L		64	150	64	290	64	990	64	220	8600	1500
Mn	mg/L		8.8	8.9	8.8	11	8.8	11	8.8	9.8	370	170
Hg	mg/L		0.00019	0.00019	0.00019	0.00019	0.00019	0.00018	0.00019	0.00019	0.00019	0.00018
Mo	mg/L		0.82	0.82	0.82	0.82	0.82	0.79	0.82	0.82	0.82	0.72
Ni	mg/L		1.6	1.5	1.6	1.6	1.6	1.7	1.6	1.6	1.6	2.3
P	mg/L		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
K	mg/L		27	27	27	27	27	200	27	27	27	0.0000014
Se	mg/L		0.86	0.9	0.86	1.2	0.86	2.3	0.86	1.1	23	80
Si	mg/L		31	31	31	31	31	31	31	31	31	31
Ag	mg/L		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.0018
Na	mg/L		0	0	0	0	0	0	0	0	7500	0.01
Sr	mg/L		6.2	5.8	6.2	5.7	6.2	5	6.2	5.8	3.2	3.5
Tl	mg/L		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0011
V	mg/L		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Zn	mg/L		2.4	2.3	6.4	6.2	7.6	7.3	3.6	4.1	400	190
TDS	mg/L		2800	2900	2800	3700	2800	6900	2800	3400	61000	210000
NO3	mgN/L		36	36	23	23	0	0	14	14	0	0
NH4	mgN/L		3.9	3.9	2.5	2.5	0	0	1.6	1.6	0	0
NO2	mgN/L		0.12	0.12	0.076	0.076	0	0	0.048	0.048	0	0
Source: SRK 2015a												

Table C-10c: Waste Rock Pore Water Concentration Estimates, 95th Percentile

		Dump Sector	NAG	NAG	NAG	NAG	NAG	NAG	PAG	PAG	PAG	PAG
		Time	LOM Year 13	LOM Year 13	LOM Year 19	LOM Year 19	LOM Year 22	LOM Year 19	LOM Year 10	LOM Year 10	Closure Year 9	Closure Year 9
Parameter	Unit	Case	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed	Well Mixed	Poorly Mixed
pH	s.u.		7.7	7.6	7.7	7.5	7.7	7.5	7.7	7.5	6.8	3.4
Sulfate	mg/L		2000	2800	2000	4400	2000	7800	2000	4500	65000	40000
Acidity	mg/L		0.17	0.17	0.17	0.17	0.17	260	0.17	0.17	0.013	42000
Alkalinity	mg/L		23	18	24	17	24	17	23	17	6.3	0.95
Al	mg/L		0.029	0.029	0.029	0.029	0.029	46	0.029	0.029	0.00021	5300
Sb	mg/L		3.1	3.1	3.1	3.1	3.1	3	3.1	3.1	3.1	2.8
As	mg/L		21	20	21	20	21	22	21	20	21	27
Ba	mg/L		0.0047	0.0044	0.0047	0.0042	0.0047	0.0039	0.0047	0.0042	0.003	0.0038
Be	mg/L		0.00068	0.00068	0.00068	0.00068	0.00068	0.021	0.00068	0.00068	0.00068	0.074
B	mg/L		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cd	mg/L		0.0013	0.0013	0.0013	0.0013	0.0013	0.013	0.0013	0.0013	0.0005	0.065
Ca	mg/L		710	650	710	590	710	530	710	590	360	500
Cr	mg/L		0.031	0.031	0.031	0.031	0.031	0.058	0.031	0.031	0.031	0.13
Co	mg/L		0.24	0.24	0.24	0.24	0.24	0.42	0.24	0.24	0.24	1.1
Cu	mg/L		0.025	0.028	0.025	0.032	0.025	0.034	0.025	0.036	2	36
F	mg/L		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Fe	mg/L		0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0043	890
Pb	mg/L		0.51	0.5	1.4	1.4	1.7	1.6	0.78	0.85	2.8	0.5
Li	mg/L		0.07	0.07	0.07	0.07	0.07	0.78	0.07	0.07	0.07	0.0000000044
Mg	mg/L		64	300	64	750	64	1600	64	760	11000	1900
Mn	mg/L		8.8	11	8.8	15	8.8	17	8.8	16	390	190
Hg	mg/L		0.00019	0.00019	0.00019	0.00019	0.00019	0.00018	0.00019	0.00019	0.00019	0.00018
Mo	mg/L		0.82	0.82	0.82	0.82	0.82	0.79	0.82	0.82	0.82	0.72
Ni	mg/L		1.6	1.6	1.6	1.6	1.6	1.8	1.6	1.6	1.6	2.3
P	mg/L		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
K	mg/L		27	27	27	27	27	300	27	27	27	0.0000017
Se	mg/L		0.86	1.2	0.86	1.9	0.87	3.4	0.86	2	28	18
Si	mg/L		31	31	31	31	31	31	31	31	31	31
Ag	mg/L		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.0018
Na	mg/L		0	0	0	0	0	0	0	0	9900	0.01
Sr	mg/L		6.2	5.6	6.2	5.1	6.2	4.6	6.2	5.1	3.1	4.3
Tl	mg/L		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0011
V	mg/L		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Zn	mg/L		3	2.9	8.1	7.9	9.6	9.2	4.6	15	400	200
TDS	mg/L		2800	3800	2800	5800	2800	10000	2800	5900	76000	49000
NO_3	mgN/L		36	36	23	23	0	0	14	14	0	0
NH_4	mgN/L		3.9	3.9	2.5	2.5	0	0	1.6	1.6	0	0
NO_2	mgN/L		0.12	0.12	0.076	0.076	0	0	0.048	0.048	0	0
Source: SRK 2015a												

For NAG walls, the rate of depletion indicated by humidity cells showed that molybdenum, selenium and sulfur would deplete within a few years; therefore, the use of constant weathering rates to represent long-term behavior was not appropriate. The kinetic test results have not shown the decay trend for these parameters; however, the relationship between oxidation rate and sulfur content has been developed. Using this relationship and assuming that molybdenum and selenium originate from oxidation of pyrite, the decay trend was calculated. The decay trend indicates loadings decreasing by a factor of 50% after 15 years, 90% after 50 years, and 99% after 100 years.

For PAG walls, depletion would occur rapidly, resulting in long-term chemistry controlled by dissolution of secondary minerals produced in the early stages of exposure. This effect was estimated by modeling the solubility of the secondary minerals expected to form due to oxidation (mainly ferrihydrite and jarosite). Concentrations of trace elements not contained in these minerals were calculated in proportion to the decrease in sulfate concentrations.

For the highwall inflows, each exposed rock category was digitized and represented in a surface area vs. depth profile. The chemistry from each category was then loaded into the pit lake backfill during the filling process until it was submerged by the lake, at which point it was no longer considered reactive. As the lake fills, each rock category loads progressively smaller and smaller quantities of dissolved material to the lake.

The following recommendations were made regarding the use of WRMC for predictions of pit wall runoff calculations (SRK 2007b):

- Operational (Pit de-watering) Phase:
    - WRMCs 1 to 6 leach at non-acidic rates.
    - WRMC 7 leaches at peak acidic rates.
- Flooding Phase
    - WRMC's 1 to 5 leach at non-acidic rates.
    - WRMC 6 leaches at acidic rates for 3 years and for remainder of time at non-acidic rates.
- Post-Flooding (Discharge from pit lake) Phase:
    - WRMC's 1 to 4 leach at non-acidic rates.
    - WRMC 5 leaches for 3 years at peak acidic rate then at long term rate.
    - WRMCs 6 and 7 leach at long term rate.

The predictions are provided for neutral, peak acidic and leached conditions. The peak acidic term refers to the chemistry of water predicted when the rock first becomes acidic. The leached term refers to long term water chemistry from acidic walls after sulfides have been fully oxidized and long term chemistry is controlled by leaching of residual oxidation products (SRK 2016). Values for 50^{th}, 75^{th}, and 95^{th} percentile concentration estimates for each WRMC are included in Tables C-11a, b, and c, respectively (SRK 2015b).

Table C-11a: Pit Wall Runoff Concentration Estimates, 50th Percentile

		WRMC	1	2	3	4	5	6	5	6	7	5	6	7
		Condition	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Peak Acidic	Peak Acidic	Peak Acidic	Leached	Leached	Leached
Parameter	**Unit**													
pH	s.u.		8.3	8.2	7.7	7.8	7.8	7.9	2.3	1.9	1.9	4	4	4
Sulfate	mg/L		120	110	1200	1000	840	450	2600	13000	14000	11	11	11
Acidity	mg/L		0.032	0.027	0.018	0.019	0.019	0.02	0	0	0	0	0	0
Alkalinity	mg/L		73	57	23	27	26	31	1	0.98	0.98	1	1	1
Al	mg/L		0.002	0.0015	0.0006	0.00072	0.00068	0.00082	160	800	850	0.0097	0.0097	0.0097
Sb	mg/L		0.31	0.37	3.1	0.48	0.12	0.44	0.19	0.28	0.28	0.00078	0.00023	0.00022
As	mg/L		0.055	0.35	28	1.1	1.3	3.8	28	130	140	0.0051	0.0051	0.0051
Ba	mg/L		0.0005	0.0008	0.0051	0.0053	0.0055	0.005	0.0048	0.0041	0.004	0.066	0.066	0.066
Be	mg/L		0.00068	0.00068	0.00068	0.00068	0.00068	0.00068	0.097	0.48	0.58	0.00041	0.00041	0.00046
Bi	mg/L		0.011	0.066	0.014	0.011	0.011	0.089	0.097	0.097	0.097	0.00041	0.000082	0.000078
B	mg/L		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.00083	0.00017	0.00016
Cd	mg/L		0.0011	0.0013	0.0013	0.0011	0.0011	0.0013	0.02	0.099	0.51	0.000084	0.000084	0.00041
Ca	mg/L		22	36	280	320	190	120	52	250	270	0.0097	0.0097	0.0097
Cr	mg/L		0.011	0.031	0.014	0.011	0.011	0.031	0.097	0.48	0.82	0.00041	0.00041	0.00066
Co	mg/L		0.0043	0.018	0.0091	0.0035	0.0028	0.025	0.63	3.1	7.1	0.0026	0.0026	0.0057
Cu	mg/L		0.0031	0.0041	0.0055	0.0038	0.0056	0.011	1.4	6.7	7	0.0097	0.0097	0.0097
Fe	mg/L		0.0019	0.002	0.0021	0.0021	0.0021	0.002	410	2100	2200	2.4	2.4	2.4
Pb	mg/L		0.0014	0.013	0.0037	0.0011	0.0011	0.018	0.024	0.12	0.13	0.0097	0.0097	0.0097
Li	mg/L		0.11	0.15	0.16	0.11	0.12	0.18	0.27	0.27	0.27	0.0011	0.00023	0.00021
Mg	mg/L		2.2	3.5	110	36	67	30	16	79	84	0.0097	0.0097	0.0097
Mn	mg/L		0.26	0.26	0.63	0.2	0.1	1.4	5.6	27	29	0.0097	0.0097	0.0097
Hg	mg/L		0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00015	0.00015	0.00015	0.00000064	0.00000013	0.00000012
Mo	mg/L		0.051	0.047	0.048	0.044	0.065	0.029	0.0094	0.0094	0.0094	0.000039	0.000008	0.0000075
Ni	mg/L		0.013	0.089	0.032	0.042	0.031	0.092	1.8	7.3	7.3	0.0075	0.0062	0.0058
P	mg/L		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0013	0.00025	0.00024
K	mg/L		43	30	56	44	54	28	1.9	36	40	2.2	2.2	2.2
Se	mg/L		0.03	0.13	0.03	0.022	0.044	0.18	0.19	0.78	0.78	0.00081	0.00066	0.00063
Si	mg/L		14	21	30	16	18	20	29	29	29	0.12	0.025	0.023
Ag	mg/L		0.00022	0.0013	0.00028	0.00022	0.00022	0.0018	0.00062	0.00062	0.00062	0.0000026	0.00000053	0.0000005
Na	mg/L		38	13	49	44	42	18	66	320	340	0.0097	0.0097	0.0097
Sr	mg/L		1.9	1.2	1.1	2.5	3	1.2	0.2	0.2	0.2	0.00084	0.00017	0.00016
Tl	mg/L		0.001	0.001	0.001	0.001	0.001	0.001	0.0019	0.0019	0.0019	0.000008	0.0000016	0.0000015
Sn	mg/L		0.0021	0.013	0.0027	0.0022	0.0022	0.018	0.019	0.019	0.019	0.000081	0.000016	0.000016
Ti	mg/L		0.19	0.2	0.22	0.22	0.21	0.2	0.19	0.19	0.19	0.00081	0.00016	0.00016
U	mg/L		0.013	0.0059	0.012	0.029	0.0075	0.0045	0.046	0.046	0.046	0.00019	0.000039	0.000037
V	mg/L		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.000013	0.0000025	0.0000024
Zn	mg/L		0.022	0.074	0.078	0.031	0.023	0.12	8.6	42	44	0.0097	0.0097	0.0097
TDS	mg/L		390	330	1800	1600	1300	730	3400	17000	18000	18	18	18

