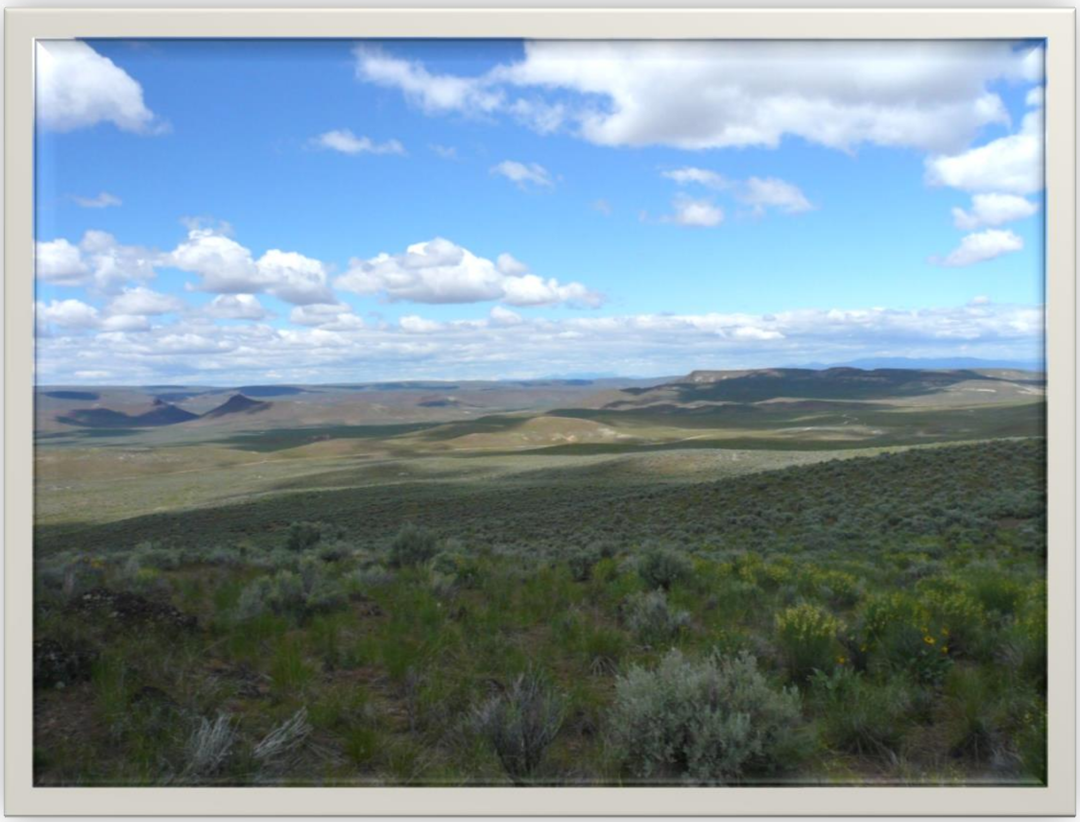
CALICO RESOURCES USA CORP.
GRASSY MOUNTAIN MINE PROJECT
STATE OF OREGON
DOGAMI DIVISION 37
CONSOLIDATED PERMIT APPLICATION

NOVEMBER 2019



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November 2019

Prepared for:

Calico Resources USA Corp.
665 Anderson Street
Winnemucca, Nevada 89445

Submitted to:

Oregon Department of Geology and Mineral Industries
Mineral Land Regulation & Reclamation
229 Broadalbin Street SW
Albany, Oregon 97321-2246

Prepared by:

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TABLE OF CONTENTS

PAGE

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
µg/m^3	micrograms per cubic meter
µm	micrometer
µS/cm	microSiemens per centimeter
3D	three-dimensional
AADT	average annual daily traffic
AASHTO	American Association of State Highway and Transportation Official
ABA	acid-base accounting
ACEC	Areas of Critical Environmental Concern
ACGIH	American Conference of Industrial Hygienists
ADR	absorption, desorption, and refining
ADT	average daily trips
amsl	above mean sea level
ANFO	Ammonium Nitrate and Fuel Oil
AP	Acidification Potential
ARD/ML	Acid Rock Drainage and Metal Leaching
Atlas	Atlas Precious Metals
ATV	all-terrain vehicle
BATFE	Bureau of Alcohol, Tobacco, Firearms and Explosives
bcy	bank cubic yards
bgs	below ground surface
Bison	Bison Engineering, Inc.
BLM	Bureau of Land Management
BMP	best management practices
BP	barometric pressure
C	Celsius
Calico	Calico Resources USA Corp.
CCC	Criterion Continuous Concentration
CES	Cascade Earth Sciences
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIL	carbon-in-leach
cm/s	centimeters per second
CMC	Criterion Maximum Concentration
CNWAD	weak acid dissociable cyanide
COG	cut-off grade
COOP	Cooperative Observer Network
CPE	corrugated polyethylene
CPT	Cone Penetration test

CRF	cemented rock fill
Cryla Agreement	Exploration and Option to Purchase Agreement Cryla Project
Cryla Project	28 Cryla, Lucky Lucy, and Winter unpatented mining claims
CSAMT	Audio-frequency Magnetotellurics
D&F	drift-and-fill
dB	decibel
De	equivalent dimension
DEM	digital elevation model
DHS	Department of Homeland Security
DO_2	dissolved oxygen
DOGAMI	Department of Geology and Mineral Industries
DPM	diesel particulate matter
drift	horizontal tunnel
dS/m	deciSiemens per meter
DSHA	deterministic seismic hazard analysis
DSL	Department of State Lands
E-Cell	Evaporation Cell
EFU	Exclusive Farm Use
EGL	effective grinding length
EM Strategies	EM Strategies, Inc.
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
Erionite SAP	Erionite Sampling and Analysis Plan
ERU	Exclusive Range Use
ESD	Education Service District
ESI	Environmental Simulations Incorporated
ESR	excavation support ratio
FOS	factors of safety
ft	feet
ft/d	feet per day
ft/hr	feet per hour
ft^2	square feet
ft^3	cubic feet
ft^3/min	cubic foot per minute
g	gram
GCL	geosynthetic clay liner
GIS	geographic information system
Golder Associates Inc.	Golder
gpm	gallons per minute
GPS	Global Positioning System
GV	Groundwater Vistas

H	horizontal
HCT	humidity cell test
HDPE	high-density polyethylene liner
HDR	HDR Engineering, Inc.
HG	high-grade
HHC	human health criteria
hp	horsepower
HSEC	Health, Safety, and Environmental Compliance
ICP	Inductive Couple Plasma
ILR	intensive-leach reactor
IMS	IMS, Inc.
In	inches
ISRM	International Society for Rock Mechanics
JCR	joint condition rating
kg	kilograms
kg/t	kilogram per ton
KOP	key observation points
kV	kilovolt
kW	kilowatts
kWh	kilowatt hour
Lb	length of the bolts
lb/ft^3	pound per cubic foot
lbs	pounds
LCRS	leakage collection and recovery systems
LG	low-grade
LHD	load-haul-dump vehicle
LOM	life of mine
Low PAG	Uncertain Potential/Lower Capacity
MBTA	Migratory Bird Treaty Act
MCC	Malheur County Code
MCE	Maximum Credible Earthquake
MCL	maximum contaminant levels
MDA	Mine Development Associates
MDL	minimum detection limit
MEK	Methyl Ethyl Ketone
mEq/L	milliequivalents per liter
MG	Medium-grade
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeters
mph	miles per hour

MRA	Malheur Resource Area
MSHA	Mine Safety and Health Administration
mtons	million tons
mV	millivolts
MW	megawatt
MWMP	meteoric water mobility procedure
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NAG	net acid generating
Newmont	Newmont Exploration Ltd.
ng/L	nanogram/liter
NNP	Net Neutralization Potential
Non-PAG	Non-Acid Generating
NP	neutralization potential
NPDES	National Pollutant Discharge Elimination System
NPI	Net Profits Interest
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NSHM	National Seismic Hazard Model
NWC	Northwest Wildlife Consultants, Inc.
NWI	National Wetland Inventory
O_3	ozone
OAR	Oregon Administrative Rule
OBE	operational basis earthquake
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODT	Oregon Department of Transportation
OED	Oregon Employment Department
OGWQG	Oregon Groundwater Quality Guidelines
ONA	Outstanding Natural Area
ONHA	Oregon Natural Heritage Areas
OPDR	Oregon Partnership for Disaster Resilience
ORS	Oregon Revised Statutes
OSP	Oregon State Police
OWRD	Oregon Water Resources Department
oz Au/ton	ounce gold per ton
PAG	potentially acid generating
Paramount	Paramount Gold Nevada Corp.
PEA	Profitability Economic Assessment
PEL	permissible exposure limit

Permit Area	Permit Boundary (Mine and Process Area and Access Road Area)
PFD	Process Flow Diagram
PFS	Prefeasibility Study
PGA	peak ground accelerations
Plan	Plan of Operations
pls	pure live seed
PLT	Point load tests
PM_{10}	particulate matter less than ten microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
portal	surface entrance to underground excavated area to remove ore
ppb	parts per billion
ppm	parts per million
Project	Grassy Mountain Mine Project
PSHA	probabilistic seismic hazard analysis
PVC	polyvinyl chloride
Q	rock mass quality
QA/QC	quality assurance/quality control
RAWS	Remote Automated Weather Stations
RC	reverse circulation
RCE	reclamation cost estimate
RCRA	Resource Conservation and Recovery Act
RF	rock fill
RMR	rock mass rating
RNAs	Research Natural Areas
ROM	run-of-mine
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
RQD	rock quality designation
s.u.	significant unit
Seabridge	Seabridge Gold Corporation
SEM	Scanning Electron Microscopy
SEORMP	Southeastern Oregon Resource Management Plan and Record of Decision
SER	Significant Emission Rates
SHA	seismic hazard analysis
Sherry & Yates	Sherry & Yates Inc.
SHPO	State Historic Preservation Office
SLM	sound level meter
SMBS	sodium metabisulphite
SMCL	secondary maximum contaminant levels
SPF	SPF Water Engineering, LLC

SPLP	synthetic precipitation leaching procedure
SRK	SRK Consulting
st/hr	short tons per hour
st/d	short tons per day
TDS	total dissolved solids
TIC	total inorganic carbon
TLV	threshold limit values
Tombstone	Tombstone Exploration Company Ltd.
tons/hr	tons per hour
TRT	Technical Review Team
TSF	Tailings Storage Facility
U.S.	United States
U.S.C.	United States Code
UCS	uniaxial compressive strength
URMR	underground rock mass ratings
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
V	vertical
VHF	very high frequency
VOC	Volatile Organic Compound
VRM	Visual Resources Management
VWP	vibrating wire piezometers
WAD	weak acid dissociable
WB&M	Willamette Base & Meridian
WEG	Wind Erodibility Group
Wm^2	watts per square meter
WPCF	Water Pollution Control Facility
WRD	waste rock dump
XRD	X-Ray Diffraction Analysis
yd^3	cubic yard

1 INTRODUCTION AND GENERAL INFORMATION

Calico Resources USA Corp. (Calico) proposes to construct, operate, reclaim, and close an underground mining and precious metal milling operation known as the Grassy Mountain Mine Project (Project). The Project is proposed in Township 21 South, Range 44 East (T21S, R44E), and T22S, R44E, Malheur County, Oregon. A detailed description of the Project and location is below.

1.1 Applicant

Operator Name:	Calico Resources USA Corp.
Mailing Address:	665 Anderson Street Winnemucca, Nevada 89445
Phone Number:	(775) 625-3600
Taxpayer Identification Number:	45-2188867

1.2 Registered Agent

CT Corporation System
780 Commercial St SE, Ste 100
Salem, Oregon 97301-3465

1.3 Owners of Surface and Mineral Rights

Surface Rights:
US Bureau of Land Management
Vale District Office
100 Oregon Street
Vale, Oregon 97918
(541) 473-3144

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445
(775) 625-3600

Mineral Rights:
Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445
(775) 625-3600

1.4 Legal Structure of Applicant in Oregon

Calico Resources USA Corp
665 Anderson Street
Winnemucca, Nevada 89445

Registry Number: 78127694

Principal Place of Business:
665 Anderson Street
Winnemucca, Nevada 89445

Mailing Address:
665 Anderson Street
Winnemucca, Nevada 89445

President:
Glen van Treek
665 Anderson Street
Winnemucca, Nevada 89445

Secretary:
Glen van Treek
665 Anderson Street
Winnemucca, Nevada 89445

Registered Agent:
CT Corporation System
780 Commercial St. SE, Ste 100
Salem, Oregon 77301-3465

1.5 Authorized Field Representative

Calico personnel, or their agents, will be on site during all Project-related activities, and will be responsible for implementing and ensuring that all activities are completed in accordance with this Permit.

Point of Contact for this Permit Application: Nancy Wolverson
665 Anderson Street
Winnemucca, Nevada 89445
Phone (775) 770-4615

Corporate Point of Contact: Carlo Buffone
665 Anderson Street
Winnemucca, Nevada 89445
Phone (775) 625-3600

1.6 Project Location and Access

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale and consists of two areas: the Mine and Process Area and the Access Road Area (Permit Area) (Figure 1 and Figure 2). The Permit Area shown in all figures and text shows and describes the boundary of the proposed Project. The Access Road extends north from the Mine and Process Area to the Malheur County Road named Twin Springs Road.