Source: SRK 2015b

Table C-11b: Pit Wall Runoff Concentration Estimates, 75th Percentile

		WRMC	1	2	3	4	5	6	5	6	7	5	6	7
		Condition	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Peak Acidic	Peak Acidic	Peak Acidic	Leached	Leached	Leached
Parameter	Unit													
pH	s.u.		8.2	8.3	7.7	7.7	7.7	7.8	3.5	3.4	3.4	4	3.7	3.7
Sulfate	mg/L		180	150	1200	1700	1500	960	2700	13000	13000	11	6.1	6.1
Acidity	mg/L		0.027	0.03	0.018	0.018	0.018	0.019	0	0	0	0	0	0
Alkalinity	mg/L		55	65	23	21	22	27	1	0.98	0.98	1	1	1
Al	mg/L		0.0015	0.0017	0.0006	0.00055	0.00057	0.0007	260	1300	1400	0.0097	0.0097	0.0097
Sb	mg/L		0.73	0.6	3.1	0.71	0.3	0.66	0.28	0.28	0.28	0.0011	0.00013	0.00013
As	mg/L		0.25	0.51	28	5.9	5.8	8.8	18	15	15	0.0051	24	24
Ba	mg/L		0.001	0.00067	0.0051	0.0048	0.0048	0.0054	0.0047	0.004	0.004	0.066	0.13	0.13
Be	mg/L		0.00068	0.00068	0.00068	0.00068	0.00068	0.00068	0.098	0.48	0.58	0.0004	0.00023	0.00027
Bi	mg/L		0.011	0.089	0.014	0.011	0.011	0.09	0.098	0.098	0.098	0.0004	0.000047	0.000045
B	mg/L		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.00082	0.000097	0.000092
Cd	mg/L		0.0012	0.0013	0.0013	0.0011	0.0013	0.0013	0.025	0.12	0.51	0.0001	0.000059	0.00024
Ca	mg/L		18	29	280	450	270	280	150	540	540	0.0097	0.0097	0.0097
Cr	mg/L		0.012	0.031	0.014	0.011	0.023	0.031	0.12	0.59	0.82	0.00049	0.00029	0.00038
Co	mg/L		0.0061	0.018	0.0091	0.018	0.015	0.027	0.85	4.2	7.1	0.0035	0.002	0.0033
Cu	mg/L		0.0045	0.0036	0.0055	0.0049	0.014	0.016	1.9	9.5	10	0.0097	0.0097	0.0097
Fe	mg/L		0.002	0.0019	0.0021	0.0021	0.0021	0.0021	110	510	540	2.4	6.6	6.6
Pb	mg/L		0.0017	0.018	0.0037	0.0017	0.0047	0.021	0.062	0.3	0.33	0.0097	0.0097	0.0097
Li	mg/L		0.16	0.18	0.16	0.14	0.15	0.19	0.32	0.32	0.32	0.0013	0.00016	0.00015
Mg	mg/L		11	2.8	110	130	170	44	91	440	470	0.0097	0.0097	0.0097
Mn	mg/L		0.41	0.31	0.63	0.39	0.32	4.2	11	54	57	0.0097	0.0097	0.0097
Hg	mg/L		0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00015	0.00015	0.00015	0.00000062	0.000000074	0.000000071
Mo	mg/L		0.18	0.14	0.048	0.067	0.19	0.063	0.0094	0.0094	0.0094	0.000038	0.0000046	0.0000043
Ni	mg/L		0.021	0.09	0.032	0.086	0.047	0.1	2.8	7.3	7.3	0.011	0.0035	0.0034
P	mg/L		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0012	0.00015	0.00014
K	mg/L		50	41	56	48	55	40	0.000028	0.0000035	0.0000032	2.2	1.2	1.2
Se	mg/L		0.067	0.18	0.03	0.022	0.15	0.18	0.2	0.78	0.78	0.0008	0.00038	0.00036
Si	mg/L		17	22	30	20	28	22	29	29	29	0.12	0.014	0.013
Ag	mg/L		0.00022	0.0018	0.00028	0.00022	0.00044	0.0018	0.00062	0.00062	0.00062	0.0000025	0.0000003	0.00000029
Na	mg/L		43	37	49	44	78	51	110	520	550	0.0097	0.0097	0.0097
Sr	mg/L		7.5	1.9	1.1	3.2	3.2	2.9	1.2	1.2	1.2	0.0048	0.00057	0.00054
Tl	mg/L		0.001	0.001	0.001	0.001	0.001	0.001	0.0019	0.0019	0.0019	0.0000078	0.00000093	0.00000089
Sn	mg/L		0.0022	0.018	0.0027	0.0024	0.0023	0.018	0.02	0.02	0.02	0.00008	0.0000095	0.000009
Ti	mg/L		0.22	0.22	0.22	0.22	0.22	0.39	0.2	0.2	0.2	0.0008	0.000095	0.00009
U	mg/L		0.017	0.013	0.012	0.039	0.026	0.0086	0.17	0.17	0.17	0.00069	0.000082	0.000078
V	mg/L		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.000012	0.0000015	0.0000014
Zn	mg/L		0.027	0.092	0.078	0.041	0.068	0.17	8.7	42	45	0.0097	0.0097	0.0097
TDS	mg/L		440	410	1800	2500	2200	1500	3500	16000	17000	18	40	40

Source: SRK 2015b

Table C-11c: Pit Wall Runoff Concentration Estimates, 95th Percentile

		WRMC	1	2	3	4	5	6	5	6	7	5	6	7
		Condition	**Neutral**	**Neutral**	**Neutral**	**Neutral**	**Neutral**	**Neutral**	**Peak Acidic**	**Peak Acidic**	**Peak Acidic**	**Leached**	**Leached**	**Leached**
Parameter	**Unit**													
pH	s.u.		8	8	7.7	7.6	7.7	7.6	4.1	4.1	4.1	4.4	4.3	4.6
Sulfate	mg/L		600	480	1200	3000	1900	2400	2700	12000	12000	32	27	26
Acidity	mg/L		0.021	0.021	0.018	0.017	0.018	0.017	0	0	0	0	0	0
Alkalinity	mg/L		36	35	23	18	23	19	1	0.99	0.99	1	1	1
Al	mg/L		0.00095	0.00092	0.0006	0.00046	0.0006	0.0005	230	1100	1200	4.1	7.9	9.4
Sb	mg/L		1.1	0.77	3.1	1.2	0.56	3.1	0.28	0.28	0.28	0.0032	0.00065	0.0006
As	mg/L		0.57	1.2	28	22	7.7	17	70	67	67	0.0051	38	52
Ba	mg/L		0.0043	0.0041	0.0051	0.0044	0.0045	0.0045	0.0046	0.004	0.0039	0.029	0.038	0.041
Be	mg/L		0.00068	0.00068	0.00068	0.00068	0.00068	0.00068	0.098	0.49	0.58	0.0012	0.0011	0.0013
Bi	mg/L		0.067	0.092	0.014	0.071	0.036	0.091	0.098	0.098	0.098	0.0012	0.00023	0.00021
B	mg/L		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0023	0.00047	0.00043
Cd	mg/L		0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.028	0.14	0.51	0.00033	0.00033	0.0011
Ca	mg/L		63	120	280	640	270	560	250	530	530	0.0097	0.0097	0.0097
Cr	mg/L		0.031	0.031	0.014	0.031	0.031	0.031	0.14	0.68	0.82	0.0016	0.0016	0.0018
Co	mg/L		0.015	0.025	0.0091	0.03	0.057	0.066	1	5.1	7.1	0.012	0.012	0.015
Cu	mg/L		0.0094	0.0095	0.0055	0.016	0.024	0.035	2.4	12	12	0.0097	0.0097	0.0097
Fe	mg/L		0.002	0.002	0.0021	0.0022	0.0021	0.0022	3.3	8.8	9.2	0.65	0.87	0.94
Pb	mg/L		0.013	0.018	0.0037	0.014	0.013	0.025	0.091	0.45	0.48	0.0097	0.0097	0.0097
Li	mg/L		0.19	0.18	0.16	0.17	0.18	0.24	0.37	0.37	0.37	0.0043	0.00086	0.00079
Mg	mg/L		38	20	110	330	170	210	150	740	780	0.0097	0.0097	0.0097
Mn	mg/L		1.5	0.88	0.63	1.1	3.3	6.3	15	75	79	0.0097	0.0097	0.0097
Hg	mg/L		0.00019	0.00019	0.00019	0.00019	0.00019	0.00019	0.00015	0.00015	0.00015	0.0000018	0.00000036	0.00000033
Mo	mg/L		0.24	0.23	0.048	0.23	0.41	0.12	0.0094	0.0094	0.0094	0.00011	0.000022	0.00002
Ni	mg/L		0.07	0.092	0.032	0.12	0.51	0.15	3.6	7.3	7.3	0.043	0.017	0.016
P	mg/L		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0035	0.00071	0.00065
K	mg/L		63	50	56	53	86	54	0.002	0.00029	0.00027	6.5	5.6	5.4
Se	mg/L		0.15	0.18	0.03	0.14	0.24	0.18	0.2	0.78	0.78	0.0023	0.0018	0.0017
Si	mg/L		22	27	30	31	31	31	29	29	29	0.34	0.068	0.063
Ag	mg/L		0.0013	0.0018	0.00028	0.0014	0.00085	0.002	0.00062	0.00062	0.00062	0.0000073	0.0000015	0.0000013
Na	mg/L		120	44	49	47	230	70	140	680	720	0.0097	0.0097	0.0097
Sr	mg/L		24	3.3	1.1	5.4	3.4	4.5	2	2	2	0.023	0.0046	0.0042
Tl	mg/L		0.001	0.001	0.001	0.001	0.001	0.001	0.0019	0.0019	0.0019	0.000022	0.0000045	0.0000042
Sn	mg/L		0.013	0.019	0.0027	0.014	0.0072	0.018	0.02	0.02	0.02	0.00023	0.000046	0.000043
Ti	mg/L		0.24	5.9	0.22	0.22	0.44	5.3	0.2	0.2	0.2	0.0023	0.00046	0.00043
U	mg/L		0.056	0.026	0.012	0.087	0.058	0.015	0.27	0.27	0.27	0.0031	0.00063	0.00058
V	mg/L		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.000035	0.0000071	0.0000065
Zn	mg/L		0.072	0.1	0.078	0.079	0.19	3	8.7	43	45	0.0097	0.0097	0.0097
TDS	mg/L		1000	820	1800	4100	2700	3400	3600	15000	16000	46	82	97
Source: SRK 2015b														

References

The following studies were used as the basis for this Appendix.

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Appendix D
WTP Source Water Characterization

D-1 Introduction

This design basis report has been prepared to serve as the source document for all the water related information required to develop a conceptual design for water treatment during the construction, pre-production and operational life of the proposed Donlin gold mine to support the Alaska Pollutant Discharge Elimination System (APDES) application and permitting process.

The report discusses the various sources of water that will require management and treatment throughout the construction, pre-production, and operating life of the mine, presents the water quality and flow data for the various water sources, and summarizes the estimated water quality and quantity for:

1. The first five year permitting cycle (construction and initial operations)

2. The second five year permitting cycle (early operations)

3. The life-of-mine (LOM) expected maximum for contaminant loading and water quantity for the combined water treatment stream

The waters include the following:

- Reclaim water from the Tailings Storage Facility (TSF) pond,
- Contact water which is retained in the Upper and Lower Contact Water Dams (CWDs),
- Water reporting to the Seepage Recovery System (SRS) pond below the TSF,
- Water from the open pit dewatering wells.

The locations of the facilities generating the flows are shown on Figure 1. The periods of time when water from each of these sources will flow to the WTP are shown on Figure 2.

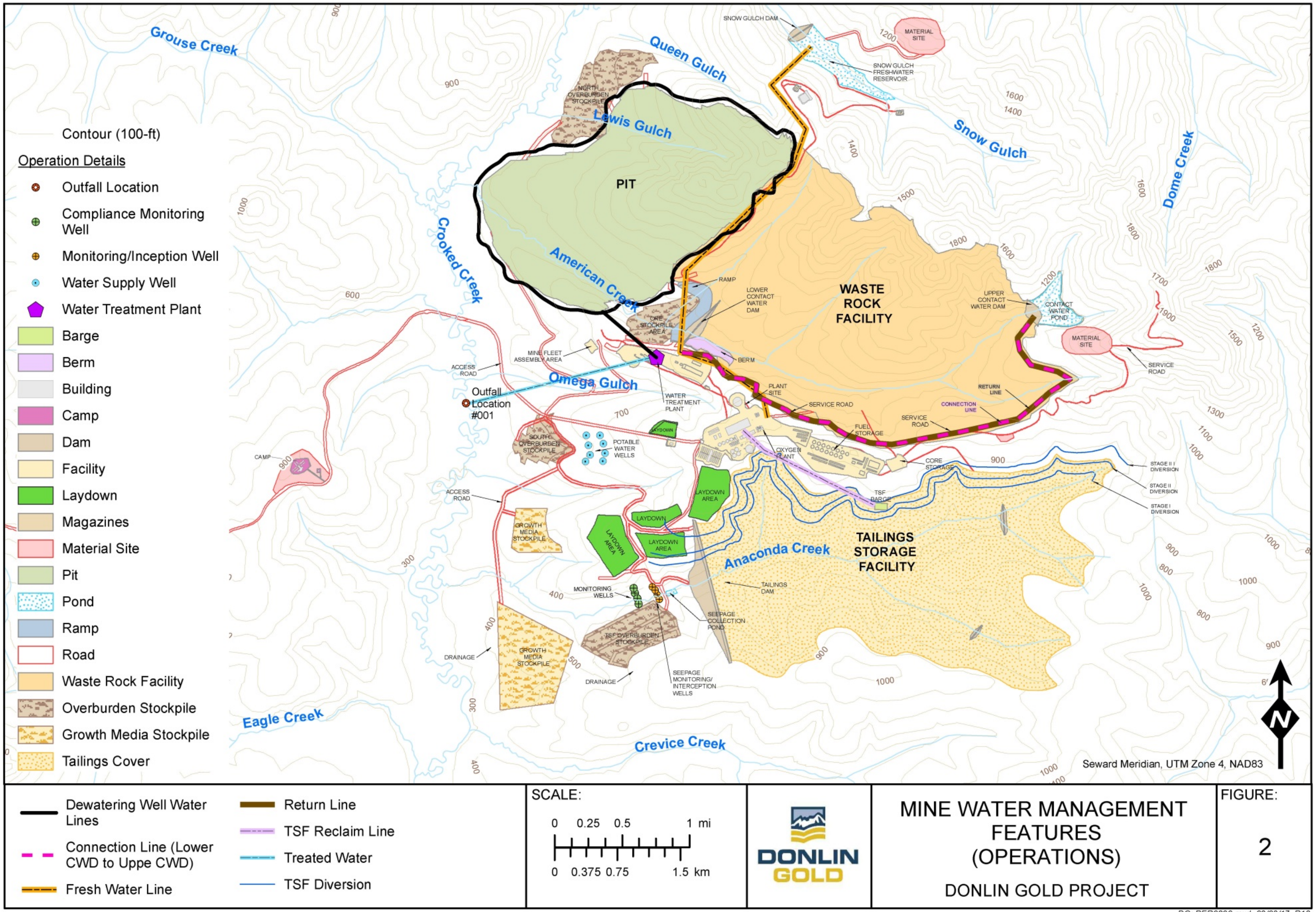
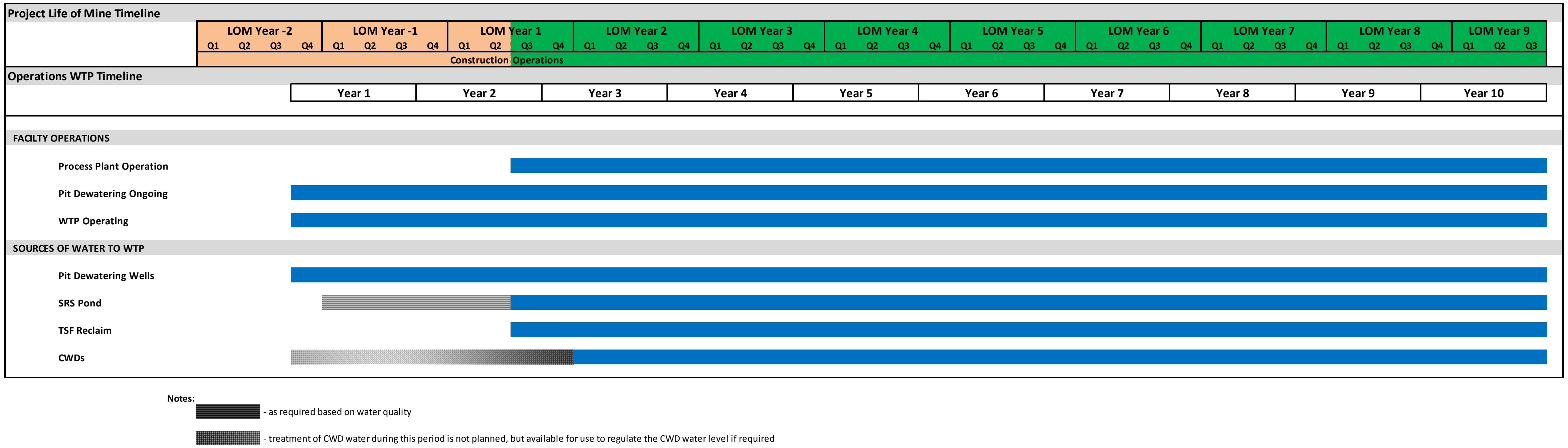

Contour (100-ft)
Operation Details
Outfall Location
Compliance Monitoring Well
Monitoring/Inception Well
Water Supply Well
Water Treatment Plant
Barge
Berm
Building
Camp
Dam
Facility
Laydown
Magazines
Material Site
Pit
Pond
Ramp
Road
Waste Rock Facility
Overburden Stockpile
Growth Media Stockpile
Tailings Cover
Grouse Creek
Queen Gulch
Lewis Gulch
Snow Gulch
Dome Creek
Crooked Creek
American Creek
Omega Gulch
Anaconda Creek
Eagle Creek
Crevice Creek
PIT
WASTE ROCK FACILITY
TAILINGS STORAGE FACILITY
SNOW GULCH DAM
MATERIAL SITE
SNOW GULCH FRESHWATER RESERVOIR
NORTH OVERBURDEN STOCKPILE
RAMP
LOWER CONTACT WATER DAM
UPPER CONTACT WATER DAM
CONTACT WATER POND
SERVICE ROAD
BERM
MINE FLEET ASSEMBLY AREA
ACCESS ROAD
Outfall Location #001
WATER TREATMENT PLANT
PLANT SITE
RETURN LINE
CONNECTION LINE
FUEL STORAGE
OXYGEN PLANT
CORE STORAGE
POTABLE WATER WELLS
SOUTH OVERBURDEN STOCKPILE
CAMP
LAYDOWN
LAYDOWN AREA
TSF BARGE
STAGE III DIVERSION
STAGE II DIVERSION
STAGE I DIVERSION
GROWTH MEDIA STOCKPILE
MONITORING WELLS
TAILINGS DAM
SEEPAGE COLLECTION POND
TSF OVERBURDEN STOCKPILE
DRAINAGE
SEEPAGE MONITORING/ INTERCEPTION WELLS
Seward Meridian, UTM Zone 4, NAD83
N
Dewatering Well Water Lines
Connection Line (Lower CWD to Uppe CWD)
Fresh Water Line
Return Line
TSF Reclaim Line
Treated Water
TSF Diversion
SCALE:
0 0.25 0.5 1 mi
0 0.375 0.75 1.5 km
DONLIN GOLD
MINE WATER MANAGEMENT FEATURES (OPERATIONS)
DONLIN GOLD PROJECT
FIGURE:
2
DG: PER0290.mxd, 02/03/17, R12

Figure 2: Operations WTP Timeline – Late Construction and Early Operations: Facility Operations Startup and Sources of Water Reporting to the WTP



D-2 Water Treatment Plant Water Sources and Quantity

As a result of capture of contact water, retention of water from the SRS, and accumulation of process water and precipitation in the TSF (reclaim water), the Donlin Gold project is expected to operate with a water surplus under average precipitation conditions. Additionally, due to the nature of the Donlin ore processing requirements, the amount of TSF reclaim water that can be utilized in the process plant is limited, driving a need for a significant amount of “make up water” in the process (increasing chloride levels in the TSF reclaim over time would adversely impact the gold recovery of the autoclave discharge material). This leads to the long term accumulation of excess process water in the TSF.

The original water management concept developed for the feasibility study included treatment and discharge of only excess open pit dewatering water. All other surplus water was to be stored in the TSF pond until closure, at which point it would be pumped to the open pit. This plan was revised in 2015. The current plan calls for the maximum feasible treatment of excess water from all four sources to minimize the long term accumulation of free water in the TSF and limit it to the level identified as a suitable reserve for process plant reclaim water in the event of a dry year. However, restrictions on the volumes of water that can be treated from the different sources exist because of water quality and the seasonal nature of some of the flows. Development of a technically and financially feasible water treatment plan has to consider these limitations. As such, the information presented in this design basis addresses these limitations, as well as the potential flows that could be generated from the four sources.

Generally pit dewatering well water and SRS pond water have the best water quality and maximizing the treatment of these sources is the most effective strategy to minimize the build-up of water in the TSF. However, to achieve the desired goals for minimizing free water buildup in the TSF the treatment of excess contact water and TSF reclaim water is also required.

Water quantities from each source reporting to the WTP have been estimated primarily using the water balance model which incorporates operational rules for water requirements for process plant operation and additional detail on flows (BGC 2016). Other supporting information includes the groundwater numerical model to estimate pit dewatering well production rates (BGC 2014) and optimization of the process plant to maximize recycling of reclaim water in process (Hatch 2015a).

Although it will be permitted for year round operation, under normal conditions the WTP is expected to operate seasonally. Treatment and discharge will be required in the summer period (April through October) when there is expected to be excess water in the Lower CWD and Upper CWD beyond that required for process use. By contrast, in the winter period (November through March), the net inflow to the CWDs is typically low, requiring dewatering well and SRS water to be used as sources for make up water to the process plant. The WTP will operate at a minimum throughput, or be dormant through the winter, with the exception of the end of the construction period when pumping is occurring from the dewatering wells throughout the year and this water cannot be used in the process plant which has not yet started operating.

The average flow to the WTP from each source during summer and winter periods and the SRS maximum weekly flow for each year of WTP operation are summarized in Table 1 and described below.

a. Tailings Storage Facility Reclaim Water

During periods of high runoff, TSF pond volumes are predicted to rise even with treatment of the other sources of contact water. Therefore, when excess TSF pond volumes develop, TSF water will be sent to the WTP and mixed for treatment along with the other sources of water. The intent of treating and discharging TSF water is to build flexibility into the water management system and minimize TSF pond volumes to the extent practical.

Treatment of water from the TSF is limited by the following:

- By regulation, the annual volume treated cannot exceed the annual volume increase resulting from excess precipitation within the TSF catchment. Excess precipitation is the net of the precipitation over the catchment area minus potential evaporative losses over the pond area. Table 2 shows the allowable discharges on an annual basis.

- The capability of the WTP to remove constituents in the TSF reclaim water to below anticipated discharge permit limits based on regulatory criteria.

- The maximum flow such that a minimum TSF pond volume of 6.0 Mm^3 will be maintained during Operations, which represents about three months of water supply to the process plant.

The ability of the proposed polishing step of reverse osmosis (RO) treatment technology to remove mercury limits the quantity of TSF reclaim water that can be treated. Calculation of this amount is an iterative process that is dependent on the overall mass loading associated with the water streams sent to the WTP. As less of the dewatering well water is treated using RO, the amount of TSF reclaim water that can be treated is reduced. The rate at which TSF reclaim water can be treated has been determined based on the current water quality and flow estimates contained in this document.

b. Contact Water

The Upper and Lower CWDs are designed to store water that will be used throughout the year as a source of make up water for the process plant. Peak runoff occurs during the spring and summer months, with negligible runoff volumes between mid-October and the beginning of April. These variable flows are in contrast to the constant fresh water demand. During the spring/summer period, runoff volumes are in excess of fresh water requirements and this excess water will be stored and/or treated as described below. The stored water will be a source of make up water for the process plant during the fall and winter.

Table 1: Average and Maximum Flows over the Summer Treatment Season, m³/h

LOM Year	APDES Year	Pit Dewatering Wells		SRS				CWD to WTP Average (BGC, 2016)	Maximum Allowable TSF Net Precipitation Discharge, 7-month discharge basis (actual flow will be based on treatment capacity)	Total Flow to WTP (BGC, 2016)	
		Total Production (BGC, 2016, Annual)	Flow to WTP (BGC, 2016)	Average Inflow to TSF Underdrain (BGC 2016)	Maximum Inflow to TSF Underdrain (Monthly Basis, BGC 2016)	Average TSF Seepage (BGC 2016, Annual)	Average Flow to WTP (BGC 2016)			Seasonal Basis	Maximum (Monthly Basis)
-2	1	334	334	--	--	--	--	0	0	334	334
-1	2	329	329	185	198	--	157[(1)]	0	0	486	549
1	3	269	265	185	198	0.28	152	0	338	417	488
2	4	316	257	161	178	0.41	132	139	338	529	759
3	5	412	172	145	162	0.55	63	58	338	294	837
4	6	355	146	**235**	**264**	0.70	101	59	707	307	883
5	7	343	197	230	258	0.84	138	95	734	433	866
6	8	323	223	219	247	0.98	157	123	734	507	834
7	9	315	242	212	239	1.13	167	146	734	560	818
8	10	392	334	205	231	1.27	**178**	172	734	690	887
9	11	369	322	198	223	1.42	176	178	641	683	856
10	12	364	317	195	220	1.56	173	178	772	676	848
11	13	360	321	189	212	1.70	171	189	772	689	837
12	14	**540**	**513**	183	206	1.85	176	212	772	**909**	**1009**
13	15	467	451	177	199	1.99	171	218	700	849	929
14	16	419	406	171	192	2.14	166	223	700	805	874
15	17	396	390	166	186	2.28	163	234	700	796	846
16	18	419	414	161	181	2.42	158	**235**	700	817	863
17	19	397	393	156	175	2.57	153	234	634	790	836
18	20	400	397	160	180	2.71	158	234	**906**	799	844
19	21	394	392	155	175	2.85	153	233	**906**	788	832
20	22	212	210	151	169	3.00	149	226	**906**	594	645
21	23	239	235	146	165	3.14	144	190	850	579	668
22	24	253	246	143	160	3.29	140	168	850	563	676
23	25	261	254	139	157	3.43	136	155	850	554	681
24	26	265	254	135	152	3.57	131	143	850	538	680
25	27	28	23	132	148	3.72	116	118	823	266	438
26	28	0	0	128	144	3.86	72	47	823	124	407
27	29	0	0	125	141	**4.01**	56	42	823	102	403

Notes: **BOLD** - maximum value over project period
1 – Average during pre-production from Q2 of LOM Year -1 to Q2 of LOM Year 1, summer and winter

Table 2: TSF Pond Allowable Excess Precipitation Discharge by TSF Campaign

TSF Campaign LOM Year	APDES Year	Annual Excess Precipitation (m^3)	Allowable Discharge (m^3/hour; 365 day per year basis)*
-1	0.25	2,654,100	no limit (no tailings in place)
1	1.25	1,727,910	197
4	4.25	3,614,130	413
5	5.25	3,749,670	428
9	9.25	3,273,660	374
10	10.25	3,947,310	451
13	13.25	3,578,310	408
17	17.25	3,238,830	370
18	18.25	4,631,040	529
21	21.25	4,343,220	496
25	25.25	4,203,000	480

Notes:
* – Water removed from the pond through evaporation, either natural or enhanced, is not limited by this allowable discharge.

The objective of treating water from the CWDs is to build flexibility into the water management system such that TSF pond volume is minimized to the extent practical during Operations, while maintaining a sufficient supply of process make up water. To balance this need for retaining enough make up water, while managing the seasonal variations in inflow, a series of operational rules were developed for contact water pond operation and contact water treatment (BGC 2016):

- When the combined pond volume of the Lower and Upper CWDs exceeds 1.8 Mm^3, water from the pit perimeter and in-pit dewatering wells and inflows to the SRS are treated at the inflow rate and then discharged to Crooked Creek.

- When the combined pond volume of the Lower and Upper CWDs exceeds 2.3 Mm^3, CWD water is pumped to the WTP at a maximum rate of 1,101 gpm (250 m^3/h) where it is combined with the other sources of water for treatment.

- When the combined pond volume of the Lower and Upper CWDs exceeds 3.6 Mm^3, the entire process water demand (fresh and non-fresh water) is pumped from the Lower CWD (and sourced from the Upper CWD if required) to the process plant.