The Mine and Process Area is located on three patented lode mining claims and unpatented lode mining claims that cover an estimated 886 acres (Figure 3). These patented and unpatented lode mining claims are part of a larger land position that includes 455 unpatented lode mining claims and nine mill site claims on lands administered by the Bureau of Land Management (BLM) Vale District Office (Figure 3). All proposed mining would occur on the patented claims, with some mine facilities on unpatented claims. The Mine and Process Area is in all or portions of Sections 5 through 8, T22S, R44E, Willamette Base & Meridian (WB&M).

The Access Road Area is located on public land administered by the BLM, and private land controlled by others (). A portion of the Access Road Area is a Malheur County Road named Twin Springs Road. The Access Road Area extends north from the Mine and Process Area to Russell Road, a paved Malheur County Road. The Access Road Area is in portions of Section 5, T22S, R44E, Sections 3, 10, 11, 14, 15, 21 through 23, 28, 29, and 32, T21S, R44E, Sections 1, 12 through 14, 23, 26, 27, and 34, T20S, R44E, Sections 6 and 7, T20S, R45E, and Sections 22, 23, 26, 35, and 36, T19S, R44E (WB&M). The width of the Access Road Area is 300 feet (150 feet on either side of the access road centerline) to accommodate possible minor widening or rerouting, and a powerline adjacent to the access road. There are several areas shown that are significantly wider than 300 feet on the Permit Area Map (Figure 3), which are areas where the final alignment has not yet been determined. The final engineering of the road will be consistent throughout, and within the Permit Area. The Access Road Area also includes a buffer on either side of the proposed road width for the collection of environmental baseline data. The road corridor will be approximately 30 feet wide, which includes a 20-foot wide road travel width (ten feet on either side of the road centerline), two-foot wide shoulders on each side of the road, minimum one-foot wide ditches on each side of the road, and appropriate cut and fill. The Access Road Area totals approximately 876 acres. All existing and planned roads are shown in Figures 1 and 2 below.

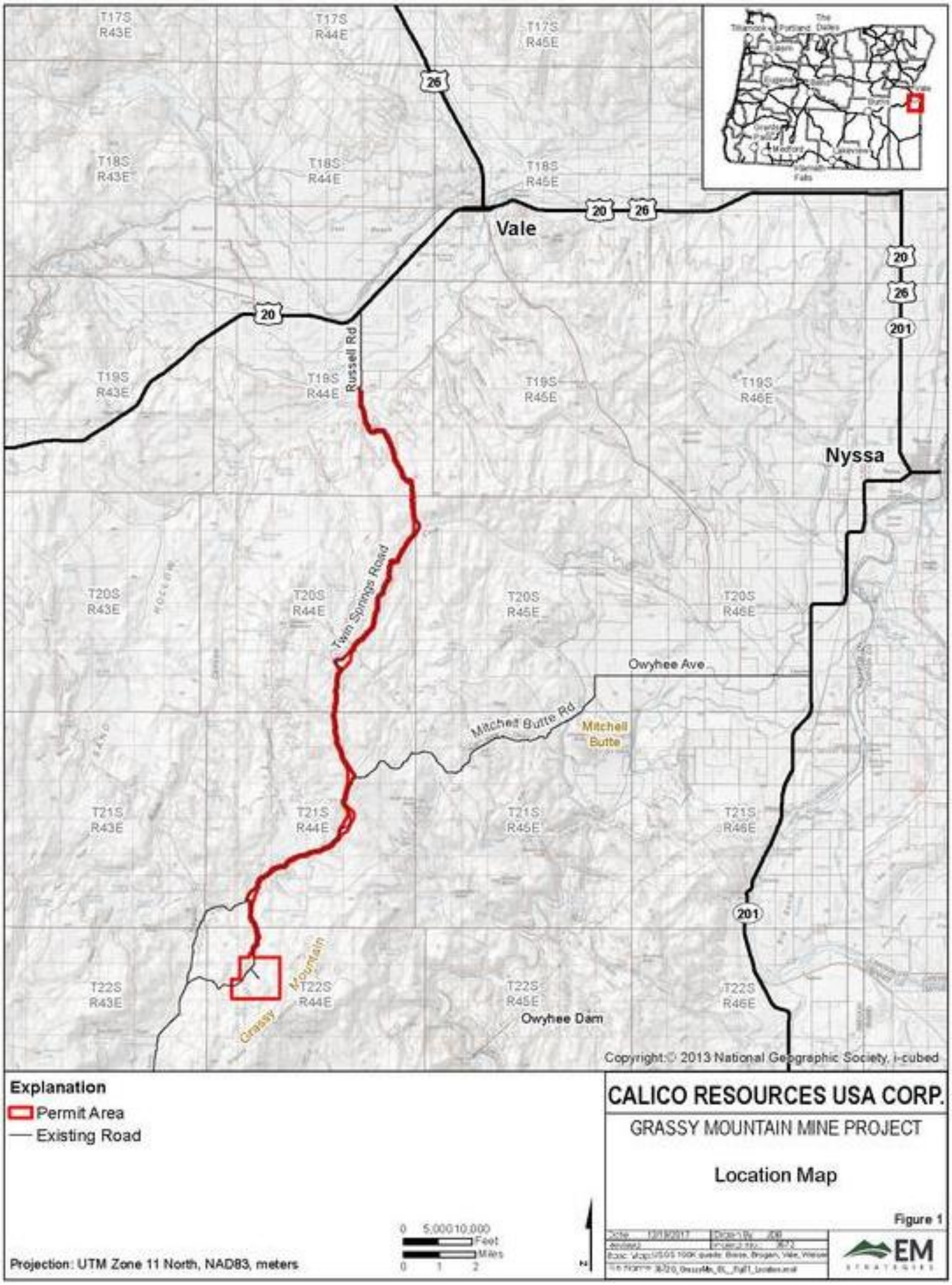


Figure 1. Location Map

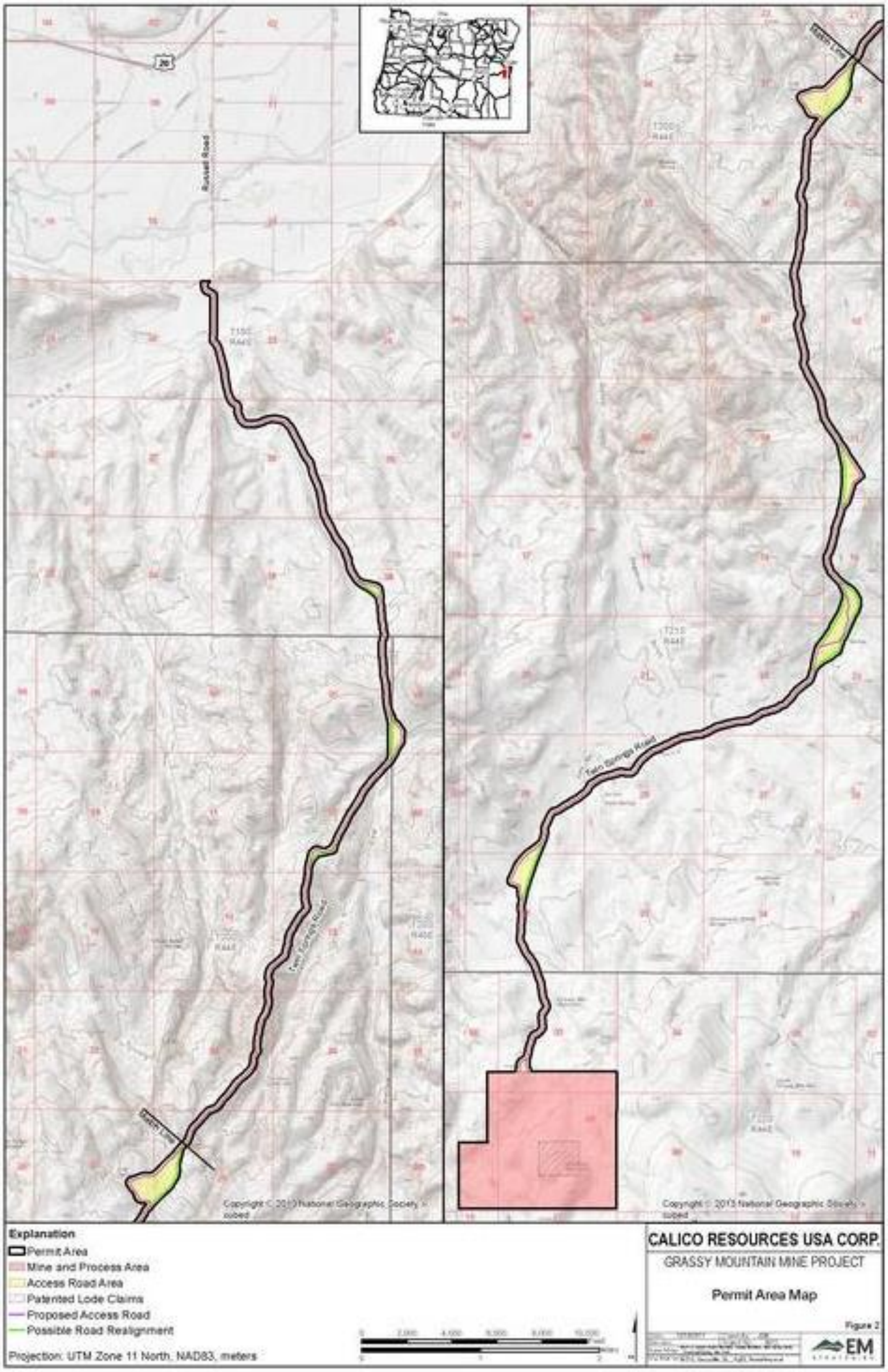


Figure 2. Permit Area Map

The study area is defined as the geographical area in which the potential direct and indirect socioeconomic effects of the Project are realized. The purpose of documenting the socioeconomic setting of the study area is to provide an understanding of the social and economic forces that have shaped the area and to provide a frame of reference necessary to estimate the social and economic effects of the Project.

Malheur County is Oregon's second largest county in the area but is largely undeveloped. The County is in the southeastern corner of the State of Oregon and is crossed by two major rivers, the Snake River and the Malheur River. Ninety-four percent of the County is undeveloped rangeland, most of which is federally owned and administered by the BLM. Developed areas along the Snake and Malheur Rivers support agricultural production areas and agriculture-focused communities.

1.7 Surface Ownership and Disturbance

1.7.1 Land Status

The Grassy Mountain property consists of 455 unpatented lode claims, nine unpatented mill site claims, six unpatented association placer claims, three patented claims, and two land leases covering all or portions of Sections 11 through 15 and 24 of T22S, R43E; portions of Sections 3 through 10 and 16 through 20, T22S, R44E; Sections 31 through 34, T21S, R44E; and Section 36, T21S, R43E, as shown in Figure 3 below. Patented claims were individually surveyed at the time of location. Unpatented claim and Fee land boundaries were established initially by Global Positioning System (GPS) handheld units and in 2011 by on-site survey work. Mining claim information is shown in Appendix X.

Calico, a wholly owned subsidiary of Paramount Gold Nevada Corp. (Paramount), owns and controls 100 percent of the mineral tenure of the unpatented mining claims, patented mining claims, fee lands, and mining leases that comprise the Grassy Mountain property. Calico acquired all right, title, and interest in the property, including all existing exploration and water rights pertaining to the Project, pursuant to the "Deed and Assignment of Mining Properties" between Seabridge Gold Inc., Seabridge Gold Corporation (Seabridge) and Calico dated February 5, 2013.

Ownership of unpatented mining claims is in the name of the holder (locator), subject to the paramount title of the United States (U.S.) of America, under the administration of the BLM. Under the Mining Law of 1872, which governs the location of unpatented mining claims on Federal lands, the locator has the right to explore, develop, and mine minerals on unpatented mining claims without payments of production royalties to the U.S. government, subject to the surface management regulation of the BLM.

Calico controls 100 percent of the surface rights to the patented and leased lands that comprise the Project, with the exception of the Bishop II leased lands. The surface rights controlled by

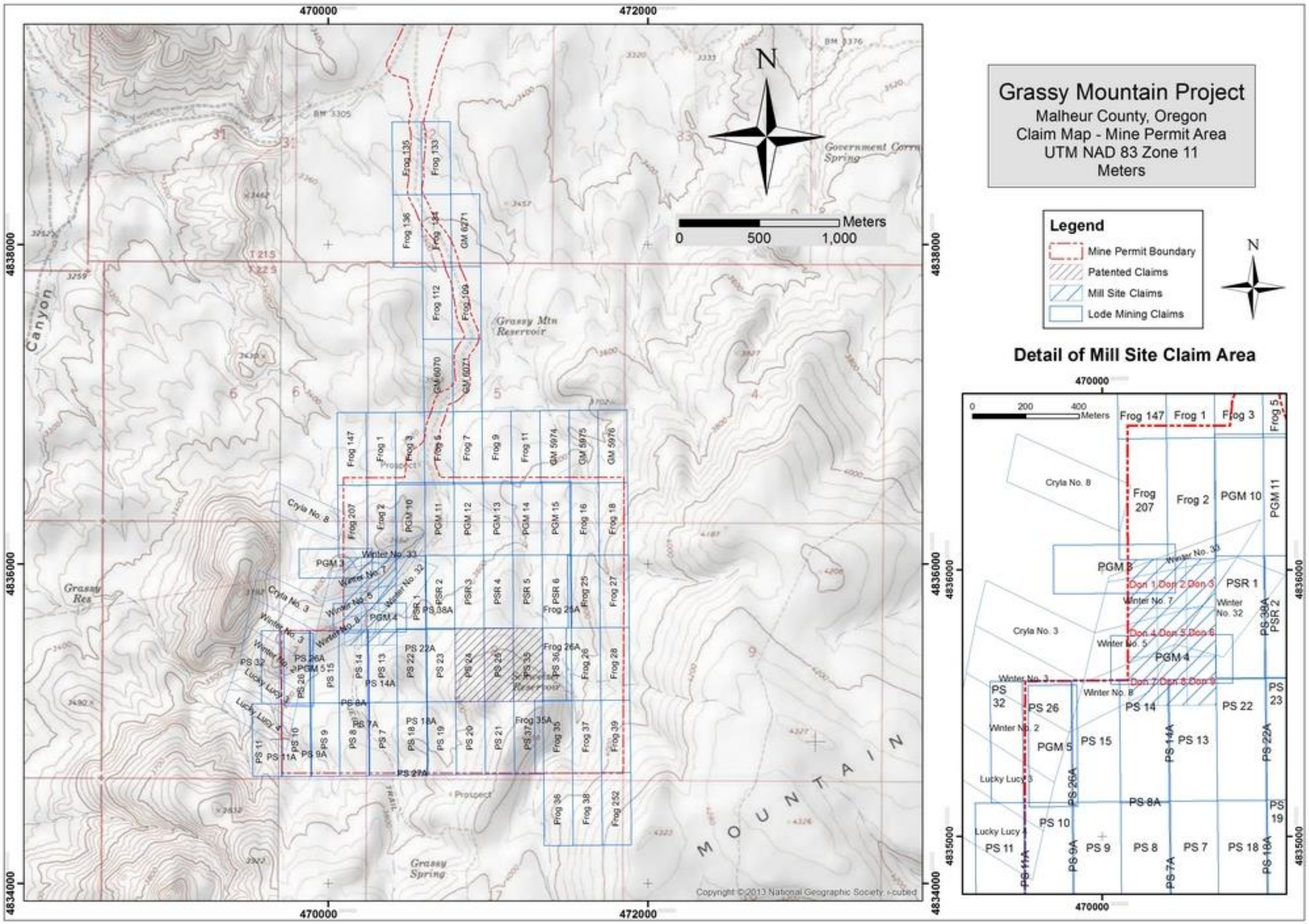


Figure 3. Grassy Mountain Land Status Map of the Mine and Process Portion of the Permit Area

Calico are subject to applicable Federal and State environmental regulations and the agreements outlined below.

1.7.1.1 Agreements and Encumbrances

Paramount's 100 percent ownership of the Project is subject to the underlying agreements and royalties summarized in the following subsections.

Seabridge Gold Corporation (Seabridge): Seabridge retains a ten percent Net Profits Interest (NPI) in the Project pursuant to the "Deed of Royalties" between Calico and Seabridge dated February 5, 2013. Pursuant to the "Deed of Royalties," within 30 days following the day that Calico has delivered to Seabridge a feasibility study on the Project, Seabridge may elect to cause Calico to purchase the ten percent NPI for ten million Canadian dollars.

Sherry & Yates Inc. (Sherry & Yates): On February 14, 2018, Calico exercised their option to purchase, whereby Sherry & Yates agreed to sell to Calico all right, title, and interest in the three patented and 37 unpatented mining claims. The 2004 lease and agreement with Sherry & Yates was terminated. The royalty attributed to Sherry & Yates has decreased from six percent to 1.5 percent.

Exploration and Option to Purchase Agreement Cryla Project (Cryla Agreement): Effective June 1, 2018, Calico executed the Cryla Agreement, whereby Cryla, LLC agreed to lease with an option to purchase the 28 Cryla, Lucky Lucy, and Winter unpatented mining claims (Cryla Project). The following terms are effective until May 31, 2043:

- Forty-thousand dollars due at signing; June 1, 2019, $40,000; June 1, 2020, and each succeeding year $60,000.
- Production royalty based on price of gold; two percent if less than or equal to $1,500 and four percent if greater than $1,500.
- Option to Purchase: Purchase price of $560,000 plus the amount determined by multiplying the number of troy ounces identified (prefeasibility or greater certainty) within the boundaries of the Cryla Project, multiplied by three dollars.

The Project covers a portion of the Calico land holdings. The Permit Area, which is the basis of this permit application is shown in Figure 2 (Section 1.6). The legal description of the Mine and Process Area includes all or portions of the following:

T22S, R44E
SW ¼ of Section 5
S ½ of SE ¼ of Section 5
NW ¼ of Section 5
SE ¼ of SE ¼ of Section 6
SE ¼ of Section 7
S ½ of NE ¼ of Section 7
NE ¼ of NE ¼ of Section 7

NW ¼ of Section 8
NE ¼ of Section 8
SW ¼ of Section 8
SE ¼ of Section 8

T21S, R44E
W ½ of SE ¼ of Section 32
E ½ of SW ¼ of Section 32
W ½ of NE ¼ of Section 32
E ½ of NW ¼ of Section 32
SW ¼ of SE ¼ of Section 29

1.7.2 Project History

The information in this section refers to the Calico holdings, which include the Project (Permit Area), which is the subject of the Consolidated Permit. The history summarized in this section of the report has been extracted and modified from Wilson et al. (2015), which was drawn from Hulse et al. (2012), with additional information derived from multiple sources, as cited. A concise, early history of the discovery of the Grassy Mountain deposit and other events to September 1988 were reported by Kelly (1988).

Portions of the present Grassy Mountain property were first staked in 1984 by two independent geologists, Dick Sherry and Skip Yates. Atlas Precious Metals (Atlas) acquired the Grassy Mountain property from Sherry and Yates in 1986. Between 1986 and 1991, Atlas conducted detailed mapping and sampling at the property and drilled a total of 227,397 feet in 400 drill holes. Of the 400 drill holes completed by Atlas at the Grassy Mountain property, 196 were reverse circulation (RC) holes drilled on 75- to 100-foot centers within what became the Grassy Mountain resource area. The remaining holes were drilled at prospects away from the main Grassy Mountain resource area. Shallow, apparently stratiform gold mineralization was delineated at the main Grassy Mountain deposit and 1.5 miles to the southwest at the Crabgrass prospect. Atlas identified exploration targets at the Project based on soil anomalies, conducted further soil and float sampling on several prospects, expanded the original claim block, and collected extensive geologic, mine engineering, civil engineering, and environmental baseline data. The baseline data were compiled to support a 1990 historical feasibility study for an envisioned open-pit heap-leach and milling operation. In addition to the Grassy Mountain deposit, Atlas delineated another gold prospect called Crabgrass, where they drilled 87 RC holes and defined three separate near-surface mineralized zones. Atlas then began to consider underground-mining scenarios, but declining gold prices and the perception of an unfavorable permitting environment discouraged Atlas from developing the project, and the property was optioned to Newmont Exploration Ltd. (Newmont) in 1992.

Newmont leased the Grassy Mountain property from Atlas in September 1992. Newmont geologists mapped the property and completed geochemical sampling. Several ground and airborne geophysical surveys were also conducted. In late 1994, Newmont drilled 15 holes and completed an in-house mineral resource estimate that became the basis for an in-house economic and mining-method evaluation that was completed in 1995. In 1994, Newmont first drilled 11 inclined diamond-core holes designed to intersect and define the geometry of potential high-grade gold zones in the main Grassy Mountain deposit. These were followed with one wedge core hole off of their initial core hole, two holes pre-collared by RC and completed with core, and one additional core hole. Newmont's 15 holes were all angled and totaled 15,009.5 feet. This drilling defined what Newmont thought could be several gold zones in excess of 0.1-ounce gold per ton (oz Au/ton) within an area of the Grassy Mountain deposit measuring approximately 600 feet long by 350 feet wide by 250 feet thick. Mineralization was constrained to the northeast by a single hole which failed to encounter high-grade gold. Newmont considered the western extent of the main high-grade zone effectively closed off after encountering only low-grade gold (0.012 to 0.019 oz Au/ton) and local barren quartz-chalcedony veins. Based on the core drilling and mapping and sampling of surface exposures, Newmont geologists concluded that high gold grades at the Grassy Mountain deposit were controlled by narrow, steeply south-dipping quartz-chalcedony veins and clay matrix breccias that would need to be properly represented during grade modeling and resource estimation.

By 1996, Atlas and Newmont had identified and named several mineralized and potentially mineralized target areas peripheral to the main Grassy Mountain gold deposit based primarily on rock-chip, float, and soil-sample data. The exploration targets are: 1) Wheatgrass; 2) North Spur; 3) Crabgrass; 4) Bluegrass and North Bluegrass; 5) Snake Flats; 6) Wood; 7) Wally; 8) Ryegrass; 9) Clover; 10) Bunchgrass; and 11) Sweetgrass. They are predominately located to the north, west and southwest of the Grassy Mountain deposit. Newmont determined that the project did not meet corporate objectives and returned the property to Atlas in September 1996.

In January 1998, Atlas granted Tombstone Exploration Company Ltd. (Tombstone) the option to purchase 100 percent of the property. Tombstone executed the option agreement and conducted an exploration program which included six holes for a total of 8,071 feet. Lack of venture capital forced Tombstone to return the property to Atlas in May 1998.

In February 2000, Seabridge entered an option agreement with Atlas to acquire a 100 percent interest in the Grassy Mountain property. Seabridge completed its acquisition of the Grassy Mountain property in April 2003; however, did not carry out exploration at the Grassy Mountain property.

In April of 2011, Seabridge signed an option agreement granting Calico the sole and exclusive right and option to earn a 100 percent interest in the Project. The acquisition of the Grassy Mountain property by Calico was completed in 2012. In 2011 and 2012, Calico carried out geologic mapping and sampling, and drilled a total of 13,634 feet in 14 RC and three core holes. Thirteen of these holes were drilled in the Grassy Mountain deposit area and four were drilled in outlying targets. Calico also commissioned a geophysical survey to assist in their exploration efforts at the Grassy Mountain property.

In 2016, Paramount acquired Calico by issuing common shares to Calico shareholders, whereby Calico shareholders had the right to receive 0.07 of a share of common stock of Paramount for every common share of Calico.

Historical exploration conducted by previous operators includes exploration programs carried out by Atlas, Newmont, Tombstone, and Calico. A variety of historical resource and reserve estimates for the Grassy Mountain gold deposit were completed on behalf of previous owners and issuers from 1990 through 1997. These historical estimates are summarized in the 2011 technical report prepared by Resource Modeling Inc. (Lechner 2011) and are described in detail in various internal reports prepared by Atlas, Newmont, and their contractors. In addition, Wilson et al. (2015) provided a summary of historical estimated resources for the Crabgrass prospect. All of these estimates are relevant only for the historical context of exploration work done during this period and are not to be relied upon. Paramount is not treating these estimates as current mineral resources and they are superseded by the current mineral resources described in the 2018 Prefeasibility Study (PFS) completed by Paramount (Mine Development Associates [MDA] 2018).

1.7.3 Project Permits

The following are the permits associated with the Project:

- Chemical Process Mines Permit (Division 37)—Oregon Department of Geology and Mineral Industries
- Chemical Mining Permit (Division 43)—Oregon Department of Environmental Quality
- Air Quality Operating Permit—Oregon Department of Environmental Quality
- Permit to Appropriate Water—Oregon Water Resources Department
- General Discharge Permit (Storm Water)—Oregon Department of Environmental Quality
- Water Pollution Control Facility Permit—Oregon Department of Environmental Quality
- Dam Safety Permit—Oregon Water Resources Department
- Plan of Operations/Record of Decision—United States Department of the Interior, Bureau of Land Management
- Hazardous Waste Identification Number—United States Environmental Protection Agency
- Explosives Permit—United States Department of the Treasury, Bureau of Alcohol, Tobacco, Firearms, and Explosives

2 EXISTING ENVIRONMENT

The following are summaries of the Baseline Studies (Appendix B), which should be referenced for the methodologies used, study areas, and data collected for each of the respective resources. Also included in Appendix B is the Environmental Baseline Study Work Plans (EM Strategies, Inc. [EM Strategies] 2017).

2.1 Air Quality Resources

The Grassy Mountain Mine Project Air Quality Resources Baseline Report (Appendix B) was submitted to Department of Geology and Minerals Industries (DOGAMI) on January 18, 2018. The report was accepted by the Technical Review Team (TRT) on February 28, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. An air quality monitoring station was established by HDR Engineering, Inc. (HDR) in July 2014 west of the Mine and Process Area portion of the Permit Area to monitor particulates (i.e., particulate matter less than 2.5 microns in aerodynamic diameter [$PM_{2.5}$] and particulate matter less than ten microns in aerodynamic diameter [PM_{10}]). A meteorological station was installed in August 2014 to monitor wind speed, wind direction, standard deviation of wind direction, temperature at nine and two meters, delta temperature, relative humidity, barometric pressure, solar radiation, and precipitation. Data collection occurred between October 2014 and September 2015.