Under these operating rules, the maximum flow of contact water to the WTP is capped at 250 m^3/h, The LOM average summer flow from the CWD to the WTP after withdrawing water for process use is expected to be 154 m^3/h (Hatch 2015a).

c. TSF Seepage Recovery System Water

The amount of seepage from the lined TSF is expected to be minimal, and most of the water reporting to the SRS pond will be underdrain water composed of groundwater and surface water from areas up gradient of the TSF. However, lined tailings storage facilities do leak, and the seepage rate from the proposed Donlin Gold TSF for the starter and ultimate dam configurations was estimated using the industry standard, two dimensional (2D), finite element groundwater flow model Seep/W (Geo-Slope, 2007). The estimated seepage rate through the liner for the starter dam in LOM Year 1 was estimated at 0.31 m^3/h, and for the ultimate TSF configuration in LOM Year 27 was 4.0 m^3/h. The estimated seepage rates between LOM Years 1 and 27 were estimated using an equation with the Seep/W model values as the endpoints (BGC 2016).

As outlined above, the SRS water represents one of the cleaner and preferred water sources to treat for the project. Therefore, under normal conditions dusing the mine operations phase, all the SRS water is directed to the WTP plant. This means that, unlike with the TSF reclaim and contact water sources, SRS water volumes requiring treatment are determined by the total volumes generated at any given time. During construction, prior to placement of tailings in the TSF, water from the SRS will be directed to the WTP as necessary.

The total quantity of groundwater, surface water, and TSF seepage entering the TSF underdrain during summer months was estimated to range from 125 to 230 m^3/h over the mine life. The SRS flow to the WTP is expected to average 149 m^3/h (BGC 2016). During the winter months the SRS flows are significantly reduced, ranging from 87 to 160 m^3/h, and the water is directed to the process plant. In dry years, SRS water would also be utilized as process make up water as required. Table 1 shows the annual seepage and groundwater flows reporting to the SRS.

d. Open Pit Dewatering Well Water

Generally speaking, the open pit dewatering well water represents the cleanest water stream available and as such is prioritized for treatment and release. Treatment and release of groundwater from the dewatering wells is not anticipated to be required on a continuous basis except during initial construction. Treatment would predominantly occur during the period from spring melt through late fall, when there is expected to be sufficient water in the Lower and Upper CWD to meet the make up water demand for the process plant. In contrast, during the winter months when the CWD pond inflows are typically low, the dewatering well water, like the SRS water, would be utilized in the process plant. Similarly, during dry years, the dewatering well water would also be used in the process plant during the summer and fall.

The dewatering wells produce water at a fairly constant rate year-round and excess dewatering well water that may be treated and discharged is available during the summer period. The average summer period flow from the dewatering wells to the WTP is expected to be 308 m^3/h, as no pit water is normally required for process use during the summer (BGC 2016). The dewatering well production estimates are based on seasonal stress periods in the numerical groundwater model (BGC, 2014). The maximum monthly rate at which dewatering well water is directed to the WTP is estimated to be equivalent to the maximum seasonal rate of 513 m^3/h in LOM year 12 (BGC 2016) as shown on Table 1.

D-3 Water Quality Data

This section describes and presents the water quality information for the four water sources presented in the discussion above. Water quality has been estimated for these sources from a combination of baseline environmental surface water and groundwater characterization data, results of humidity cell tests, and modeling estimates using process and geochemistry models.

Where the design basis concentrations are calculated using background environmental characterization data, reported non-detect results have been assigned a value of one-half the method detection limit for calculation of 95th percentile estimates. The exception was early (2004 through 2006) mercury analyses in which the method detection limit was not reported. A value of one-half the method reporting limit was used for mercury analyses non-detects from this period.

a. TSF Reclaim Water

TSF water quality information is available from multiple sources with each source subject to certain limitations. The TSF values used for the design basis are not 95th percentile values, but instead represent steady-state LOM concentrations in the TSF reclaim water. The estimated parameter levels in the TSF reclaim water are summarized in Table 3.

Detailed analysis is available from a set of final tails generated from pilot process plant test work (SGS 2008). Theese test results are considered to be representative of the Donlin process design and resulting tailings filtrate water quality. This test work was conducted using a once-through configuration, so the measured water quality does not account for concentration of dissolved salts as a function of reuse of TSF reclaim water in the process.

Hatch (2015b) estimated the concentration factor for the TSF and reclaim water system using the Metsim® process model, taking into consideration the latest process design criteria optimized to minimize water retained in the TSF, including updated water supply quantities, water usage within the process, and TSF settling density. A tracer species was added to the process tailings in proportion to the volume of solution. The process model was then run such that the tracer accumulated to a steady-state in the tailings solution (after being reclaimed, used through the process plant, and returning to the TSF). Upon reaching steady-state, the ratio of tracer returned in the tailings solution to new tracer was found to be 3. This concentration factor is representative of the build-up in concentration of inert species within the process.

Estimates of TSF reclaim water concentrations were also evaluated by geochemical modeling (SRK 2015d). Concentrations were estimated based on the tailings filtrate water quality from the 2007 Feasibility Pilot Phase 2 test work, and were adjusted to account for the concentration by recirculation through the process plant and for equilibration with mineral phases expected to form as a result of this concentrating effect using the concentration factor of 3.

Finally, concentrations for certain key species are available from the May 2015 Metsim® process models of nominal plant operation (Hatch 2015a). Although Metsim® does not have

Table 3: TSF Reclaim Water Dissolved Concentrations Estimate, mg/L (based on Hatch 2015c)

Constituent	Source Document Concentrations			Design Dissolved Concentration TSF Reclaim Water[a,b,c,d]
	Tailings Filtrate FS Pilot Phase 2, Total (SGS 2008)	Geochemistry TSF Reclaim Pond (SRK 2015d)	Metsim TSF Reclaim (Hatch 2015a)	
Alkalinity	44	25	–	25[b]
Al	0.02	0.013	0.55	0.013 [b]
Ammonia	9.6	**29**	9.6	**29** [a,b]
Sb	**0.046**	**0.022**	–	**0.022** [b]
As	**1.1**	**3.3**	**0.1**	**3.3** [a,b]
Ba	0.023	0.011	–	0.011 [b]
Be	<0.00002	<0.00006	–	0.00003 [a,b,f]
B	0.20	0.59	–	0.59 [a,b]
Cd	**0.00024**	**0.00073**	–	**0.00073** [a,b]
Ca	449	**610**	**532**	**610** [b]
Cl	NA	26	23	26 [b]
Cr	0.0039	0.012	0.004	0.012 [a,b]
Co	0.0064	0.019	–	0.019 [a,b]
Cu	0.0077	**0.018**	**0.02**	**0.018** [b]
CN_{WAD}	–	–	**0.12** (total)	**0.14 – 0.73** [d]
F	0.91	**2**	0.91	**2** [b]
Fe	0.27	0.0044	0.18	0.0044 [b]
Pb	0.001	**0.003**	–	**0.003** [a,b]
Li	<0.002	<0.006	–	0.003 [a,b,f]
Mg	150	440	**1733**	**1733**[c]
Mn	**0.68**	**2**	**57.8**	**2** [a,b]
Hg	**0.00004**	**0.073**[e]	–	**0.010**[d]
Mo	**0.078**	**0.23**	–	**0.23** [a,b]
Ni	0.021	**0.062**	<0.001	**0.062** [a,b]
Nitrate	–	–	–	–
pH (s.u.)	7.6	7.7	7.6	7.7 [b]
P	–	–	–	–
K	40.4	120	25.8	120 [a,b]
Se	**0.014**	**0.042**	**0.014**	**0.042** [a,b]
Si	2.3	7	54	7 [a,b]
Ag	0.00003	–	–	0.00009[a]
Na	376	**1,100**	485	**1,100** [b]
Sr	2.6	7.9	–	7.9 [a,b]
SO_4	**2,500**	**5,800**	**8,605**	**8,605**[c]
TDS	**3,850**	–	**11,841**	**11,550**[a]
Tl	0.00014	0.00041	–	0.00041 [a,b]
V	0.00047	0.0048	–	0.0048 [b]
Zn	0.011	0.033	0.1	0.033 [a,b]

Notes:
BOLD – concentration exceeds most stringent water quality standard as presented in Table 10
a – SGS (2008) Pilot Phase 2 tails filtrate multiplied by a concentration factor of 3 (Hatch 2015b).
b – SRK (2015d) geochemical modeling
c – Hatch (2015a) Metsim process model
d – Concentrations of 0.010 mg/L for mercury and 0.14 – 0.73 mg/L for CN_{WAD} used for design.
e – Estimate does not consider use of UNR reagent
f – not detected above method reporting limit, one-half method reporting limit used to estimate concentration

a built-in aqueous chemistry thermodynamic module, thus requiring chemical reactions to be input manually, the Metsim® results are viewed as a good indication of steady-state concentrations in the TSF reclaim water.

The design basis concentrations are generally the 2007 Feasibility Pilot Phase 2 concentrations multiplied by the concentration factor. In cases where the resulting factored value is greater than the projected TSF reclaim pond water quality derived from geochemical modeling, the result from the geochemical model was adopted as the design basis value because solubility limits were factored into the geochemical analysis. There are some exceptions. For mercury, a design basis value of 0.010 mg/L was selected based on a study of mercury deportment at Donlin Gold (Hatch 2013) by utilizing UNR reagent to stabilize mercury in TSF water and reduce both groundwater concentrations and potential volatilization. The magnesium and sulfate steady-state concentrations derived from the Metsim® model (Hatch 2015a) have been used because these values are perceived to best reflect the latest process design criteria. Project testwork indicates the Carbon in Leach (CIL) tailings slurry after CN destruct will contain a CN_{WAD} concentration of 1 mg/L. For the purpose of calculating the CN_{WAD} concentration in the TSF reclaim water, the CN_{WAD} concentration in the CIL tailings is assumed to be equal to the CN_{TOT} concentration of 1 mg/L The CIL tailings slurry flow is estimated as 810 m^3/h (Hatch 2015a). This water is combined with overflow from the chloride wash counter current decant (CCD) of 1,630 m^3/h (Hatch 2015a) and with the underflow from the flotation tailings thickener of 1,840 m^3/h (Hatch 2015a), both of which are assumed to have a CN_{WAD} concentration equivalent to the concentration in the supernatant TSF water, which is 0.14 mg/L during summer (see below). The CN_{WAD} concentration in the resulting combined tailings stream is 0.31 mg/L. The combined flow during process plant operation is 4,280 m^3/h.

The cyanide concentration in the TSF supernatant water is diluted slightly by inflow from precipitation on the TSF and runoff from areas above the TSF in the Anaconda drainage, which are assumed to not contain CN. Based on the water balance (BGC 2016), inflow from these sources would average approximately 274 m^3/h. The average flow from the process plant to the TSF, based on approximately 93% process plant operation, is 3,960 m^3/h (BGC 2016). The resulting CN_{WAD} concentration in the combined tailings water reporting to the TSF is 0.29 mg/L.

The TSF reclaim water quality in Table 3 assumes 50% natural degradation of CN_{WAD} in the summer months, which is the period of time the WTP operation is anticipated. The resulting CN_{WAD} concentration in the supernatant water that would report to the reclaim is 0.14 mg/L. During winter months, assuming no natural degradation occurred, the CN_{WAD} concentration in reclaim water would be 0.73 mg/L.

Table 4 indicates that, with sufficient time, it is possible to attain a very low concentration of CN_{WAD} with natural degradation alone. At a pH below 9.0, as is expected for the Donlin Gold TSF, CN_{WAD} will be expected to dissociate and some of the resultant free cyanide will be lost from the pond surface from natural degradation. This statement is supported by Figure 3 which shows that greater than 50% natural degradation (attenuation) may be seen with the extended residence times that are typical in tailings ponds (Hatch, 2015c). This information supports the assertion of 50% natural degradation of CN_{WAD} in the TSF during summer months.

Table 4: Effluent Quality of Canadian Gold Mines Applying Batch Natural Cyanide Attenuation Systems (Meech, 2013, as presented in Hatch, 2015c)

Mine	Location	Barren Bleed mg/L		Final Effluent mg/L	
		Total Cyanide	WAD Cyanide	Total Cyanide	WAD Cyanide
Dome Mines	Porcupine, Ontario	100	98.6 (1983)	0.04	0.02 (1983)
Lupin Mines	Contwoyto, N.W.T.	223	186	0.2	0.02 (Sept. 1984)
Cullaton Lake (two ponds)	Keewatin District	800	140 (1982)	--	<0.1 (Sept. 1984)

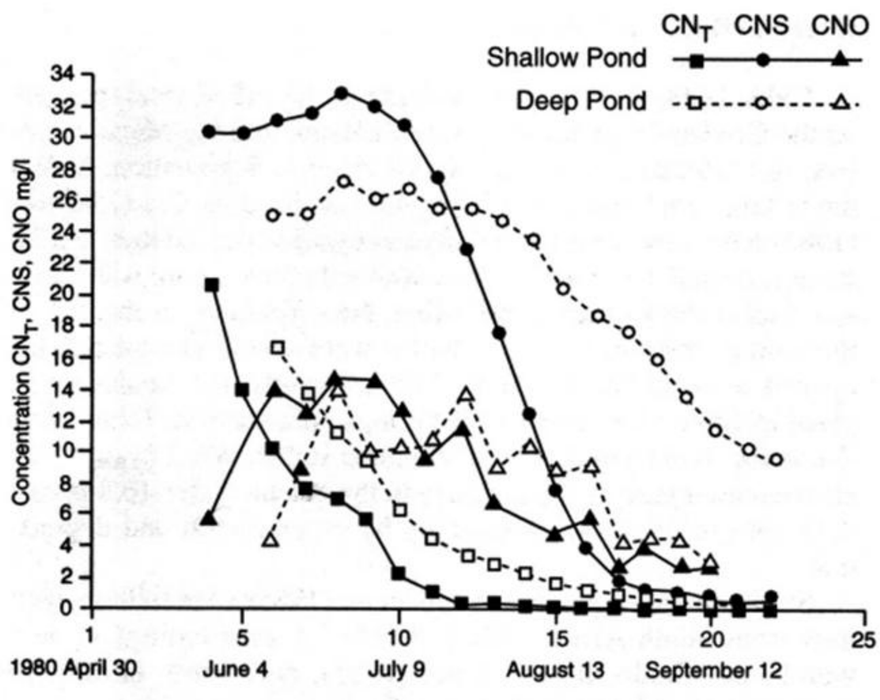


Figure 3: **Natural Cyanide Degradation in a Northern Canadian Mine (Meech, 2013, as presented in Hatch, 2015c)**

b. Contact Water

The CWD water quality was estimated using the flow and estimated constituent concentrations of each source of water discharging to the Lower CWD. The resultant contact water dam balance has runoff and seepage inputs from the following sources:

- Undisturbed ground
- Non-acid potentially generating (NAG) waste rock
- Potentially acid generating (PAG) waste rock
- Open pit sumps

- South Overburden Stockpile (SOB).