No monitoring has been performed within the Local Air Quality Study Area for ambient concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), or sulfur dioxide (SO_2), nor do regulatory agencies specify background concentrations for these pollutants. In the absence of major population centers, commercial activity, or highways near the proposed mine, the background concentrations of CO, NO_2, and SO_2 at the Permit Area boundary are expected to be very low. Taking into consideration the surrounding settings (terrain, land use, and proximity of sources), the ambient monitoring data collected at the St. Luke's Meridian station (16-001-0010) in Meridian, Idaho, were used to provide conservative background concentrations for the Project. This station is the closest monitoring station by proximity to the Local Air Quality Study Area. Due to its semi-urban location and proximity to the City of Boise, the data collected at this station were used as extremely conservative values as compared to the isolated and rural setting of the Local Air Quality Study Area. The background concentrations are shown in Table 1 and the meteorological station data are shown in Table 2.

Table 1. Ambient Pollutant Concentration Summary

Standard	Concentration	Source	Method
Carbon Monoxide 8-Hour	0.244 ppm	16-001-0010 Meridian, ID	2014-2016 (annual mean)
Carbon Monoxide 1-Hour	0.244 ppm	16-001-0010 Meridian, ID	2014-2016 (annual mean)
Lead 3-Month Average	1.99E-04	16-001-0010 Meridian, ID	2014-2016 (annual mean divided by 4)

Standard	Concentration	Source	Method
Nitrogen Dioxide 1-Hour	43.63 ppb	16-001-0010 Meridian, ID	2014-2016 (average 98th percentile)
Nitrogen Dioxide Annual	10.72 ppb	16-001-0010 Meridian, ID	2014-2016 (annual mean)
Ozone 8-Hour	.063 ppm	16-001-0010 Meridian, ID	2014-2016 (Annual Fourth High Average)
$PM_{2.5}$ 24-Hours	21 ug/m^3	Site Collected Data	Oct.2014-Sept.2015 Second High (less dates affected by wildfire smoke)
$PM_{2.5}$ Primary Annual	4.6 ug/m^3	Site Collected Data	Oct.2014-Sept.2015 Adjusted Annual Average (less dates affected by wildfire smoke)
PM_{10} 24-Hours	23 ug/m^3	Site Collected Data	Oct.2014-Sept.2015 Second High (less dates affected by wildfire smoke)
Sulfur Dioxide 1-Hour	4.17 ppb	16-001-0010 Meridian, ID	2014-2016 (average 99th percentile)
Sulfur Dioxide 3-Hours	.623 ppb	16-001-0010 Meridian, ID	2014-2016 (annual mean)

Source: U.S. Environmental Protection Agency (EPA) 2017; Bison Engineering, Inc. (Bison) 2015
ppb = parts per billion; ppm = parts per million; µg/m^3 = micrograms per cubic meter

Table 2. Quarterly and Annual Means for Meteorological Parameters

Quarter	Wind Speed (mph)	Wind Direction (Degrees)	Temp 9 meters (°F)	Temp 2 meters (° F)	Relative Humidity	BP (In Hg)	Solar Radiation (Wm^2)	Total Precipitation (In)
2014 3rd	7.0	340	68.1	68.0	38.2	26.48	224	0.85
2014 4th	7.3	284	41.7	41.2	68.9	26.56	91	3.22
2015 1st	6.6	300	39.4	39.0	74.2	26.65	116	2.18
2015 2nd	7.7	344	60.9	60.9	43.6	26.45	274	2.22
2015 3rd	7.2	295	71.9	71.8	33.9	26.48	254	1.64
Oct. 1, 2014 – Sept. 30, 2015	7.2	311	53.6	53.3	54.8	26.53	184	9.26

Source: Bison 2015
mph = miles per hour; °F = degrees Fahrenheit; BP = barometric pressure; In = inches; Hg = mercury; Wm^2 = watts per square meter

2.1 <u>Aquatic Resources</u>

The Grassy Mountain Mine Project Aquatic Resources Baseline Report (Appendix B) was originally submitted to DOGAMI on January 11, 2018, then again on August 24, 2018. The report was accepted by the TRT on December 14, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. A review of existing information from Oregon Department of Fish and Wildlife (ODFW) indicated that fish are unlikely to occur within the Aquatic Resources Study Area partially due to a fish barrier downstream at Rye Field Reservoir, and the ephemeral nature of the drainages in the Aquatic Resources Study Area. The information review yielded a list of five special status amphibian species that occur in southeastern Oregon: blotched tiger salamander (*Ambystoma tigrinum melanosticum*), a BLM special status species;

Columbia spotted frog (*Rana luteiventris*), a U.S. Fish and Wildlife Service (USFWS) Species of Concern and Sensitive-Critical ODFW species; northern leopard frog (*Rana pipiens*), a BLM sensitive species; western toad (*Anaxyrus boreas*), a BLM special status and ODFW sensitive species; and woodhouse toad (*Bufo woodhousii*), a BLM special status species.

Field surveys were conducted in May and October 2014 by HDR in the Aquatic Resources Study Area. Habitat suitable for fish was limited and the 18 sites visited showed no connection to perennial streams. Electrofishing in May 2014 was only feasible in limited reaches of Negro Rock Canyon; no fish were captured. Fish surveys were not conducted in October 2014 as there was no flowing water observed.

Only ten of the 18 sites included standing or flowing water during the May 2014 field surveys; therefore, only the ten sites were surveyed for amphibians. No special status amphibian species were observed; however, Pacific treefrog (*Pseudacris regilla*), a common species in Oregon, were observed at several sites in May 2014. The presence of treefrogs may be indicative of habitat suitability for other species with similar breeding requirements, which may have limited populations in the Aquatic Resources Study Area.

2.2 Areas of Critical Environmental Concern/Research Natural Areas

The Grassy Mountain Mine Project Areas of Critical Environmental Concern/Research Natural Areas Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Permit Area is in the Malheur Resource Area (MRA). There are 17 combined Areas of Critical Environmental Concern (ACECs)/Research Natural Areas (RNAs) and 11 ACECs in the MRA. There are no ACECs/RNAs or ACECs in the Permit Area. The closest ACEC or ACEC/RNA to the Permit Area is the Owyhee River Below The Dam ACEC.

2.3 Cultural Resources

In November 2017, a cultural resource inventory of 830 acres (Survey Area) was conducted for the proposed Project in Malheur County, Oregon. The Area of Potential Effect consists of a total of 1,762 acres, of which 932 acres were previously inventoried during previous iterations of the Project; the recent cultural Survey Area comprises the remaining 830 acres. The results of this inventory were discussed in a cultural resources inventory report submitted to the BLM on November 21, 2018. The BLM provided comments on the draft report on February 8, 2019. A revised draft was submitted on April 26, 2019; the BLM accepted the revised draft and submitted the draft to the State Historic Preservation Office (SHPO) on June 28, 2019. On August 9, 2019, the SHPO sent a letter to the BLM stating they finished their review of the built environment portion of the report, and subsequently provided preliminary comments on the archaeological portion of the report in a letter sent to the BLM on August 14, 2019.

A total of eight newly identified archaeological resources, five previously recorded archaeological resources, 14 built resources, and 20 isolated finds were identified during the inventory of the Survey Area. Of the eight newly identified archaeological resources, five are prehistoric simple flaked stone sites, two are prehistoric complex flaked stone sites, and one is a historic berm and ditch site associated with the historic Lowe Reservoir. The historic berm and ditch site is recommended as not eligible for listing in the National Register of Historic Places (NRHP) under any evaluation criteria, while one of the newly recorded prehistoric sites is recommended as eligible for listing in the NRHP under Criterion D. The remaining six newly recorded prehistoric sites are recommended to be considered unevaluated for listing in the NRHP until subsurface testing is completed. Of the 14 newly recorded built resources, 12 are historic road segments, one is a segment of a historic canal, and one is the historic Grassy Mountain Reservoir. All 14 built resources are recommended as not eligible for listing in the NRHP under any evaluation criteria. Of the six previously recorded archaeological sites, one is a prehistoric simple flaked stone sites, two are prehistoric basic habitation sites,, and one is a multicomponent site including prehistoric complex flaked stone and historic prospecting components. One of the previously recorded prehistoric sites is recommended as eligible for listing in the NRHP under Criterion D, while the historic component of the previously recorded multicomponent site is recommended as not eligible for the NRHP under any evaluation criteria. The prehistoric component of the multicomponent site and the remaining four previously recorded prehistoric sites are recommended to be considered unevaluated for the listing in the NRHP until further subsurface investigations are completed. Of the 20 isolated artifacts identified, seven are prehistoric, 12 are historic, and one is multicomponent, all of which are recommended as not eligible for listing in the NRHP under any evaluation criteria.

2.4 Environmental Justice

The Grassy Mountain Mine Project Environmental Justice Baseline Report (Appendix B) was submitted to DOGAMI on February 23, 2018. The report was accepted by the TRT on July 20, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Environmental Justice Study Area includes Malheur County and incorporates census tracts 9702, 9703, 9704, 9705, 9706, 9707, 9709, and 9400. Census tracts 9702, 9703, and 9704 include portions of the City of Ontario. Census Tract 9705 includes the City of Nyssa and community of Cairo. Census Tract 9706 includes the City of Vale and smaller communities of Willowcreek and Jamieson. The City of Adrian, and the communities of Kingman and Owyhee are included in Census Tract 9707. Census Tract 9709 encompasses the majority of the remainder of Malheur County, except for a small portion of the Fort McDermitt Indian Reservation (Census Tract 9400) at the southern border of the County that is shared with Nevada.

Table 3 summarizes information about race and ethnicity for the Environmental Justice Study Area from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison. Malheur County is a very large geographic area and its statistics do not necessarily provide good measures of income and poverty for the Environmental Justice Study Area.

Table 3. Race and Ethnicity for Oregon, Malheur County, and the Environmental Justice Study Area

Race or Ethnicity	Percent of Population								
	Oregon	**Malheur County**	**9702**	**9703**	**9704**	**9705**	**9706**	**9707**	**9709**
Race									
White Alone	85.1	85.7	80.9	89.8	78.9	89.1	91.5	90.5	82.6
Black or African American Alone	1.8	1.2	0.4	0.8	0.6	1.4	0.2	0	3.7
American Indian and Alaska Native Alone	1.2	0.8	0.7	0.6	0.2	0.2	0.7	1.5	1.8
Asian Alone	4.0	1.6	2.5	1.7	1.5	1.2	0.9	2.3	1.8
Native Hawaiian and Other Pacific Islander Alone	0.4	0	0.2	0	0	0	0	0	0
Some other race alone	3.4	6.6	9.2	3.7	14.2	5.6	5.6	3.1	4.0
Two or more races	4.1	4.0	6.0	3.4	4.7	2.6	1.3	2.6	6.0
Ethnicity									
Hispanic or Latino (of any race)	12.3	32.7	37.1	30.8	49.9	48.3	20.9	14.4	18.0
Not Hispanic or Latino	87.7	67.3	62.9	69.2	50.1	51.7	79.1	85.6	82.0

Source: U.S. Census Bureau 2016a

The American Community Survey (U.S. Census Bureau 2016a) data show that people living in all geographies are predominantly white alone. The U.S. Census Bureau collects information about Hispanic and Latino ethnicity separately from information about race. People of Hispanic or Latino origin might not feel like they belong in any of the race categories and thus identify with *some other race alone* or *two or more races*. Together these other categories comprise most of the racial minorities in the Study Area. All the communities in the Environmental Justice Study Area, except for Jordan Valley, have higher proportions of Hispanic or Latino residents when compared to the state as a whole. The cities of Vale and Adrian have lower proportions of Hispanic or Latino residents when compared to the entire County.

Census data and information available from the State of Oregon indicate that there are minority populations living in Census Tract 9709, the tract that contains the Project, as well as in adjacent census tracts. Census Tract 9709 contains the largest percentage of Black or African American persons; however, Census Tract 9709 is also the largest tract by size in the Environmental Justice Study Area, so the minority population could be spread throughout the Census Tract. The largest percentage of Asian persons live near the City of Ontario.

Table 4 summarizes the information about household income for the Environmental Justice Study Area from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison.

Table 4. Income Summary for Oregon, Malheur County, and the Environmental Justice Study Area

Income Type	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Mean Income (dollars)	69,040	48,070	51,620	45,779	35,172	51,738	47,130	62,615	54,382
Median Income (dollars)	51,243	35,418	42,132	28,831	26,399	44,597	37,033	42,434	42,826
People with Earnings (percent of population)	75.6	71.6	67.4	61.7	70.7	78.3	72.9	73.6	81.7

Source: U.S. Census Bureau 2016b

Using the mean and median incomes for the Environmental Justice Study Area shown in Table 4, the U.S. Census Bureau income data suggest that the mean and median incomes for the Environmental Justice Study Area are above the U.S. Census Bureau poverty threshold for a five-person household and primarily above the U.S. Department of Health and Human Services poverty guidelines; however, the mean income in Census Tract 9704 is above the threshold for a six-person household, the median income in Census Tract 9703 is above the threshold for a six-person household, and the median income in Census Tract 9706 is above the threshold for a seven-person household.

Table 5 summarizes poverty information for the Environmental Justice Study Area from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison. The average family size is from the U.S. 2010 Census, as there are no current data available.

Table 5. Poverty Summary for Oregon, Malheur County, and the Environmental Justice Study Area

Income Type	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Families									
Average Family Size (number of people)	3.0	3.24	3.13	3.03	3.60	3.52	3.17	3.09	2.93
Families Living in Poverty in the Last 12 Months (percent of population)	11.2	18.1	12.4	29.2	27.0	17.7	13.5	8.4	13.0
Individuals									
Average Household Size (number of people)	2.51	2.62	2.63	2.46	2.43	2.99	2.70	2.57	2.51
Individuals living in poverty in the last 12 months (percent of population)	16.5	25.5	25.2	31.9	36.2	24.4	21.4	11.8	15.4
People receiving Supplemental Security Income (SSI) (percent of population)	4.6	8.4	7.4	11.6	12.1	4.1	8.4	3.9	8.0
People Receiving Food Stamps in Last 12 Months (percent of population)	19.2	27.6	15.0	42.6	43.3	33.5	18.1	17.0	8.7

Source: U.S. Census Bureau 2010, 2016b, 2016c, 2016d

Table 6 summarizes employment information for the Environmental Justice Study Area for persons living in poverty from the U.S. Census Bureau. The table includes data for Malheur County and Oregon as a whole for comparison.

Table 6. Employment Summary for People Living in Poverty in Oregon, Malheur County, and the Environmental Justice Study Area

Employment Type	Oregon	Malheur County	9702	9703	9704	9705	9706	9707	9709
Individuals Living in Poverty in the Last 12 Months (percent of population for whom poverty is determined)	16.5	25.5	25.2	31.9	36.2	24.4	21.4	11.8	15.4
Individuals who worked full time in last 12 months (percent of population in poverty)	3.1	7.6	10.3	6.3	7.8	8.5	2.9	4.3	11.5
Individuals who did not work in last 12 months (percent of population in poverty)	22.5	30.6	31.8	36.2	41.8	27.1	26.5	16.5	21.0

Source: U.S. Census Bureau 2016c

In general, the Census data suggest that the Environmental Justice Study Area could support low-income populations. Mean and median incomes in the Environmental Justice Study Area are the lowest in Census Tract 9704, which mainly encompasses the urban center of the City of Ontario. The proportions of families and individuals living in poverty are higher in the Census Tracts surrounding the City of Ontario than the rest of the Environmental Justice Study Area. The rate of individuals that did not work in the last 12 months is also highest in the City of Ontario.

2.5 Geochemistry

The Grassy Mountain Mine Project Geochemistry Baseline Report (Appendix B) is being submitted with this Consolidated Permit. Previous versions of this report have been submitted to DOGAMI over the last few years. Additionally, there have been several requests for additional data. This report includes data previously submitted, along with additional data and interpretations, as requested by DOGAMI. The report is designed to conform to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Geochemistry Study Area was established to develop an environmental baseline for assessing potential impacts from Project facilities and to provide background data, which includes an area encompassing the Permit Area.

The purpose of the baseline geochemical characterization program is to define the potential geochemical reactivity and chemical stability of mine waste that will be produced by the proposed Project. The results of the geochemical characterization program will assist in determining the potential for acid rock drainage and metal leaching associated with the Project. Data produced during this study can be used in the Project design process and as an operational tool for identifying material types that require special handling during operations.

The characterization work undertaken for the Project meets the following regulatory requirements: Oregon DOGAMI Division 37 Chemical Process Mining; Oregon Administrative Rule (OAR) 632-037-0055 and OAR 632-037-0085 (Environmental Evaluation); and applicable Oregon Department of Environmental Quality (ODEQ) Division 43 Chemical Mining Rules, OAR 340-043, which address process mining.

In addition, the geochemical characterization program was designed to follow guidelines set forth in the Bureau of Land Management Instruction Memorandum NV-2013-046, Nevada Bureau of Land Management Rock Characterization Resources and Water Analysis Guidance for Mining Activities (BLM 2013). Provide baseline data of the quality and quantity of local groundwater resources.

The geologic setting, groundwater, surface water and mine plan were critical to the sample choices and types of testing that were chosen to characterize the geochemistry baseline setting. Please refer to those reports for background information on these topics (Appendix B). SRK Consulting (SRK) has developed a conceptual geochemical model based on the deposit geology combined with the proposed mining and processing methods. This conceptual model provides the basis for the scope and methodology of the geochemistry baseline study and defines the approach for sample selection, laboratory procedures and key criteria for decision-making throughout the process.

The design of the geochemical characterization program has been developed based on the geology of the site and the mine plan information and includes the following steps:

- Refinement of the current conceptual geochemical model for each mine facility including understanding of the geological materials involved and the conceptual management approach;
- Design of the sampling approach for each component;
- Selection of suitable test procedures to assess potential impacts; and
- Table 7 provides a list of the mine facilities that will require geochemical characterization, location and duration of the facility, and the types of geochemical data required. To date, the characterization program described herein is complete for six potential sources listed in Table 7 including: 1) waste rock dumps (WRDs); 2) ore stockpiles; 3) underground workings; 4) tailings impoundment; 5) borrow material; and 6) access and haul road cuts.

Table 7. Program Design

Source	Description	Location	Duration	Composition	Sample Types	Geochemical Data Needs				
						Static	Mineralogy	SPLP	MWMP	HCT
Waste rock dump	Waste rock dump	Mine area (surface)	Permanent	PAG and Non-PAG waste rock	Core	X	X	--	X	X
Ore stockpile	Ore stockpiled near mill	Plant site	LOM	Underground ore	Core	X	X	--	X	--
Underground workings	Exposed rock in workings	Mine area (underground)	Permanent	Waste rock and ore	Core	X	X	--	X	X
Tailings Impoundment	Tailings	Plant site	Permanent	Tailings with and without lime amendment	Metallurgical test work	X	X	X	X	X
Borrow material	Borrow materials for construction	Various	Permanent	Basalt	Core	X	X	--	X	--
Access and haul roads	Surface development (cut/fill)	Various	Permanent	Alluvium/ bedrock	Surface samples	X	X	--	X	--
Underground backfill	Rock Fill and Cemented Rock Fill	Mine area (underground)	Permanent	Basalt with or without cement	Core	X	X	--	X	--
Underground backfill[1]	Cemented Rock Fill	Mine area (underground)	Permanent	Waste rock with cement	Cemented core	X	--	--	X	--

[1] Characterization of this material source is not included in this study and will be provided under separate cover.
LOM = life of mine; PAG = potentially acid generating; Non-PAG = Non-Acid Generating; SPLP = synthetic precipitation leaching procedure; MWMP = meteoric water mobility procedure; HCT = humidity cell test

The term material type typically denotes a unique combination of lithology, alteration, and oxidation state. However, because silicic alteration is pervasive in the Grassy Mountain deposit and the deposit is mostly oxidized, material types were delineated solely on lithology. Based on this assumption, a total of eight material types have been identified and are summarized in Table 8 along with an estimated percentage of each material type that will be mined based on the geologic block model. The number and types of samples collected are based primarily on the type of test work that was planned.

Table 8. Grassy Mountain Material Types

Material Type	Approximate Proportion of Development Rock – Ore/Waste (%)
Siltstone	54
Sandstone	26
Sinter	11
Mud/clay	5
Breccia	<1
Mudstone	<1
Tuff	<1
Basalt	<1

Source: Calico (personal comm.)

Waste Rock and Ore: For evaluation of the waste rock and ore SRK collected a total of 105 samples for geochemical characterization testing, which included 68 samples collected from exploration drill core and 36 pulp samples representative of development rock (ore and waste rock).

To characterize the Acid Rock Drainage and Metal Leaching (ARD/ML) potential for the Project, a weighted approach was taken to assess the geochemical variability of geologic materials that will be encountered during mining. The approach included the collection of an appropriate number of samples based on the relative importance or mass of the lithological unit with respect to the total mass in the deposit. Professional judgment and sound geological knowledge of a deposit are significant factors in the number and types of samples selected, as opposed to a strictly numerical approach. Table 9 is the collection and testing matrix.

Table 9. Sample Collection and Testing Matrix

Material Type	Proportion of Development Rock - Ore/Waste (%)	Number of Samples Submitted for Testing				
		Core		Pulps		Total
		Waste	Ore	Waste	Ore	
Siltstone	54	13	9	10	1	33
Sandstone	26	19	5	14	2	40
Sinter	11	6	1	4	0	11

Material Type	Proportion of Development Rock - Ore/Waste (%)	Number of Samples Submitted for Testing				
		Core		Pulps		Total
		Waste	Ore	Waste	Ore	
Mud/clay	5	1	0	3	1	5
Breccia	<1	1	6	0	0	7
Mudstone	<1	6	1	0	1	8
Tuff	<1	0	0	0	0	0
Basalt	<1	0	0	0	0	0
TOTAL	100	46	22	31	5	104

Borrow and Road Cut Material: Calico resources drilled three diamond drill holes in the proposed basalt quarry location. Holes were logged by Calico geologists and a total of 20 representative samples were submitted for preparation and geochemical testing as summarized in Table 10.

Table 10. Summary of Borrow Material Test Work

Type	Lithology	Number of Samples	Lab Analyses				
			Mineralogy	Multi-Element Analysis	ABA	NAG	MWMP
Borrow Material	Andesitic Basalt	7	1	7	7	7	3
	Vesicular Basalt	4	3	4	4	4	3
	Basalt	2	1	2	2	2	--
	Clay	1	1	1	1	1	--
	Sand and Clay	1	--	1	1	1	1
	Sediments	5	2	5	5	5	2
Road Cut Material	Basalt	7	7	7	7	7	6
Total		27	15	27	27	27	15

ABA = acid-base accounting; NAG = net acid generating

Calico collected samples along the main access road from exposed outcrops in the area where major cuts will be required during road construction. This program resulted in seven samples of basalt. Samples were submitted for sample preparation and geochemical characterization testing using the same methods as the borrow material.

Tailings Samples: A total of four samples generated from metallurgical testing programs were collected, one sample in 2015 and three in 2018. The test work conducted on these four samples is summarized in Table 11.

Table 11. Summary of Tailings Sample Test Work

Year	Sample	Description	Lab Analyses						
			Decant Solution Analysis	Multi-Element Analysis	ABA/ TIC	NAG	Modified MWMP	Modified SPLP	HCT
2015	Calico Leach Res. After CN Destruct.	Mixed Lithology	--	x	x	x	x	--	x
2018	Arkose (1 of 2)	Arkose Sandstone	x	x	x	x	--	x	--
	Arkose (2 of 2)	Arkose Sandstone	x	--	--	--	--	--	--
	MLDWT (1 of 2)	Clay	x	x	x	x	--	x	--
	MLDWT (2 of 2)	Clay	x	--	--	--	--	--	--
	SLST (1 of 2)	Siltstone	x	x	x	x	--	x	--
	SLST (2 of 2)	Siltstone	x	--	--	--	--	--	--

TIC = total inorganic carbon

Following analysis of the original sample material, hydrated lime was added to the tailings samples to generate material representative of amended tailings. The results of the ABA tests from the original samples were used to determine the quantity of hydrated lime that needed to be added to the tailings samples to produce a sample of tailings that is net neutralizing based on the criteria specified in the OAR 340-043-0130 (2). A rigorous quality assurance/quality control (QA/QC) program was followed (See Appendix B).

The following test work methods are included in this report. Full details of the methods are in the Geochemistry Report in Appendix B.

Static Methods:

- Multi-element analysis using aqua regia digest and Inductive Couple Plasma (ICP) analysis to determine total metal and metalloid chemistry for 48 elements (ALS Chemex Method ME-MS41);
- ABA using the modified Sobek method (Sobek 1978) with sulfur speciation by hot water, hydrochloric acid (HCl), and nitric acid extraction;
- Total Sulfur determined from analysis of an untreated sample using a LECO furnace. The result is a measure of all sulfur forms in the sample;
- Non-Extractable Sulfur determined from digestion of a sample with nitric acid followed by filtration and then LECO analysis. Nitric acid removes sulfate and sulfide minerals and the only remaining minerals are insoluble sulfate minerals such as barite;

- Non-Sulfate Sulfur determined from digestion with hot water followed by filtration and then LECO analysis. The hot water extraction leaches sulfate minerals (e.g., gypsum) from the sample leaving behind sulfide sulfur and non-extractable sulfur forms;
- TIC Analysis by LECO;
- NAG test that reports the final NAG pH and final NAG value after a two-stage hydrogen peroxide digest.
- Nevada MWMP (MWMP – ASTM EE2242-13) and leachate analysis;
- Modified SPLP (EPA 1998) and analysis of leachate;
- X-Ray Diffraction Analysis (XRD), petrography and Scanning Electron Microscopy (SEM);
- HCT Procedure (ASTM D5744-13e1) and analysis of extracts; and
- Mineralogy according to the February 2015 Erionite Sampling and Analysis Plan (Erionite SAP).

Table 12 shows the analytes for the leach tests and Table 13 lists the waste and ore samples submitted for MWMP tests.