As the flows associated with the various sources change over the mine life, the water quality estimate for the contact water changes accordingly. The conceptual flow diagram and assumed water type for each input to the CWD ponds are provided in Figure 4. The flow from each of the source areas was estimated over the LOM using a simplified water balance model (WBM) which assumed average precipitation for the LOM. The contributing areas from each waste rock management category in the pit contributing to the open pit runoff were calculated based on mined ore and mined waste in-situ volumes calculated year by year and averaged over the LOM using the method described in BGC 2013 and flow data from the water balance model (BGC 2016). The constituent concentrations in each contributing source of water to the CWD are summarized in Table 5 and described below.

Runoff from Undisturbed Ground

Runoff from undisturbed ground below the Upper CWD is characterized by water quality from surface monitoring station ANDA (lower Anaconda Creek drainage). This station was selected rather than stations within the American Creek drainage as the current American Creek monitoring stations are influenced by mineralized areas lower in the drainage; ;during operations these mineralized areas will be primarily within the pit area. Water quality at ANDA was characterized as the 95th percentile dissolved concentrations at this station from Q3 2005 through Q2 2015 (Donlin 2016).

Runoff from undisturbed ground above the Upper CWD is characterized by water quality from surface water monitoring station ACAW (upper American Creek drainage). This station was located to provide background water quality above the planned upper extent of the waste rock in the American Creek drainage.

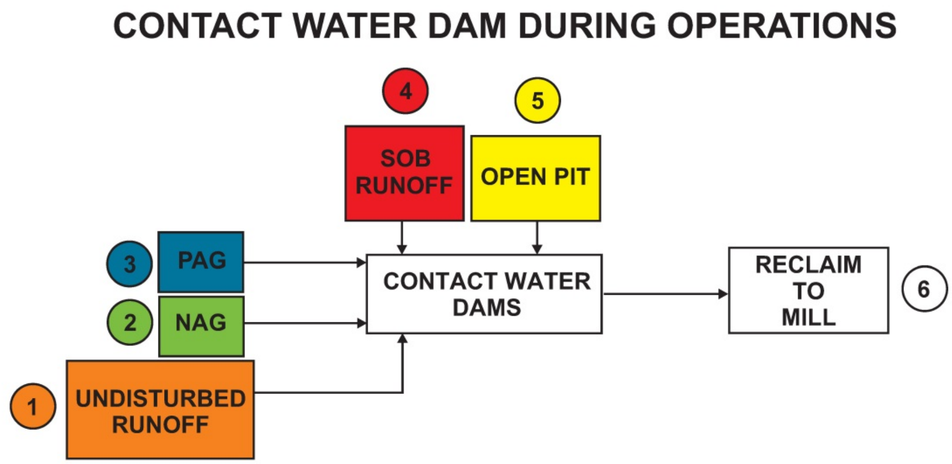
Non-potentially acid generating (NAG) waste rock

This source consists of waste rock facility (WRF) surface runoff from exposed rock and seepage, and reclaimed waste rock seepage from NAG material in which potentially acid generating (PAG) components are assumed to be well-mixed. “Well mixed” refers to waste rock mixtures where all waste categories are in close contact so that the rock mass behaves as a single mass with characteristics indicated by the mixture and buffering takes place by reaction with solid minerals (SRK 2012a). The leachate water chemistry for this material was calculated from 75th percentile release rates for NAG materials during early years of mine operation (SRK 2015a).

Potentially acid generating (PAG) waste rock

This source consists of WRF surface runoff, WRF seepage, and reclaimed waste rock seepage from poorly mixed PAG material. “Poorly mixed” refers to waste rock mixtures in which each category reacts separately to produce distinctive leachates which then mix. Neutralization of acidity occurs by mixing of waters rather than reaction with solids (SRK 2012a). The leachate water chemistry for this material was selected as 75th percentile concentration of poorly mixed PAG during early years of mine operation (SRK 2015a).

Figure 4: Areas Contributing Flow to the Lower CWD



IN FLOW WATER BALANCE COMPONENTS

1. Undisturbed Ground Upgradient of the WRSF, Reclaimed Waste Rock Surface Runoff, Direct Precipitation/Evaporation to Pond
2. NAG: Waste Dump Surface Runoff and Seepage, Reclaimed Waste Rock Seepage
3. PAG: Waste Dump Surface Runoff, Waste Dump Seepage, Reclaimed Waste Rock
4. SOB: Surface Runoff and Seepage
5. Open Pit Runoff
6. Mass Removal to Process Plant

Notes

Evaporation from ponds removes concentrations assumed for direct precipitation to ponds.

(source: modified after BGC 2013)

Table 5: Upper and Lower Contact Water Dam Inflow Components - 95th Percentile Estimates

Constituent	Concentration, dissolved (mg/L)											
	Clean Runoff[a] Lower CWD Area	Clean Runoff[p] Upper CWD Area	Waste Rock Runoff		SOB[d]	Pit Runoff						
			NAG[b]	PAG[c]		Highwall 2[e]	Highwall 4[f]	Highwall 5[g]	Highwall 6[h]	Highwall 7[i]	Ore[j]	Open Pit Runoff[k]
Alkalinity	126	118	23	19	6 – 22	65	21	22	27	0.98	27	53
Al	0.0561	0.0164	0.029	0.029	0.8	0.0017	0.00055	0.00057	0.0007	1400	0.0007	0.0014
Ammonia	0.2	0.00688	3.9	1.6	0.1	0.35[L]	0.35[L]	0.35[L]	0.35[L]	0.35[L]	0.35[L]	0.35[L]
Sb	0.000155	0.000396	3.1	3.1	0.0013	0.6	0.71	0.3	0.66	0.28	0.66	0.61
As	0.00125	0.00125	21	20	0.011	0.51	5.9	5.8	8.8	15	8.8	2.7
Ba	0.208	0.0541	0.0047	0.0045	0.38	0.00067	0.0048	0.0048	0.0054	0.004	0.0054	0.0020
Be	0.000065	0.000065	0.00068	0.00068	0.001	0.00068	0.00068	0.00068	0.00068	0.58	0.00068	0.00068
B	0.0139	0.0075	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cd	0.000075	0.000075	0.0013	0.0013	0.0005	0.0013	0.0011	0.0013	0.0013	0.51	0.0013	0.0013
Ca	30.4	36.8	710	660	39	29	450	270	280	540	280	117
Cl	2.08	0.720	1[L]	1[L]	4.6	1[L]	1[L]	1[L]	1[L]	1[L]	1[L]	1[o]
Cr	0.000598	0.00102	0.031	0.031	0.002	0.031	0.011	0.023	0.031	0.82	0.031	0.029
Co	0.0006	0.0006	0.24	0.24	0.004	0.018	0.018	0.015	0.027	7.1	0.027	0.020
Cu	0.00264	0.000665	0.025	0.029	0.025	0.0036	0.0049	0.014	0.016	10	0.016	0.006
CN_{WAD}	0.00125	0.0043	0.005[mL]	0.005[m]	0.005	0.005[m]	0.005[m]	0.005[m]	0.005[m]	0.005[m]	0.005[m]	0.005[m]
F	0.0846	0.0818	0.8	0.8	0.34	-	-	-	-	-	-	-
Fe	0.337	0.0039	0.0021	0.0021	1.2	0.0019	0.0021	0.0021	0.0021	540	0.0021	0.0020
Pb	0.000208	0.000128	0.42	0.7	0.005	0.018	0.0017	0.0047	0.021	0.33	0.021	0.017
Li	0.00288	0.00155	0.07	0.07	0.011	0.18	0.14	0.15	0.19	0.32	0.19	0.18
Mg	7.58	14.8	64	220	4.4	2.8	130	170	44	470	44	24
Mn	0.140	0.00273	8.8	9.8	0.48	0.31	0.39	0.32	4.2	57	4.2	1.1
Hg	0.0000070	0.00000092	0.00019	0.00019	0.000050	0.00019	0.00019	0.00019	0.00019	0.00015	0.00019	0.00019
Mo	0.00155	0.00155	0.82	0.82	0.01	0.14	0.067	0.19	0.063	0.0094	0.063	0.12
Ni	0.000982	0.001847	1.6	1.6	0.005	0.09	0.086	0.047	0.1	7.3	0.1	0.1
NO_3	1	1.478	36[n]	14[n]	-	-	-	-	-	-	-	-
pH	8.2	8.45	7.7	7.6	6.8	8.3	7.7	7.7	7.8	3.4	7.8	8.1
P	-	-	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
K	0.692	0.47	27	27	4.2	41	48	55	40	0.0000032	40	42
Se	0.00075	0.0016	0.86	1.1	0.0025	0.18	0.022	0.15	0.18	0.78	0.18	0.17
Si	-	-	31	31	31	22	20	28	22	29	22	22
Na	13.3	1.884	0	0	11	37	44	78	51	550	51	41
Ag	0.000155	0000155	0.002	0.002	0.0025	0.0018	0.00022	0.00044	0.0018	0.00062	0.0018	0.0016
Sr	-	-	6.2	5.8	0.34	1.9	3.2	3.2	2.9	1.2	2.9	2.2
SO_4	4.09	30.6	2,000	2,500	67	150	1,700	1,500	960	13,000	960	460
TDS	154	176	2,800	3,400	133	410	2,500	2,200	1,500	17,000	1,500	827
Tl	0.000155	0.000155	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0019	0.001	0.001
V	0.00500	0.0031	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Zn	0.00622	0.00924	2.4	4.1	0.019	0.092	0.041	0.068	0.17	45	0.17	0.10

Notes:
a – Donlin 2016. Site monitoring data, station ANDA, 2005-2015
b – SRK 2015a, NAG, P75, 2027 (FS mining schedule), well mixed
c – SRK 2015a, PAG, P75, 2024 (FS mining schedule), poorly mixed
d – SRK 2015c
e – SRK 2015b, Waste Rock Management Category 2 leachate, 75th percentile
f – SRK 2015b, Waste Rock Management Category 4 leachate, 75th percentile
g – SRK 2015b, Waste Rock Management Category 5 leachate, 75th percentile
h – SRK 2015b, Waste Rock Management Category 6 leachate, 75th percentile
i – SRK 2015b, Waste Rock Management Category 7 leachate, 75th percentile
j – assumed to be the same as Highwall 6
k – calculated based on average area exposed over LOM; 70% Highwall 2, 8% Highwall 4, 2% Highwall 5; 4% Highwall 6, 0% Highwall 7, and 16% Ore
L – SRK 2014a
m - SRK 2014b
n – last year of ammonia concentrations data for respective NAG (LOM Year 19) and PAG (LOM Year 11) category used
o – total basis
p – Donlin 2016. Site monitoring data, station ACAW, 2007-2015
- - no estimate available

Open Pit Runoff

The open pit runoff water is characterized based on a blend of water from rock with different categories of acid-generating potential. The relative contribution from each area is based on the estimated volume of material from each ARD category within the pit area.

The categories in the pit consist of calculated concentrations determined using 75th percentile release rates for waste rock management category (WRMC) 2, 4, 5, and 6 material leaching at non-acidic rates, ore (characterized as WRMC 6 material leaching at a non-acidic rate), and WRMC 7 material leaching at peak acidic rate (SRK 2012b, 2015b). The ore material was characterized as WRMC 6 based on the relatively short length of time that the material would be exposed in the pit highwall. WRMC 7 material was conservatively assumed to be leaching at the peak acidic rate during operations as this material category oxidizes rapidly. By using the 75th percentile values for all source values, the combined values provide conservative estimates for the mixed flows.

The South Overburden Stockpile (SOB)

This source consists of surface runoff and seepage from the SOB. The leachate water chemistry terms for this source were taken as the maximum respective concentrations from the results of meteoric water mobility procedure tests of coarse, medium and fine colluvium overburden material (SRK 2015c).

CWD Predicted Concentrations

To approximate the resultant water quality in the Lower CWD pond, a conservative mixing model was adopted using the source flows and chemistries described above. The following assumptions were applied to calculate concentrations (BGC 2013):

- No chemical reactions
- Complete, instantaneous mixing of all chemical concentration streams
- Mass is neither applied with precipitation nor removed with evaporation
- Mass is conserved.

The resulting water quality estimates for Years 1-5, 6-10, and the LOM maximum are shown in Table 6 below.

Upper CWD Predicted Concentrations

Water in the Upper CWD consists of a mixture of water from the Lower CWD and undisturbed runoff from the upper American Creek drainage reporting to the Upper CWD. The undisturbed runoff concentrations were estimated using the runoff volume from the undisturbed area above the Upper CWD and the water quality from monitoring station ACAW.

The resulting water quality estimates for Years 1-5, 6-10, and the LOM maximum are shown in Table 7 below. The Upper CWD water quality predictions vary significantly both as the mine development progresses and seasonally, as demonstrated by the attached plot of the TDS predictions in the Upper and Lower CWDs (Figure 5).