Table 12. List of Analytes for Leach Tests

Parameter	Laboratory Method	Detection Limit	Reporting Limit	Fraction[2]
Alkalinity	SM 2320B	2 mg/L	20 mg/L	dissolved
Bicarbonate	SM 2320	2 mg/L	20 mg/L	dissolved
Carbonate	SM 2320	2 mg/L	20 mg/L	dissolved
Aluminum	EPA 200.7	0.03 mg/L	0.15 mg/L	dissolved
Ammonia Direct as N	EPA 350.1	0.05 mg/L	0.5 mg/L	dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	dissolved
Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	dissolved
Barium	EPA 200.7	0.003 mg/L	0.015 mg/L	dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	dissolved
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	dissolved
Boron	EPA 200.8	0.0005 mg/L	0.001 mg/L	dissolved
Cadmium	EPA 200.8	0.001 mg/L	0.0005 mg/L	dissolved
Calcium	EPA 200.7	0.2 mg/L	1 mg/L	dissolved
Chloride	EPA 300.0	0.5 mg/L	2.5 mg/L	dissolved
Chromium	EPA 200.8	0.0005 mg/L	0.002 mg/L	dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	dissolved
Conductivity	SM 2510B	1 umhos/cm	10 umhos/cm	dissolved
Copper	EPA 200.8	0.0005 mg/L	0.0025 mg/L	dissolved
Cyanide[1], Total	EPA 335.4	0.003 mg/L	0.01 mg/L	dissolved
Cyanide, Weak Acid Digestion	SM 4500	0.003 mg/L	0.01 mg/L	dissolved
Fluoride	EPA 300.0	0.1 mg/L	0.5 mg/L	dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	dissolved
Hardness	SM 2340B	calc	calc	dissolved
Iron	EPA 200.7	0.02 mg/L	0.05 mg/L	dissolved
Lead	EPA 200.8	0.0001 mg/L	0.0005 mg/L	dissolved
Lithium	EPA 200.7	0.02 mg/L	0.1 mg/L	dissolved
Magnesium	EPA 200.7	0.2 mg/L	1 mg/L	dissolved
Manganese	EPA 200.8	0.0005 mg/L	0.0025 mg/L	dissolved

Parameter	Laboratory Method	Detection Limit	Reporting Limit	Fraction[2]
Mercury[3]	EPA 200.8	0.0001 mg/L	0.0001 mg/L	dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	dissolved
Nickel	EPA 200.8	0.0006 mg/L	0.003 mg/L	dissolved
Nitrate+Nitrite as N	EPA 353.2	0.02 mg/L	0.1 mg/L	dissolved
pH (s.u.)	SM 4500-H B	0.1 C	0.1 C	dissolved
Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	dissolved
Potassium	EPA 200.7	0.3 mg/L	1.5 mg/L	dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	dissolved
Selenium	EPA 200.8	0.0001 mg/L	0.00025 mg/L	dissolved
Silver	EPA 200.8	0.00005 mg/L	0.00025 mg/L	dissolved
Sodium	EPA 200.7	0.3 mg/L	1.5 mg/L	dissolved
Strontium	EPA 200.7	0.01 mg/L	0.05 mg/L	dissolved
Sulfate	EPA 300.0	0.5 mg/L	2.5 mg/L	dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	dissolved
Tin	EPA 200.8	0.0004 mg/L	0.002 mg/L	dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	dissolved
Total Dissolved Solids	SM 2540C	10 mg/L	20 mg/L	dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	dissolved
Zinc	EPA 200.7	0.01 mg/L	0.05 mg/L	dissolved

[1] Weak Acid Dissociable (WAD) cyanide and total cyanide will be analyzed for the tailings sample only.
[2] As part of the MWMP ASTM method, the column extract is filtered with a 0.45 micrometer (µm) filter. Extract analyses are therefore considered dissolved concentrations.
[3] HCT samples with mercury at concentrations below detection will be submitted every eight weeks for low level mercury using Method 1631E (low level) to obtain a detection limit of 0.2 nanogram/liter (ng/L) and 0.5 ng/L. MWMP extracts will be submitted for Method 1631E.
mg/L = milligrams per liter; umhos/cm = microhoms per centimeter

The objective of the static testing program described above was to allow rapid assessment of the acid generating and metal leaching characteristics of the main lithological units that will be exposed on site. However, these static tests do not consider the temporal variations that may occur in leachate chemistry as a result of long-term changes in oxidation, dissolution, and desorption reaction rates. The results of static tests need to be confirmed using kinetic methods, particularly for samples which demonstrate an uncertain potential for acid generation on the basis of ABA and NAG test work results. The Kinetic tests (e.g., HCT) evaluate temporal changes in leachate chemistry, through the sequential leaching of the rock weathered in a regular cycle of exposure to dry and wet air in a controlled laboratory environment. These cycles simulate and accelerate the chemical weathering rates observed under field conditions, using test conditions that are specifically designed to target oxidation of sulfide minerals. The goal of kinetic testing is to provide reaction rate data to support prediction of the leachate chemistry that would likely occur through contact of meteoric water with waste rock.

Table 13. Waste Rock and Ore Samples Submitted for MWMP Testing

Sample Type	Sample ID	From (ft)	To (ft)	Lithology	Paste pH	Sulfate Sulfur	Sulfide Sulfur	NNP	NPR	NAG pH	Total NAG	Sample Selection Rational
					s.u	wt%	wt%	-	-	s.u.	kg H_2SO4 eq/t	
Ore	GMC-006	593	613	Sandstone	7	0.06	0.045	-1.1	0.21	4.7	0	50th percentile sulfide S
	CAL-001	487	505.4	Sandstone	5.4	0.16	0.23	-6.8	0.07	3.1	13	95th percentile sulfide S
	CAL-002	235	255	Siltstone	6.7	0.099	0.11	-3	0.14	2.7	14	50th percentile sulfide S
	GMC-003	485	495	Siltstone	6.1	0.37	0.24	-7.1	0.04	2.5	15	95th percentile sulfide S
	CAL-002	430	438.2	Breccia	6.6	0.26	0.36	-11	0.03	2.7	16	95th percentile sulfide S
	CAL-002	480	496	Breccia	6.9	0.13	0.099	-2.8	0.1	3.3	11	50th percentile sulfide S
Waste	CAL-002	86	95	Sandstone	6.4	0.23	0.25	-7.4	0.04	2.4	12	95th percentile sulfide S
	CAL-004	860	875	Sandstone	7.7	0.16	0.083	-2.3	0.12	3.1	15	50th percentile sulfide S
	CAL-004	445	455	Sandstone	5.9	0.23	0.025	-0.5	0.38	5.6	0	75th percentile sulfate S, 25th percentile sulfide S
	GMC-012	780	800	Sandstone	6.5	0.35	0.18	-5.3	0.05	2.7	11	95th percentile sulfate S, 75th percentile sulfide S
	CAL-001	750	762	Siltstone	6.6	0.28	0.065	-1.7	0.15	3.7	15	50th percentile sulfide S
	GMC-014	176	184	Siltstone	3.3	0.62	0.49	-15	0.02	2.7	30	95th percentile sulfide S
	CAL-002	697	706	Siltstone	7.2	0.23	0.085	-2.4	0.11	3.5	12	75th percentile sulfate, 50th percentile sulfide S
	GMC-014	44	59	Siltstone	5.9	0.44	0.01	0	1.0	5.4	0	95th percentile sulfate, 25th percentile sulfide S
	CAL-001	380	400	Sinter	7.7	0.012	0.014	0.1	1.3	5.5	0	50th percentile sulfide S
	CAL-002	177	187	Sinter	6.9	0.041	0.044	-1.1	0.21	4	16	95th percentile sulfide S
	GMC-014	208	215	Sinter	6.3	0.16	0.022	-0.4	0.43	5.1	0	95th percentile sulfate, 70th percentile sulfide S
	GMC-012[1]	919	946	Mudstone	3	0.82	1.86	-57.8	0.01	2.24	64	95th percentile sulfide S
	CAL-004	295	315	Mud/clay	5.4	0.11	0.073	-2	0.13	3.2	9.2	75th percentile sulfide S (only available core sample – HCT)

ABA Criteria	PAG	NNP<-20 or NPR<1
	Low PAG	NP between -20 and +20 or NPR between 1 and 3
	Non-PAG	NNP>20 or NPR >3
NAG Criteria	PAG	NAG>20
	Low to Moderate PAG	NAG between 1 and 20
	Non-PAG	NAG<1

Source: Grassy Mountain Static Test Database Rev14

[1] This sample was chosen to replace the two mudstone samples identified in the work plan (CAL-003 675-685 and GMC-012 832-851) as those samples were consumed in HCT testing. PAG = potentially acid generating Low PAG = Uncertain Potential/Lower Capacity, Non-PAG = Non-Acid Generating

SRK selected a representative subset of nine waste rock samples from the static test database for kinetic testing. Details of these samples are provided in Table 14.

The steps taken to select samples for kinetic testing include:

- Identify the main material types that require characterization.
- Select two samples per material type including one that represents the median/mean sulfide sulfur content (50th percentile) and one that represents the 95th percentile sulfide content.
- Where more than one sample was available, the sample with the lowest neutralization potential (NP) was selected in order to characterize the effect of net acid generation.

The kinetic testing method selected for this project is the standard humidity cell test procedure designed to simulate water-rock interactions in order to evaluate the rate of sulfide mineral oxidation and thereby predict acid generation and metals mobility (ASTM D-5744-13e1). Under ASTM methodology, the test typically runs for a minimum of 20 weeks and follows a seven-day cycle, unless uncertain chemistry requires that it be run longer to achieve steady state conditions. The HCTs were executed until the majority of the mineral reactions that can be predicted from mineralogy or static testing have been observed. This endpoint was assessed by monitoring the release rates of key constituents such as pH, sulfate, acidity, alkalinity and iron as well as dissolved metals and metalloids. The Grassy Mountain HCTs were operated for 87 weeks and were terminated following approval from DOGAMI and BLM. Following termination of the leach portion of the HCTs, the material within the cells was blended and split for termination testing. Termination testing included multi-element analysis, ABA and NAG on the test residues to define the mineralogical processes that occurred as the materials were exposed to oxygen and water. Mineralogy on the HCT test residues is not considered necessary since the results of the HCT program are conclusive and indicate the majority of the waste rock and ore material will generate acid and leach metals.

Results for waste rock and ore are shown in the tables below: Table 15 is a summary of multi-element assay results (mg/kg); Table 16 is a summary of ABA; Table 17 is summary of NAG results; Table 18 is a summary of XRD results; Table 19 is a summary of MWMP results; Table 20 is a summary of HCT leachate concentration (mg/L) compared to Oregon Groundwater Quality Guidelines (OGWQG); and Table 21 comparison between static and HCT tests.

Table 14. Samples Submitted for Kinetic Testing

Sample ID	Lithology	Paste pH (s.u.)	Sulfide Sulfur (wt%)	NNP (kg $CaCO_3$ eq/t)	NPR	NAG pH (s.u.)	Total NAG (kg H_2SO_4 eq/t)	Sample Selection Rational
CAL-002 (86-95)	Sandstone	6.36	0.246	-7.7	0.04	2.37	11.7	95th percentile sulfide S
CAL-004 (860-875)	Sandstone	7.73	0.083	2.6	0.12	3.14	14.7	50th percentile sulfide S
CAL-003 (675-685)	Mudstone	3.76	1.36	-42.5	0.01	2.33	47.2	95th percentile sulfide S
GMC-012 (832-851)	Mudstone	3.78	0.526	-16.4	0.02	2.56	18	50th percentile sulfide S
CAL-004 (295-315)	Mud/clay	5.44	0.073	-2.3	0.13	3.2	9.2	75th percentile sulfide S (only available core sample)
CAL-001 (750-762)	Siltstone	6.57	0.065	-2.0	0.15	3.7	14.5	50th percentile sulfide S
GMC-014 (176-184)	Siltstone	3.29	0.488	-15.3	0.02	2.7	29.7	95th percentile sulfide S
CAL-001 (380-400)	Sinter	7.72	0.014	0.1	1.25	5.54	0	50th percentile sulfide S
CAL-002 (177-187)	Sinter	6.91	0.044	-1.4	0.21	3.96	15.6	95th percentile sulfide S
Calico Leach Res. After CN Destruct.	Tailings	6.80	0.089	-2.8	0.11	3.21	4.6	--

Criteria for AP Predictions:

ABA Criteria	PAG	NNP<-20 or NPR<1
	Low PAG	NP between -20 and +20 or NPR between 1 and 3
	Non-PAG	NNP>20 or NPR >3
NAG Criteria	PAG	NAG>20
	Low to Moderate PAG	NAG between 1 and 20
	Non-PAG	NAG<1

Source: Grassy Mountain HCT Database Rev02

PAG = Potentially Acid Generating, Low PAG = Uncertain Potential/Lower Capacity, Non-PAG = Non-Acid Generating