Table 6: Lower CWD Concentrations - 95th Percentile Estimates

	Estimated Water Quality, mg/L (maximum by period)		
Constituent	**APDES Years 1- 5**	**APDES Years 6 - 10**	**APDES Years 11 - 26.25**
Alkalinity	107	105	98
Al	0.10	0.13	0.18
Ammonium	0.78	1.0	1.0
Sb	**0.74**	**0.96**	**0.97**
As	**2.9**	**4.4**	**4.4**
Ba	0.19	0.19	0.20
Be	0.00048	0.00055	0.00057
B	0.14	0.16	0.17
Cd	**0.00086**	**0.0010**	**0.0011**
Ca	168	218	218
Cl	2.1	2.1	2.3
Cr	0.019	0.023	0.024
Co	0.044	**0.062**	**0.061**
Cu	0.0082	**0.010**	**0.010**
CN_{WAD}	0.0037	0.0042	0.0043
F	0.15	0.20	0.20
Fe	0.35	0.36	0.43
Pb	**0.068**	**0.099**	**0.098**
Li	0.10	0.11	0.13
Mg	24	29	29
Mn	**1.8**	**2.5**	**2.5**
Hg	**0.00012**	**0.00015**	**0.00015**
Mo	**0.17**	**0.23**	**0.24**
Ni	**0.27**	**0.38**	**0.38**
Nitrate	5.3	7.8	7.7
pH	8.1	8.1	8.1
P	0.20	0.23	0.25
K	25	29	31
Se	**0.20**	**0.27**	**0.27**
Si	16	19	20
Na	25	26	30
Ag	0.0012	0.0014	0.0014
Sr	2.0	2.5	2.5
SO_4	**513**	**659**	**670**
TDS	**861**	**1,053**	**1,073**
TSS	–	–	–
Tl	0.00071	0.00082	0.00085
V	0.0046	0.0045	0.0044
Zn	**0.39**	**0.57**	**0.57**

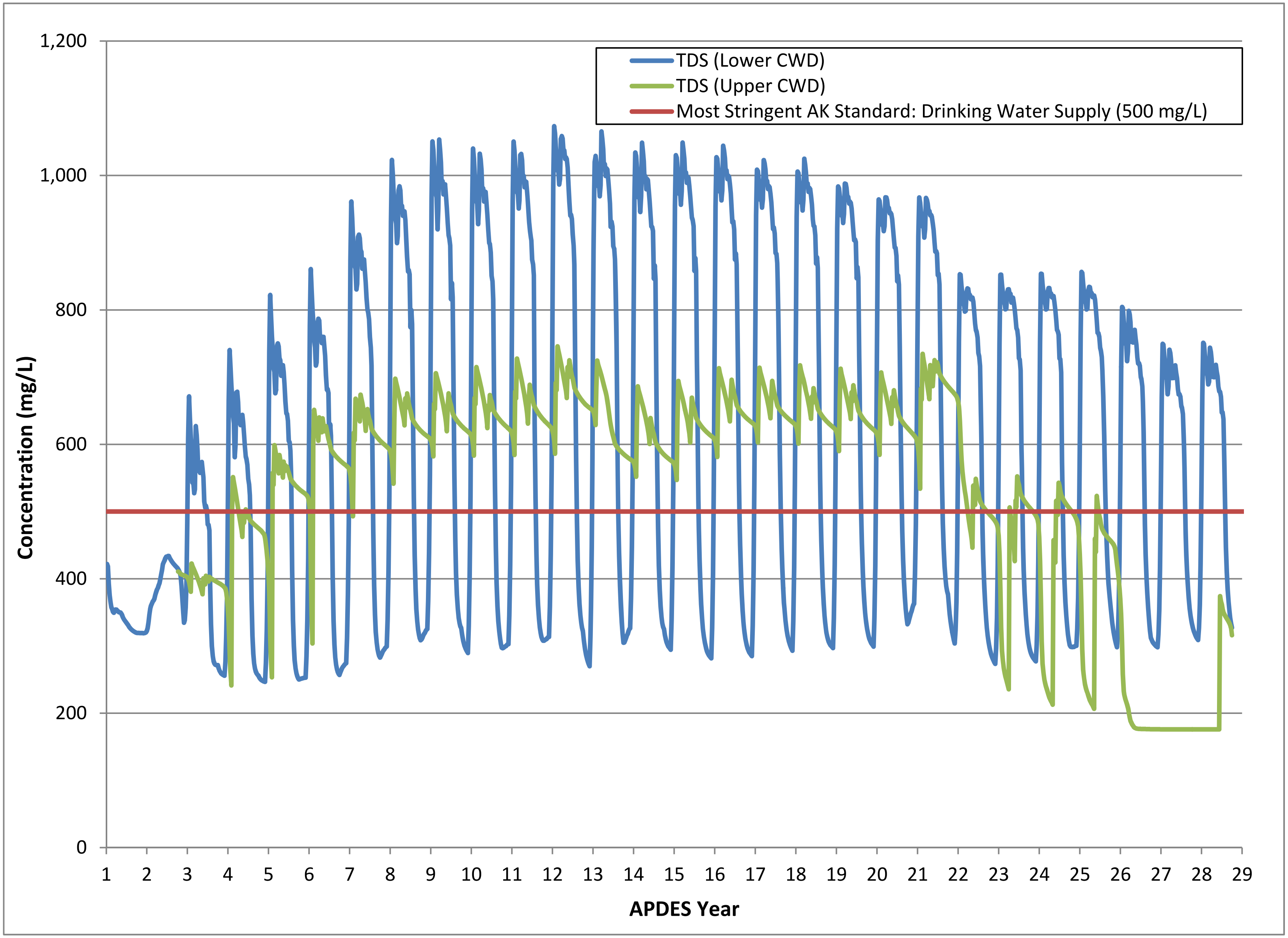
Notes:
BOLD – concentration exceeds most stringent water quality standard as presented in Table 10

Table 7: Upper CWD Concentrations - 95th Percentile Estimates

Constituent	Estimated Water Quality, mg/L (maximum by period)		
	APDES Years 1- 5	**APDES Years 6 - 10**	**APDES Years 11 - 26.25**
Alkalinity	113	97	118
Al	0.085	0.043	0.049
Ammonium	0.58	0.66	0.68
Sb	**0.52**	**0.60**	**0.62**
As	**2.0**	**2.6**	**2.7**
Ba	0.16	0.088	0.089
Be	0.00036	0.00038	0.00043
B	0.10	0.10	0.12
Cd	**0.00063**	**0.00066**	**0.00076**
Ca	128	147	151
Cl	1.9	1.3	1.3
Cr	0.014	0.015	0.017
Co	0.031	0.038	0.039
Cu	0.0063	0.0066	0.0068
CN_{WAD}	0.0041	0.0041	0.0043
F	0.13	0.15	0.15
Fe	0.29	0.14	0.14
Pb	**0.047**	**0.059**	**0.061**
Li	0.071	0.073	0.089
Mg	21	23	23
Mn	**1.3**	**1.5**	**1.6**
Hg	**0.000089**	**0.000093**	**0.00011**
Mo	**0.12**	**0.15**	**0.15**
Ni	**0.19**	**0.23**	**0.24**
Nitrate	4.1	5.1	5.2
pH	8.4	8.2	8.5
P	0.14*	0.15*	0.17*
K	18	18	22
Se	**0.14**	**0.17**	**0.17**
Si	11	12	14
Na	20	18	22
Ag	0.0009	0.0009	0.0010
Sr	1.4	1.6	1.6
SO_4	**365**	**423**	**437**
TDS	**651**	**728**	**746**
TSS	–	–	–
Tl	0.00055	0.00058	0.00064
V	0.0043	0.0036	0.0036
Zn	**0.28**	**0.34**	**0.35**

Notes:
BOLD – concentration exceeds most stringent water quality standard as presented in Table 10
*- based on Lower CWD water quality only

Figure 5: Predicted TDS Concentration in the Upper and Lower CWDs



c. TSF Seepage Recovery System (SRS)

As with the contact water, the flows that drive the SRS water quality (pore water from the TSF that could potentially seep through the liner and the groundwater and surface water originating from above the TSF that is captured in the TSF underdrain) vary both seasonally and over the LOM.

The water reporting to the TSF underdrain from areas above the TSF is characterized by water quality at the surface water site ANUP located in upper Anaconda Creek. The ANUP concentrations used to estimate the underdrain quality are the 95th percentile dissolved concentrations at this station from Q3 2005 through Q2 2015 (Donlin 2016).

The TSF pore water chemistry was derived from the tailings reclaim water estimate, with additional modeling conducted with Geochemist's Workbench® (GWB) to predict parameter values under conditions of deep burial (SRK 2015d). GWB is a geochemical modeling software program originally developed at the University of Illinois at Urbana-Champaign, and currently maintained and updated by Aqueous Solutions LLC. GWB was used to determine whether the concentrations of any ions would be affected by reaching the solubility of minerals.

TSF pore water quality predictions are summarized in Table 8. The TSF water chemistry (with the exception of cyanide and mercury) was derived from the tailings supernatant generated during pilot tests of process plant operations conducted in 2006 and 2007, as described in SRK (2011). The pilot process plant test results were adjusted for the following factors to produce final estimates of constituent concentrations in TSF reclaim water (SRK 2015d):

- Concentrations were multiplied by a factor of 3 to account for being concentrated by re-circulation through the process plant and for equilibration with mineral phases expected to form as a result of this concentrating effect (see TSF Reclaim section for description). The resulting chemistry was then modeled with GWB to determine whether the concentrations of any ions would be affected by reaching the solubility of minerals. The equilibrated chemistry was obtained assuming these minerals precipitate.
- The interaction of the equilibrated TSF reclaim pond water chemistry with tailings under the sub-oxic conditions resulting from consumption of oxygen by dissolved organic carbon was evaluated using GWB.
- Finally, all resulting solutions were checked for ion balances.

The effects of sub-oxic conditions on cyanide and its degradation by-products (cyanate, thiocyanate, ammonia and nitrate) were not modeled. Degradation of cyanide in pore water is anticipated, however a conservative value of 0.73 mg/L was assigned to pore water, equivalent to the high (winter) value in the TSF reclaim water.

The mercury concentration in the TSF reclaim water was estimated as 0.010 mg/L, and in turn in the TSF pore water, based on observed concentrations at an operating facility using similar tailings water mercury abatement as proposed at Donlin.

The resulting water quality estimates for Years 1-5, 6-10, and the LOM maximum are shown in Table 9. As was the case for the CWD, the water quality predictions for the SRS vary significantly throughout the life of the mine both as the TSF footprint expands and seasonally.

This is shown by the predicted TDS concentration over the first 10 years the WTP operates (Figure 6).

d. Dewatering Well Water

The 95th percentile water quality values for six long-term monitoring wells in the pit area between the first quarter of 2004 and the third quarter of 2013 are compiled in Table 10. The hardness-dependent water quality standards in Table 10 were calculated from the water quality in Crooked Creek at monitoring station CCBO, which is adjacent to the proposed discharge point. Figure 7 shows the monitoring well locations relative to the ultimate pit footprint.

Although water samples prior to 2005 had not been collected and analyzed under the procedures established in the 2005 Project QAPP submitted to the Alaska Department of Environmental Conservation for approval, these results were conservatively included in the water treatment evaluation as above-average concentrations of several constituents were present in samples collected during 2004. These higher levels in 2004 may have been a result of natural variability, field procedures inconsistent with later sampling, water in the vicinity of the wells drilled in 2003 re-equilibrating with natural conditions, drilling-impacted water near the well screen “cleaning up” from purging during sampling events, or other factors. Additional wells in the pit area, including MW05-23, MW07-11, MW13-03, and MW03-07, were not considered for estimating 95th percentile concentrations as only a small number of samples were collected during pumping tests at these sites (maximum of three per well). The concentrations in these samples were, however, within the range of those from the wells used in the statistical analysis.

The monitoring data and treatability screening in Table 10 show sufficient variability to allow for differentiation between “low mineralization” and “high mineralization” well water. In order to produce water quality estimates for these two populations, wells MW03-02, MW03-14, and MW03-16 were characterized as high mineralization wells, and MW03-01, MW03-04, and MW03-15 were characterized as low mineralization wells. The water quality values for the low mineralized and high mineralized wells are compiled in Table 11.

Table 8: TSF Pore Water and Underdrain Inflow Concentrations (mg/L)

Constituent	TSF Pore Water Concentrations Estimate[a]	Underdrain Inflow Water Quality Estimate[d]
Alkalinity	530[b]	121[e]
Al	0.0056[b]	0.033
Ammonia	**29**[b]	0.097[e]
Sb	**1.1**[b]	0.00016
As	**15**[b]	0.0013
Ba	0.011[b]	0.16
Be	<0.00006[b]	0.000065
B	0.59[b]	0.0075
Cd	**0.00073**[b]	0.000075
Ca	**1,000**[b]	32
Cl	25[b]	1.6[e]
Cr	0.012[b]	0.00056
Co	0.019[b]	0.0006
Cu	**0.018**[b]	0.00093
CN_{WAD}	**0.73**	0.0016[e]
F	**2**[b]	0.087[e]
Fe	**98**[b]	0.20
Pb	**0.003**[b]	0.00021
Li	<0.006[b]	0.0016
Mg	**1,000**[b]	8.2
Mn	**2**[b]	**0.43**
Hg	**0.010**	**0.000019**[e]
Mo	**0.23**[b]	0.0016
Ni	**0.062**[b]	0.00061
Nitrate	–	–
pH	**5.5**[e]	7.9[e]
P	–	–
K	120	1.7
Se	**0.042**	0.00075
Si	7	–
Ag	**0.0028**[f]	0.00016
Na	**1,100**	6.8
Sr	7.9	–
SO_4	**4,400**	4.8[e]
TDS	**7,779**[b,c]	161
TSS	–	–
Tl	0.00041[b]	0.00016
V	0.0048[b]	0.0031
Zn	0.033[b]	0.010

Notes:
BOLD – concentration exceeds most stringent water quality standard as presented in Table 10
a – dissolved basis except pH
b – SRK 2015d
c – sum of constituents contributing to TDS
d – Donlin 2016. Site monitoring data, station ANUP, 2007-2013, dissolved basis except where noted
e – total basis
f – SRK, 2007
"-" – no estimate available

Table 9: SRS Concentrations - 95th Percentile Estimates

Constituent	Estimated Water Quality, mg/L		
	APDES Years 1- 5	**APDES Years 6 - 10**	**APDES Years 11 - 26.25**
Alkalinity	124	127	145
Al	0.033	0.033	0.032
Ammonium	1.2	1.4	**2.6**
Sb	**0.0073**	**0.016**	**0.066**
As	**0.099**	**0.22**	**0.89**
Ba	0.15	0.15	0.15
Be	0.000065	0.000065	0.000065
B	0.011	0.016	0.042
Cd	0.000079	0.000085	0.00011
Ca	38	46	90
Cl	1.8	2.0	3.0
Cr	0.00063	0.00073	0.0012
Co	0.00072	0.00087	0.0017
Cu	0.0010	0.0012	0.0019
CN_{WAD}	**0.0063**	**0.012**	**0.045**
F	0.10	0.12	0.20
Fe	0.84	**1.6**	**6.0**
Pb	0.00023	0.00025	0.00038
Li	0.0016	0.0016	0.0016
Mg	15	23	67
Mn	**0.44**	**0.45**	**0.52**
Hg	**0.000084**	**0.00017**	**0.00061**
Mo	0.0030	0.0049	**0.015**
Ni	0.0010	0.0015	0.0043
Nitrate	–	–	–
pH	7.8	7.8	7.8
P	–	–	–
K	2.4	3.4	9
Se	0.0010	0.0014	0.0032
Si	–	–	–
Ag	0.00017	0.00019	0.00031
Na	14	23	72
Sr		–	–
SO_4	33	69	**266**
TDS	210	273	**615**
TSS	–	–	–
Tl	0.00016	0.00016	0.00017
V	0.0031	0.0031	0.0032
Zn	0.010	0.011	0.012

Notes: “–“ – not estimated

Figure 6: Predicted TDS Concentration in the SRS, Average Flow Conditions

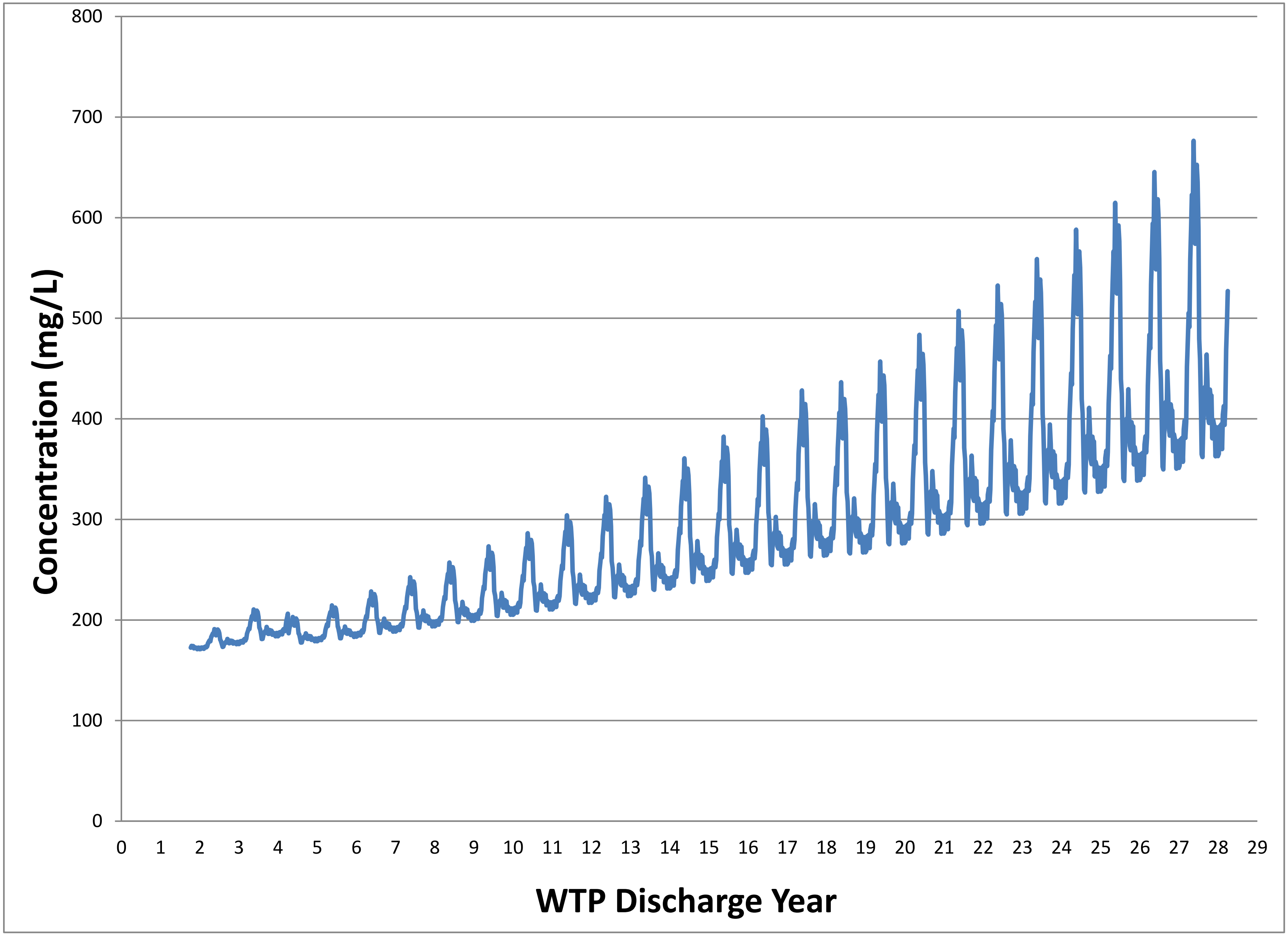


Table 10: Pit Area Monitoring Wells - 95th Percentile Water Quality Estimates

Constituent	Monitoring well 95th Percentile Concentration, Total Basis[(a)] (mg/L)						Most Stringent Water Quality Standard (mg/L)
	MW03-01	MW03-04	MW03-15	MW03-02	MW03-14	MW03-16	
Alkalinity	138	149	152	305	466	226	20 (minimum) AQ
Al	0.0129	0.0189	0.297	0.616	**11.1**	0.616	0.75 AQ
Ammonia	0.156	0.393	0.369	1.15	0.895	0.412	2.99 AQ
Sb	0.000155	0.000340	0.000812	0.000508	**0.0351**	**0.00658**	0.006 HH
As	**0.256**	**0.0216**	**0.116**	**0.0186**	**1.14**	**2.28**	0.010 HH
Ba	0.0408	0.885	0.166	1.60	0.318	0.0605	2 HH
Be	0.000065	0.000065	0.000065	0.000361	0.00153	0.000257	0.004 HH
B	0.0431	0.0243	0.0286	0.134	0.205	0.0387	0.75 Irrig
Cd	0.000075	0.000075	0.000178	0.000075	**0.000373**	**0.000245**	0.00023 AQ
Ca	33.7	44.0	32.6	12.4	6.37	63.8	500 DW[(d)]
Cl	0.692	0.822	0.951	0.952	9.02	1.81	230 AQ
Cr	0.000653	0.00147	0.00172	0.00641	0.0101	0.00187	0.100 HH
Co	0.0006	0.0006	0.0006	0.00253	0.0120	0.00179	0.050 Irrig
Cu	0.000492	0.000654	0.00145	0.00699	**0.0336**	0.00371	0.0089 AQ
CN_{WAD}	0.0041	0.00307	0.00294	0.0041	0.00436	0.00396	0.0052 AQ
F	0.155	0.148	0.233	0.199	**2.41**	0.326	1 Irrig
Fe	**1.89**	**5.74**	**2.25**	**1.78**	**1.24**	**2.24**	1 AQ
Pb	0.000247	0.000318	0.000714	**0.00458**	**0.00748**	**0.00271**	0.0025 AQ
Li	0.0173	0.00876	0.0103	0.0797	0.190	0.0325	2.5 Irrig
Mg	16.3	7.03	10.9	10.9	3.88	26.9	500 DW[(d)]
Mn	**0.283**	**1.46**	**0.417**	**0.165**	0.0343	**0.165**	0.050 HH
Hg	0.00000156	0.00000242	0.00000206	**0.0000152**	**0.0000413**	0.0000112	0.000012 AQ
Mo	0.00155	0.00155	0.00155	0.00176	**0.04246**	0.00155	0.010 Irrig
Ni	0.00184	0.00150	0.00167	0.00634	0.0188	0.00760	0.043 AQ
Nitrate	1.72	1.00	0.155	0.373	0.155	0.607	10 DW
pH, field	7.5	7.7	**8.7**	**8.7**	**9.2**	8.4	6.5-8.5 AQ
P	0.0310	0.0315	0.0845	0.0795	1.43	0.217	500 DW[(d)]
K	0.813	0.733	0.739	2.03	8.08	3.50	500 DW[(d)]
Se	0.00075	0.00075	0.00075	0.00075	**0.0154**	0.00143	0.005 AQ
Si	6.00	5.91	6.20	6.25	20.0	10.8	500 DW[(d)]
Na	4.39	8.46	11.3	108	239	19.0	500 DW[(d)]
Ag	0.00016	0.00016	0.00016	0.00016	0.0017	0.00016	0.00016
Sr	0.310	0.363	0.387	1.01	0.209	0.632	8 picocuries/L (Sr-90) DW
SO_4	28.2	10.3	10.7	12.4	73.4	107	250 DW
TDS[(b)]	183	183	166	364	**1,138**	378	500 DW
TSS	3.20	12.7	**21.5**	**216**	**39.7**	**36.7**	20[(c)]
Tl	0.000155	0.000155	0.000155	0.000490	0.00167	0.000517	0.0017 HH
V	0.0031	0.0031	0.0031	0.0031	0.065	0.0031	0.1 Irrig
Zn	0.00429	0.0214	0.00606	0.0438	0.0346	0.0239	0.119 AQ

Notes:

AQ – aquatic life criteria

DW – drinking water criteria

HH – human health criteria

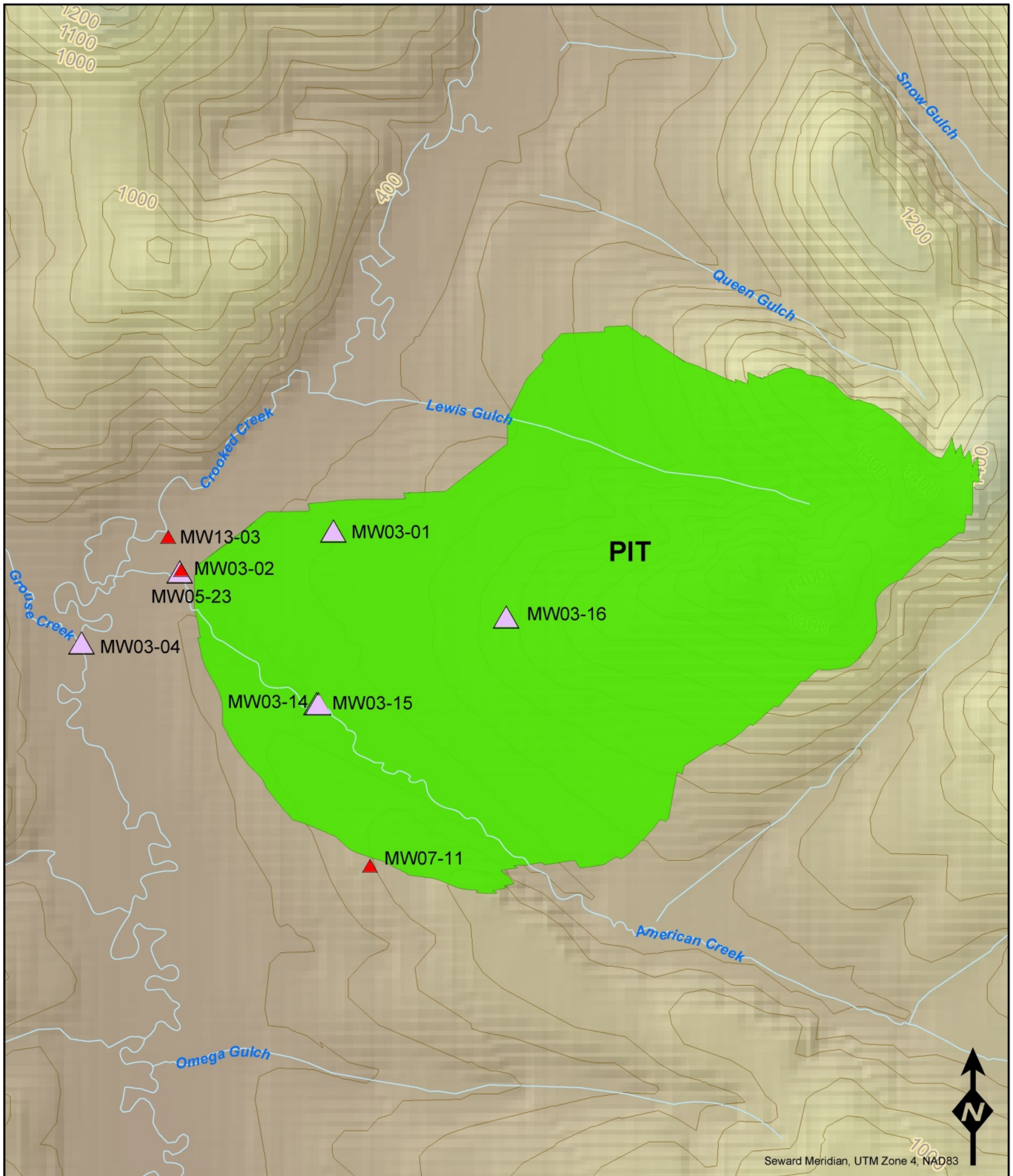
Irrig – irrigation criteria

a – Well Water Quality is from the period of Q1–2004 through Q3–2013. Non-detects were assigned a value of one-half the method detection limit.

b – Dissolved basis

c – 40 CFR 440 Subpart J, Effluent Limitation Guidelines, applicable to discharge of mine drainage water

d – no individual Alaska Water Quality Standard, 500 mg/L upper limit based on TDS