Table 15. Summary of Multi-Element Assay Results (mg/kg) Waste Rock and Ore

Material Type		Ag	Al	As	Au	B	Ba	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Li	Mg
	Average crustal abundance (Mason 1966)	*0.07*	*81,300*	*2*	*0.004*	*10*	*425*	*36,300*	*0.2*	*25*	*100*	*55*	*50,000*	*0.08*	*25,900*	*20*	*20,900*
Sandstone (n = 40)	Min	0.05	1000	14	<0.2	<10	30	100	<0.01	0.4	7	4	4400	0.14	700	0.4	<100
	P5	0.06	1400	39	<0.2	<10	30	100	0.01	0.5	9	5.6	5000	0.23	1000	0.6	100
	Average	2.2	2600	140	0.39	<10	57	1000	0.037	1.7	88	9.2	8900	1.7	1800	2.1	380
	P95	5.3	4700	290	1	<10	110	1600	0.11	4.5	150	17	13000	3.3	3600	2.4	600
	Max	6.3	8400	370	1.6	<10	120	22000	0.34	8	180	24	22000	12	3700	39	8600
Breccia (n = 7)	Min	0.78	1500	53	<0.2	<10	40	100	<0.01	0.5	92	7	4800	0.7	1300	0.4	<100
	P5	1.1	1500	58	<0.2	<10	43	130	0.01	0.5	96	7.2	5000	0.76	1300	0.43	100
	Average	5.7	1900	110	2.8	<10	69	290	0.016	1	130	11	7300	1.5	2000	0.64	100
	P95	11	2400	190	8.6	<10	100	400	0.034	1.7	160	17	10000	2.3	2900	0.87	100
	Max	12	2400	200	9.7	<10	110	400	0.04	1.8	160	17	10000	2.4	3200	0.9	100
Siltstone (n = 33)	Min	0.05	300	51	<0.2	<10	20	100	<0.01	0.4	8	5.5	5500	0.39	200	0.5	<100
	P5	0.08	660	63	<0.2	<10	30	100	0.01	0.56	8.6	6.3	5900	0.49	500	0.66	100
	Average	2.8	3000	150	0.45	<10	53	1700	0.056	2.5	110	11	11000	2.2	1700	2.5	370
	P95	8.6	12000	290	1.4	<10	84	4800	0.21	7.4	240	18	17000	5.5	3100	9.4	1000
	Max	15	14000	290	1.6	<10	90	33000	0.51	23	260	23	19000	7.3	3200	28	5600
Sinter (n = 11)	Min	0.12	300	14	<0.2	<10	20	100	<0.01	0.5	37	4.9	3700	0.37	200	0.6	<100
	P5	0.26	300	18	<0.2	<10	20	100	0.01	0.55	41	5	4100	0.38	200	0.6	100
	Average	2.1	730	59	1.4	<10	36	210	0.016	1.4	180	8.9	10000	1.3	550	1.1	120
	P95	5.3	1100	160	6.5	<10	60	450	0.045	3.7	270	15	22000	2.1	1300	1.8	200
	Max	7.7	1100	270	13	<10	60	500	0.07	5	290	18	22000	2.2	1300	2.2	300
Mud/clay (n = 5)	Min	0.09	1800	80	<0.2	<10	50	900	<0.05	0.9	16	7.3	11000	1.9	1100	0.8	400
	P5	0.12	2100	92	<0.2	<10	52	1100	<0.05	1.1	17	8	11000	2	1100	0.86	400
	Average	0.7	4300	180	0.42	<10	68	1800	0.12	2.8	58	20	15000	2.8	1600	2.2	660
	P95	1.7	5800	240	0.82	<10	80	2400	0.26	4.9	130	36	20000	3.9	2100	3.5	880
	Max	1.9	5900	250	0.9	<10	80	2500	0.3	5	150	38	21000	4	2100	3.6	900
Basal mudstone (n = 8)	Min	0.59	2800	15	<0.2	<10	10	700	<0.01	0.1	8	6	2000	0.12	1800	0.2	<100
	P5	0.7	2900	18	0.2	<10	14	770	<0.01	0.17	12	6.2	2500	0.15	1800	0.27	140
	Average	2.5	4000	140	0.28	<10	46	1200	0.079	4.5	47	15	12000	2.6	2300	0.79	300
	P95	5.8	6700	390	0.5	<10	110	2300	0.27	12	98	27	19000	5.3	3100	1.7	600
	Max	7.2	7100	500	0.5	<10	130	2500	0.28	13	100	30	21000	5.3	3300	2.1	700
Sandstone (n = 40)	Min	7	0.72	100	2.3	20	2.9	100	1.9	0.1	0.2	0.2	0.09	0.22	1	<0.05	2
	P5	15	1.2	100	2.7	30	3.6	100	4.6	0.2	0.4	0.2	0.13	0.29	3	0.07	4
	Average	48	17	220	9.1	140	13	2300	14	0.38	1.4	0.36	0.39	0.56	6.7	1.1	17
	P95	120	35	400	19	470	29	5100	25	0.61	4.8	0.51	0.95	0.98	15	3.3	46
	Max	290	150	900	27	550	130	10000	94	1.1	5.5	0.7	2	1.4	31	4.9	110
Breccia (n = 7)	Min	16	4.9	100	5.4	40	2.1	1300	4.4	0.2	0.6	0.3	0.05	0.26	3	<0.05	2
	P5	17	5.8	100	5.9	40	2.5	1300	4.5	0.2	0.63	0.3	0.068	0.29	3	0.053	2.6
	Average	22	14	130	9	64	4.8	2900	14	0.3	2.4	0.37	0.39	0.5	5	0.14	5.7
	P95	29	28	200	13	110	7.2	5700	32	0.58	5.3	0.47	0.9	0.7	8.4	0.33	8.7
	Max	30	33	200	13	120	7.4	6200	38	0.7	6	0.5	1.1	0.72	9	0.4	9
Siltstone (n = 33)	Min	11	1.3	100	3.3	10	1	100	5.5	0.1	0.3	0.2	0.11	0.09	2	<0.05	3
	P5	14	2.3	100	3.7	16	1.4	100	5.7	0.2	0.62	0.3	0.13	0.1	2	0.1	3.6
	Average	64	13	180	12	190	15	2800	16	0.59	1.9	0.45	0.53	0.67	7.1	1	19

Material Type		**Ag**	**Al**	**As**	**Au**	**B**	**Ba**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Hg**	**K**	**Li**	**Mg**
	Average crustal abundance (Mason 1966)	*0.07*	*81,300*	*2*	*0.004*	*10*	*425*	*36,300*	*0.2*	*25*	*100*	*55*	*50,000*	*0.08*	*25,900*	*20*	*20,900*
	P95	180	39	400	27	610	46	8000	37	1.9	5.5	0.78	1.6	1.3	14	2.6	56
	Max	520	72	1000	39	740	50	11000	55	2.2	6.1	0.9	2.4	2.8	16	8.7	110
Sinter (n = 11)	Min	14	4.5	100	2.7	10	0.5	100	3.9	0.1	0.7	0.2	0.11	<0.05	2	0.1	3
	P5	21	4.7	100	6.3	10	1.1	150	3.9	0.1	0.7	0.2	0.12	0.05	2	0.14	3
	Average	70	11	100	25	46	7.2	780	9.4	0.19	1.2	0.38	0.29	0.14	4.9	1	7.4
	P95	140	26	100	56	160	21	2400	24	0.35	2	0.55	0.72	0.34	11	2.7	18
	Max	140	29	100	65	200	25	3000	36	0.4	2.1	0.6	0.88	0.48	11	3.2	20
Mud/clay (n = 5)	Min	50	1.5	100	5.2	60	5.2	100	17	0.5	0.4	0.3	0.21	0.48	4	0.42	16
	P5	53	2	120	5.2	70	6.7	220	18	0.54	0.44	0.32	0.22	0.48	5.6	0.65	16
	Average	97	6.5	400	8.7	200	59	1700	31	1.1	1	0.76	0.66	0.71	17	4.6	120
	P95	170	11	1000	14	480	120	3400	51	1.6	2	1.6	1.4	1.1	24	12	330
	Max	190	11	1200	16	560	120	3700	56	1.7	2.3	1.8	1.6	1.2	25	15	390
Basal mudstone (n = 8)	Min	7	4.8	100	2.3	10	7.6	200	3.2	0.1	0.2	0.2	0.08	0.46	1	<0.05	2
	P5	8.4	5	100	2.5	42	9.5	310	3.8	0.14	0.38	0.24	0.084	0.5	1.4	0.089	2.4
	Average	24	14	110	9.2	160	23	8900	8.6	0.55	2.3	0.35	0.34	0.94	4.5	0.28	21
	P95	59	28	170	16	230	41	22000	18	1.2	5.2	0.47	0.68	1.4	11	0.55	58
	Max	78	32	200	18	240	43	25000	19	1.3	6.5	0.5	0.73	1.5	13	0.59	70

	Indicates less than three times average crustal abundance			
	Indicates between three and six times average crustal abundance			
	Indicates between six and 12 times average crustal abundance			
	Indicates greater than 12 times average crustal abundance			

Note: P5 = 5th Percentile, P95=95th percentile
Source: Grassy Mountain Static Test Database Rev14

Table 16. Summary of Acid Base Accounting Results Waste Rock and Ore

Material Type		pH	Total sulfur	Sulfate sulfur[1]	Sulfide sulfur[2]	AP[3]	NP	NNP[5]	NPR[6]
		s.u.	wt%	wt%	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	-	-
Sandstone (n = 40)	Min	5.3	<0.01	<0.01	<0.01	<0.3	<0.3	-30	0.03
	P5	5.4	0.01	0.01	0.01	0.3	0.3	-8	0.04
	Average	6.1	0.25	0.15	0.094	2.9	2.3	-0.7	0.77
	P95	8	0.56	0.3	0.25	7.9	3.2	2.8	10
	Max	8.4	1.2	0.35	0.88	27	57	57	190
Breccia (n = 7)	Min	5.4	0.14	0.082	<0.01	<0.3	<0.3	-10	0.03
	P5	5.6	0.14	0.086	0.015	0.45	0.3	-10	0.033
	Average	6.2	0.32	0.17	0.12	3.7	0.33	-3	0.088
	P95	7.3	0.6	0.28	0.33	10	0.44	-0.01	1.3
	Max	7.4	0.63	0.3	0.36	11	0.5	0.2	1.7
Siltstone (n = 33)	Min	3.3	<0.01	<0.01	<0.01	<0.3	<0.3	-30	0.01
	P5	5	0.011	0.011	0.01	0.3	0.3	-10	0.026
	Average	4.8	0.3	0.17	0.12	3.9	2.9	-0.9	0.76
	P95	7.4	0.83	0.4	0.38	12	3.7	3.4	9.7
	Max	7.8	1.1	0.62	0.83	26	73	65	15
Sinter (n = 11)	Min	6.3	<0.01	0.01	<0.01	<0.3	<0.3	-5	0.18
	P5	6.4	0.012	0.011	0.01	0.3	0.3	-3	0.2
	Average	6.8	0.083	0.054	0.032	0.99	2.5	1.5	2.6
	P95	7.8	0.25	0.15	0.11	3.5	7.9	7.5	20
	Max	8	0.32	0.16	0.18	5.5	8.6	8.2	22
Mud/clay (n = 5)	Min	5.4	0.014	0.014	<0.01	<0.3	<0.3	-3	0.13
	P5	5.5	0.026	0.022	0.012	0.38	0.34	-3	0.18
	Average	6.1	0.19	0.12	0.067	2.1	1.6	-0.5	0.76
	P95	8	0.38	0.2	0.15	4.5	3.7	1.7	2
	Max	8	0.41	0.21	0.16	5.1	4.1	2.1	2.1
Basal mudstone (n = 8)	Min	3	0.017	0.017	<0.01	<0.3	<0.3	-60	0.01
	P5	3.1	0.028	0.022	0.012	0.37	0.3	-50	0.01
	Average	3.7	0.95	0.29	0.64	20	0.39	-20	0.019
	P95	7	2.4	0.7	1.7	53	0.76	-0.07	0.86
	Max	7.1	2.7	0.82	1.9	58	1	0	1

Source: Grassy Mountain Static Test Database Rev14. Note: P5 = 5th Percentile, P95=95th percentile.

[1] Sulfate sulfur concentrations determined by hot water extraction.

[2.] Sulfide sulfur concentrations calculated from non-sulfate sulfur values determined by hot water extraction.

[3] Acidification Potential (AP) calculated from sulfide sulfur.

[4] Neutralization Potential (NP) determined from titration according to the modified Sobek method.

[5] Net Neutralization Potential (NNP) = NP-AP.

[6] Neutralization Potential Ratio (NPR) = NP/AP

Table 17. Summary of Net Acid Generation Results Waste Rock and Ore

Material Type	NAG pH (s.u.)			Total NAG (kg H_2SO_4 eq/t)		
	Mean	Min.	Max	Mean	Min.	Max
Sandstone (n = 40)	4.47	2.37	6.78	5.71	0	24.6
Breccia (n = 7)	4.24	2.66	5.66	5.81	0	15.6
Siltstone (n = 33)	4.11	2.47	9.62	8.73	0	29.7
Sinter (n = 11)	4.90	2.84	5.54	2.38	0	15.6
Mud/clay (n = 5)	5.02	3.20	6.23	4.52	0	12.8
Mudstone (n = 8)	3.85	2.24	6.08	22.6	0	64.1

Source: Grassy Mountain Static Test Database Rev14

Table 18. X-Ray Diffraction Results Waste Rock and Ore

Mineral Phase	Sinter		Sandstone			Siltstone			Mudstone			Breccia
	CAL 001 (380 - 400)	CAL 002 (177 - 187)	CAL 001 (487 - 505)	CAL 002 (86 - 95)	CAL 004 (860 - 875)	CAL 001 (750 - 762)	GMC 003 (485 - 495)	GMC 014 (176 - 184)	CAL 003 (675 - 685)	CAL 004 (295 - 315)	GMC 012 (832 - 851)	CAL 002 (430 - 438)
Quartz	98	98	84	89	80	75	89	82	50	88	66	72
Orthoclase	1	2	8	11	12	14	7					9
Calcite	1											
Illite			8		8	11	4	7	42	6		
Albite										2		10
Muscovite											32	9
Kaolinite									6			
Pyrite								2	2			
Magnetite										2		
Goethite										2		
Anorthoclase											2	
Rectorite								9				

Note: Results presented as percentages of total mineral phases present.