Groundwater Monitoring WellUsed for Pit-Water Evaluation

Groundwater Production Well Sampled During Pumping Tests

Pit Layout

Ground Surface Elevation Contours (100 ft)

DONLIN GOLD

PIT AREA GROUNDWATER MONITORING LOCATIONS

DONLIN GOLD PROJECT

SCALE: 0 500 1,000 2,000 ft; 0 150 300 600 m

FIGURE: 7

Table 11: Dewatering Well Water - 95th Percentile Estimates

Constituent	Unit	Low Mineralized Wells[a]	High Mineralized Wells[a]
		95th Percentile (total unless noted)	
Alkalinity	mg/L	151	459
Al	mg/L	0.10	**3.9**
Ammonia	mg/L	0.37	1.141
Sb	mg/L	0.00037	0.0058
As	mg/L	**0.24**	**2.2**
Ba	mg/L	0.87	1.5
Be	mg/L	0.000065	0.00059
B	mg/L	0.040	0.19
Cd	mg/L	0.000075	0.00020
Ca	mg/L	44	64
Cl	mg/L	0.92	6.5
Cr	mg/L	0.0015	0.0072
Co	mg/L	0.0006	0.0030
Cu	mg/L	0.00066	**0.011**
CN_{WAD}	mg/L	0.0039	0.0042
F	mg/L	0.17	**2.3**
Fe	mg/L	**5.7**	**1.8**
Pb	mg/L	0.00044	**0.0045**
Li	mg/L	0.016	0.17
Mg	mg/L	16	27
Mn	mg/L	**1.4**	**0.13**
Hg	mg/L	0.0000023	**0.000022**
Mo	mg/L	0.0016	0.0081
Ni	mg/L	0.0018	0.0092
Nitrate+ Nitrite	mg/L	0.95	0.29
pH (field)	s.u.	7.8	**8.9**
P	mg/L	0.060	0.93
K	mg/L	0.80	8.1
Se	mg/L	0.00075	0.0016
Si	mg/L	6.3	17
Na	mg/L	11	235
Ag	mg/L	0.00016	0.00016
Sr	mg/L	0.38	1.0
SO_4	mg/L	27	99
TDS[b]	mg/L	183	**690**
TSS	mg/L	13	**167**
Tl	mg/L	0.00016	0.00061
V	mg/L	0.0031	0.0084
Zn	mg/L	0.014	0.042

Notes:

a – Low mineralized wells are represented by water quality at MW03-01, MW03-04 and MW03-15 and high mineralized wells by MW03-02, MW03-14 and MW03-16 from the period of Q1– 2004 through Q3–2013. Non-detects were assigned a value of one-half the method detection limit.

b – Dissolved basis

D-4 Water Treatment Design Basis by Time Period

The water treatment design basis is summarized in Tables 12 and 13 for the first and second APDES permit periods, and in Table 14 for the remainder of WTP operating period. For this report, the first and second APDES permit periods are five years since APDES permits are to be reissued every five years. However, ADEC may not reissue an APDES permit by the end of the five-year term, in which case the permit is typically administratively extended until reissued.

Table 12: WTP Maximum Annual Source Water Flow Rate and Water Quality, First APDES Permit Period (WTP Operating Years 1-5)

Constituent	TSF Pond	CWDs		SRS	Dewatering Wells		Total flow to WTP
		Upper	Lower		Low Mineralization	High Mineralization	
Flow (m^3/h)							
Operating Season, Avg.	56*	250		177	213	213	529
Monthly Maximum	Not estimated separately from total flow to WTP			219	Not estimated separately from total flow to WTP		837
95th Percentile Water Quality (mg/L unless otherwise specified)							
Alkalinity	25	113	107	124	151	459	
Al	0.013	0.085	0.10	0.033	0.10	**3.9**	
Ammonia	**29**	0.58	0.78	1.2	0.37	1.141	
Sb	**0.022**	**0.52**	**0.74**	**0.0073**	0.00037	0.0058	
As	**3.3**	**2.0**	**2.9**	**0.099**	**0.24**	**2.2**	
Ba	0.011	0.16	0.19	0.15	0.87	1.5	
Be	0.00003	0.00036	0.00048	0.000065	0.000065	0.00059	
B	0.59	0.10	0.14	0.011	0.040	0.19	
Cd	**0.00073**	**0.00063**	**0.00086**	0.000079	0.000075	0.00020	
Ca	**610**	128	168	38	44	64	
Cl	26	1.9	2.1	1.8	0.92	6.5	
Cr	0.012	0.014	0.019	0.00063	0.0015	0.0072	
Co	0.019	0.031	0.044	0.00072	0.0006	0.0030	
Cu	**0.018**	0.0063	0.0082	0.0010	0.00066	**0.011**	
CN_{WAD}	**0.14** (summer) – **0.73** (winter)	0.0041	0.0037	**0.0063**	0.0039	0.0042	
F	**2**	0.13	0.15	0.10	0.17	**2.3**	
Fe	0.0044	0.29	0.35	0.84	**5.7**	**1.8**	
Pb	**0.003**	**0.047**	**0.068**	0.00023	0.00044	**0.0045**	
Li	0.003	0.071	0.10	0.0016	0.016	0.17	
Mg	**1,733**	21	24	15	16	27	
Mn	**2**	**1.3**	**1.8**	**0.44**	**1.4**	**0.13**	
Hg	**0.010**	**0.000089**	**0.00012**	**0.000084**	0.0000023	**0.000022**	
Mo	**0.23**	**0.12**	**0.17**	0.0030	0.0016	0.0081	
Ni	**0.062**	**0.19**	**0.27**	0.0010	0.0018	0.0092	
Nitrate	-	4.1	5.3	–	0.95	0.29	
pH	7.7	8.4	8.1	7.8	7.8	**8.9**	
P	–	0.14	0.20	–	0.060	0.93	
K	120	18	25	2.4	0.80	8.1	
Se	**0.042**	**0.14**	**0.20**	0.0010	0.00075	0.0016	
Si	7	12	16	–	6.3	17	
Ag	0.00009	0.0009	0.0012	0.00017	0.00016	0.00016	
Na	**1,100**	20	25	14	11	235	
Sr	7.9	1.4	2.0	–	0.38	1.0	
SO_4	**8,605**	**365**	**513**	33	27	99	
TDS	**11,550**	**651**	**861**	210	183	**690**	
TSS	–	–	–	–	13	167	
Tl	0.00041	0.00055	0.00071	0.00016	0.00016	0.00061	
V	0.0048	0.0043	0.0046	0.0031	0.0031	0.0084	
Zn	0.033	**0.28**	**0.39**	0.010	0.014	0.042	

Notes: "–" - not estimated
* - flow estimate based on maintaining adequate TSF pond volume, actual flow will be based on water quality

Table 13: WTP Source Water Maximum Annual Flow Rate and Water Quality, Second APDES Permit Period (WTP Operating Years 6-10)

Constituent	TSF Pond	CWDs		SRS	Dewatering Wells		Total flow to WTP
		Upper	Lower		Low Mineralization	High Mineralization	
Flow (m^3/h)							
Operating Season, Avg.	56*	250		234	202	202	690
Monthly Maximum	Not estimated separately from total flow to WTP			292	Not estimated separately from total flow to WTP		887
95th Percentile Water Quality (mg/L unless otherwise specified)							
Alkalinity	25	97	105	127	151	459	
Al	0.013	0.043	0.13	0.033	0.10	**3.9**	
Ammonia	**29**	0.66	1.0	1.4	0.37	1.141	
Sb	**0.022**	**0.60**	**0.96**	**0.016**	0.00037	0.0058	
As	**3.3**	**2.6**	**4.4**	**0.22**	**0.24**	**2.2**	
Ba	0.011	0.088	0.19	0.15	0.87	1.5	
Be	0.00003	0.00038	0.00055	0.000065	0.000065	0.00059	
B	0.59	0.11	0.16	0.016	0.040	0.19	
Cd	**0.00073**	**0.00066**	**0.0010**	0.000085	0.000075	0.00020	
Ca	**610**	147	218	46	44	64	
Cl	26	1.3	2.1	2.0	0.92	6.5	
Cr	0.012	0.015	0.023	0.00073	0.0015	0.0072	
Co	0.019	0.038	**0.062**	0.00087	0.0006	0.0030	
Cu	**0.018**	0.0066	**0.010**	0.0012	0.00066	**0.011**	
CN_{WAD}	**0.14** (summer) – **0.73** (winter)	0.0041	0.0042	**0.012**	0.0039	0.0042	
F	**2**	0.15	0.20	0.12	0.17	**2.3**	
Fe	0.0044	0.14	0.36	**1.6**	**5.7**	**1.8**	
Pb	**0.003**	**0.059**	**0.099**	0.00025	0.00044	**0.0045**	
Li	0.003	0.073	0.11	0.0016	0.016	0.17	
Mg	**1,733**	23	29	23	16	27	
Mn	**2**	**1.5**	**2.5**	**0.45**	**1.4**	**0.13**	
Hg	**0.010**	**0.000093**	**0.00015**	**0.00017**	0.0000023	**0.000022**	
Mo	**0.23**	**0.15**	**0.23**	0.0049	0.0016	0.0081	
Ni	**0.062**	**0.23**	**0.38**	0.0015	0.0018	0.0092	
Nitrate	-	5.1	7.8	–	0.95	0.29	
pH	7.7	8.2	8.1	7.8	7.8	**8.9**	
P	-	0.15	0.23	–	0.060	0.93	
K	120	18	29	3.4	0.80	8.1	
Se	**0.042**	**0.17**	**0.27**	0.0014	0.00075	0.0016	
Si	7	12	19	–	6.3	17	
Ag	0.00009	0.0009	0.0014	0.00019	0.00016	0.00016	
Na	**1,100**	18	26	23	11	235	
Sr	7.9	1.6	2.5	–	0.38	1.0	
SO_4	**8,605**	**423**	**659**	69	27	99	
TDS	**11,550**	**728**	**1,053**	273	183	**690**	
TSS	-	–	–	–	13	167	
Tl	0.00041	0.00058	0.00082	0.00016	0.00016	0.00061	
V	0.0048	0.0036	0.0045	0.0031	0.0031	0.0084	
Zn	0.033	**0.34**	**0.57**	0.011	0.014	0.042	

Notes: "–" - not estimated
* - flow estimate based on maintaining adequate TSF pond volume, actual flow will be based on water quality

Table 14: WTP Source Water Maximum Annual Flow Rate and Water Quality (WTP Operating Years 11-26.25)

Constituent	TSF Pond	CWDs		SRS	Dewatering Wells		Total flow to WTP
		Upper	Lower		Low Mineralization	High Mineralization	
Flow (m^3/h)							
Operating Season, Avg.	56*	250		197	288	288	909
Monthly Maximum	Not estimated separately from total flow to WTP			245	Not estimated separately from total flow to WTP		1,009
95th Percentile Water Quality (mg/L unless otherwise specified)							
Alkalinity	25	118	98	145	151	459	
Al	0.013	0.049	0.18	0.032	0.10	**3.9**	
Ammonia	**29**	0.68	1.0	2.6	0.37	1.1	
Sb	**0.022**	**0.62**	**0.97**	**0.066**	0.00037	0.0058	
As	**3.3**	**2.7**	**4.4**	**0.89**	**0.24**	**2.2**	
Ba	0.011	0.089	0.20	0.15	0.87	1.5	
Be	0.00003	0.00043	0.00057	0.000065	0.000065	0.00059	
B	0.59	0.12	0.17	0.042	0.040	0.19	
Cd	**0.00073**	**0.00076**	**0.0011**	0.00011	0.000075	0.00020	
Ca	**610**	151	218	90	44	64	
Cl	26	1.3	2.3	3.0	0.92	6.5	
Cr	0.012	0.017	0.024	0.0012	0.0015	0.0072	
Co	0.019	0.039	**0.061**	0.0017	0.0006	0.0030	
Cu	**0.018**	0.0068	**0.010**	0.0019	0.00066	**0.011**	
CN_{WAD}	**0.14** (summer) – **0.73** (winter)	0.0043	0.0043	**0.045**	0.0039	0.0042	
F	**2**	0.15	0.20	0.20	0.17	**2.3**	
Fe	0.0044	0.14	0.43	**6.0**	**5.7**	**1.8**	
Pb	**0.003**	**0.061**	**0.098**	0.00038	0.00044	**0.0045**	
Li	0.003	0.089	0.13	0.0016	0.016	0.17	
Mg	**1,733**	23	29	67	16	27	
Mn	**2**	**1.6**	**2.5**	**0.52**	**1.4**	**0.13**	
Hg	**0.010**	**0.00011**	**0.00015**	**0.00061**	0.0000023	**0.000022**	
Mo	**0.23**	**0.15**	**0.24**	**0.015**	0.0016	0.0081	
Ni	**0.062**	**0.24**	**0.38**	0.0043	0.0018	0.0092	
Nitrate	-	5.2	7.7	–	0.95	0.29	
pH	7.7	8.5	8.1	7.8	7.8	**8.9**	
P	-	0.17	0.25	–	0.060	0.93	
K	120	22	31	9	0.80	8.1	
Se	**0.042**	**0.17**	**0.27**	0.0032	0.00075	0.0016	
Si	7	14	20	–	6.3	17	
Ag	0.00009	0.0010	0.0014	0.00031	0.00016	0.00016	
Na	**1,100**	22	30	72	11	235	
Sr	7.9	1.6	2.5	–	0.38	1.0	
SO_4	**8,605**	**437**	**670**	**266**	27	99	
TDS	**11,550**	**746**	**1073**	**615**	183	**690**	
TSS	-	–	–	–	13	**167**	
Tl	0.00041	0.00064	0.00085	0.00017	0.00016	0.00061	
V	0.0048	0.0036	0.0044	0.0032	0.0031	0.0084	
Zn	0.033	**0.35**	**0.57**	0.012	0.014	0.042	

Notes: "–" - not estimated
* - flow estimate based on maintaining adequate TSF pond volume, actual flow will be based on water quality

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