Table 19. Summary of MWMP Results Waste Rock and Ore

Parameter	Oregon Groundwater Quality Guidelines	Sandstone						Breccia		Siltstone						Sinter			Mud/Clay	Mudstone
		Ore		Waste Rock				Ore		Ore		Waste Rock				Waste Rock			Waste Rock	Waste Rock
		GMC-006 (593-613)	CAL-001 (487-505.4)	CAL-004 (445-455)	GMC-012 (780-800)	CAL-002 (86-95)	CAL-004 (860-875)	CAL-002 (480-496)	CAL-002 (430-438.2)	CAL-002 (235-255)	GMC-003 (485-495)	GMC-014 (44-59)	CAL-001 (750-762)	CAL-002 (697-706)	GMC-014 (176-184)	CAL-001 (380-400)	GMC-014 (208-215)	CAL-002 (177-187)	CAL-004 (295-315)	GMC-012 (919-946)
pH	*6.5-8.5*	7.30	6.60	6.40	6.00	5.60	7.90	7.00	6.50	6.70	6.40	5.10	5.30	6.50	2.30	9.40	6.40	7.20	4.90	2.00
TDS	*500*	24	20	130	<10	242	42	34	24	20	28	1,440	<10	<10	8,680	150	24	52	556	9,100
SO4	*250*	2.4	<1	48.7	2.4	139	10.8	4.6	2.2	3.8	5	732	5.5	1.1	5,360	35.1	8.4	26.8	329	5,060
As	*0.05*	0.010	0.0012	0.0039	0.00040	0.041	0.028	0.021	0.0048	0.0066	0.0027	0.030	0.0011	0.0025	16.7	0.18	0.0015	0.0084	0.051	18.5
Ba	*1*	0.0070	0.016	<0.003	<0.003	0.064	0.10	0.0050	0.0050	0.0040	0.010	0.015	<0.003	<0.003	<0.02	0.026	<0.003	0.012	0.030	<0.02
Cd	*0.01*	<0.0001	<0.0001	<0.0001	<0.0001	0.00050	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00080	<0.0001	<0.0001	0.053	<0.0001	<0.0001	<0.0001	0.00030	0.14
Cl	*250*	0.60	0.70	4.50	0.70	5.20	1.00	0.90	0.80	0.80	<0.5	144	0.60	0.60	3.90	0.80	<0.5	1.40	15.4	2.10
Cr	*0.05*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.14	<0.01	<0.01	<0.01	<0.01	0.15
Cu	*1*	<0.01	<0.01	<0.01	<0.01	0.020	<0.01	<0.01	<0.01	<0.01	0.020	<0.01	<0.01	<0.01	6.73	<0.01	0.020	<0.01	0.050	3.07
F	*4*	0.080	<0.05	0.12	<0.05	0.21	0.48	0.20	<0.05	<0.05	<0.05	0.36	0.060	0.060	11.0	0.33	0.050	0.23	0.56	<5
Fe	*0.3*	<0.02	<0.02	<0.02	0.090	11.1	0.22	0.030	0.040	<0.02	0.44	<0.02	0.13	<0.02	479	<0.02	<0.02	<0.02	0.73	773
Pb	*0.05*	<0.0001	0.00030	<0.0001	0.00040	0.00040	0.00050	<0.0001	0.00010	<0.0001	0.00020	0.0024	<0.0001	<0.0001	0.0096	0.00010	0.00040	0.00020	0.00040	0.0098
Mn	*0.05*	0.0060	<0.005	0.032	<0.005	0.29	<0.005	<0.005	0.0090	<0.005	0.0090	0.50	<0.005	<0.005	6.43	<0.005	0.0060	0.0060	0.50	1.02
Hg	*0.002*	<0.0002	<0.0002	0.00030	<0.0002	<0.0002	0.00050	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
NO_3	*10*	0.08	0.14	0.13	0.02	0.06	0.14	0.04	0.02	<0.02	0.14	2.56	0.04	0.08	0.10	0.07	0.03	0.05	0.46	0.08
Se	*0.01*	0.00090	0.00010	0.016	<0.0001	0.0094	0.0037	0.0018	0.00060	0.00010	0.00070	0.0089	0.00030	0.00010	0.044	0.011	<0.0001	0.0091	0.036	0.034
Ag	*0.05*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.050
Zn	*5*	0.010	0.010	<0.01	0.020	0.040	<0.01	0.010	0.020	<0.01	0.060	0.19	0.010	<0.01	12.5	<0.01	0.020	0.010	0.070	24.5

Table 20. Summary of HCT Leachate Concentration (mg/L) Compared to Oregon Groundwater Quality Guidelines

Parameter	OGWQG	HC-1	HC-2	HC-3	HC-4	HC-5	HC-6	HC-7	HC-8	HC-9	HC-10
		Sandstone	Sandstone	Mudstone	Mudstone	Mud/Clay	Siltstone	Siltstone	Sinter	Sinter	Tailings
pH	*6.5-8.5*	X	X	X	X	X	X	X	O	X	X
As	*0.05*	X	O	X	O	O		X			
Ag	*0.05*										
Ba	*1*										
Cd	*0.01*			O	O			O			
Cu	*1*			O	O						O
Cl	*250*										
Cr	*0.05*	O	O	O	O			O			
F	*4*	O	O	X	O	O	O	O	O	O	O
Fe	*0.3*	X	X	X	X	X	X	X			X
Pb	*0.05*					O		O			
Hg	*0.002*		O								
Mn	*0.05*	O	O	X	O	X		X			X
NO_3	*10*										
Se	*0.01*		O	O	O	O	O	O			
SO4	*250*			X	O			O			
TDS	*500*			X	O			O			
Zn	*5*			O	O			O			

Source: Grassy Mountain HCT Database Rev02
Notes:
X indicates greater than 50% of measurements exceeded the Oregon Groundwater Quality Guidelines.
O indicates between 25% and 50% of measurements exceeded the Oregon Groundwater Quality Guidelines.
Blank cells Indicate measurements are all below the Oregon Groundwater Quality Guidelines.
All samples appeared to exceed as silver detection limit was higher than the standard.
Note: Due to differences in the liquid to solid ratio used in the test compared to typical site conditions HCT results only provide a qualitative estimate of elemental concentrations in the resulting leachates and are not considered conclusive or to represent actual predictions of water quality.

Table 21. Comparison of Humidity Cell Test and Static Tests Results

Cell	Sample ID	Lithology	Sulfide Sulfur (wt%)	NNP (kg $CaCO_3$ eq/t)	NPR	NAG pH (s.u.)	Total NAG (kg H_2SO_4 eq/t)	Final HCT pH	HCT Prediction
1	CAL-002 (86-95)	Sandstone	0.246	-7.7	0.04	2.37	11.7	3.37	Acidic
2	CAL-004 (860-875)	Sandstone	0.083	2.6	0.12	3.14	14.7	3.82	Acidic
3	CAL-003 (675-685)	Mudstone	1.36	-42.5	0.01	2.33	47.2	2.29	Acidic
4	GMC-012 (832-851)	Mudstone	0.526	-16.4	0.02	2.56	18	3.18	Acidic
5	CAL-004 (295-315)	Mud/clay	0.073	-2.3	0.13	3.2	9.2	3.41	Acidic
6	CAL-001 (750-762)	Siltstone	0.065	-2.0	0.15	3.7	14.5	3.71	Acidic
7	GMC-014 (176-184)	Siltstone	0.488	-15.3	0.02	2.7	29.7	2.59	Acidic
8	CAL-001 (380-400)	Sinter	0.014	0.1	1.25	5.54	0	6.88	Non-acidic
9	CAL-002 (177-187)	Sinter	0.044	-1.4	0.21	3.96	15.6	5.03	Non-acidic

Criteria for AP Predictions:

ABA Criteria	PAG	NNP<-20 or NPR<1
	Low PAG	NP between -20 and +20 or NPR between 1 and 3
	Non-PAG	NNP>20 or NPR >3
NAG Criteria	PAG	NAG>20
	Low to Moderate PAG	NAG between 1 and 20
	Non-PAG	NAG<1
HCT Criteria	Acidic	HCT pH < 5
	Non-acidic	HCT pH > 5

Source: Grassy Mountain HCT Database Rev02

PAG = Potentially Acid Generating, Low PAG = Uncertain Potential/Lower Capacity, Non-PAG = Non-Acid Generating

The results of the test work on the tailings samples are summarized in the following tables: Table 22 ABA results; Table 23 NAG results; Table 24 mineralogy results; Table 25 calculated lime amendment rates; Table 26 modified MWMP and SPLP results; and Table 27 supernatant results.

Table 22. Acid Base Accounting Results – Tailings

Sample	Paste pH	Total sulfur	Sulfate sulfur[1]	Sulfide sulfur[2]	AP[3]	NP[4]	NNP[5]	NPR[6]
	s.u.	wt%	wt%	wt%	kg $CaCO_3$/t	kg $CaCO_3$/t	kg $CaCO_3$/t	-
Calico Leach Res. After CN Destruct.	6.8	0.35	0.26	0.089	2.8	0.3	-3	0.11
Arkose (1 of 2)	8	0.36	0.26	0.09	2.8	4.2	1.4	1.5
MLDWT (1 of 2)	8.1	0.43	0.24	0.19	5.9	4.7	-1.2	0.8
SLST (1 of 2)	8.1	0.42	0.24	0.18	5.6	4.5	-1.1	0.8

Source: Grassy Mountain Static Test Database Rev14. Note: P5 = 5th Percentile, P95=95th percentile.
[1] Sulfate sulfur concentrations determined by hot water extraction.
[2.] Sulfide sulfur concentrations calculated from non-sulfate sulfur values determined by hot water extraction.
[3] Acidification Potential (AP) calculated from sulfide sulfur.
[4] Neutralization Potential (NP) determined from titration according to the modified Sobek method.
[5] Net Neutralization Potential (NNP) = NP-AP.
[6] Neutralization Potential Ratio (NPR) = NP/AP.

Table 23. Net Acid Generation Results – Tailings

Sample	NAG pH	NAG
	s.u.	kg H_2SO_4/t
Calico Leach Res. After CN Destruct.	3.21	4.60
Arkose (1 of 2)	5.56	0
MLDWT (1 of 2)	5.76	0
SLST (1 of 2)	2.94	7
Source: Grassy Mountain Static Test Database Rev14		

Table 24. Mineralogy Results – Tailings

Phase Found	Percentage
Quartz	75
Orthoclase	14
Muscovite	11

Table 25. Calculated Lime Amendment Rates

Sample Name	ABA Results on Initial Sample					Lime Addition - NPR >3		Lime Addition - NNP >20	
	Sulfide Sulfur (wt%)	AGP (kg $CaCO_3$/t)	ANP (kg $CaCO_3$/t)	NNP (kg $CaCO_3$/t)	NPR	Net NP needed (kg $CaCO_3$/t)	$Ca(OH)_2$ Addition (g/kg)	Net NP needed (kg $CaCO_3$/t)	$Ca(OH)_2$ Addition (g/kg)
Arkose (1of 2)	0.09	2.81	4.2	1.4	1.5	4.2375	3.2	18.6	14.0
MLDWT (1of 2)	0.19	5.94	4.7	-1.2	0.8	13.1125	9.8	21.2	15.9
SLST (1of 2)	0.18	5.63	4.5	-1.1	0.8	12.375	9.3	21.1	15.8

Table 26. Summary of Modified MWMP and SPLP Results

Parameter	Oregon Groundwater Quality Guidelines	Modified MWMP	Modified SPLP		
		Calico Leach Res. After CN Destruct.	Arkose (1/2)	MLDWT (1/2)	SLST (1/2)
Arsenic	*0.05*	0.0046	0.0053	0.0076	0.0031
Barium	*1*	0.045	0.277	0.332	0.339
Cadmium	*0.01*	0.003	<0.0001	<0.0001	<0.0001
Chloride	*250*	1.6	14.8	44.8	20.6
Chromium	*0.05*	<0.01	0.05	0.07	0.04
Copper	*1*	15.1	0.04	0.03	0.02
Fluoride	*4*	0.9	<1	<1	<1
Iron	*0.3*	1.24	<0.02	0.02	<0.02
Lead	*0.05*	0.0028	0.0009	0.0009	0.0025
Manganese	*0.05*	5.6	<0.005	<0.005	<0.005
Mercury	*0.002*	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate/Nitrite as N	*10*	0.17	0.29	0.37	0.28
pH (s.u.)	*6.5-8.5*	4.5	12.1	12.2	12.2
Selenium	*0.01*	0.012	0.0244	0.033	0.0218
Silver	*0.05*	<0.01	<0.01	<0.01	<0.01
Sulfate	*250*	606	286	178	3.6
TDS	*500*	948	<0.005	<0.005	0.005
Zinc	*5*	0.55	<0.01	<0.01	<0.01
All units in mg/L except pH, which is in standard units (s.u.) Pink shaded cells = Concentration exceeds Oregon Groundwater Quality Guidelines (OAR 340-40-020) Source: Grassy Mountain Static Test Database Rev14					

The kinetic test results on the tailings sample is as follows:

The tailings sample from the 2015 metallurgical test program that was not amended with lime was submitted for humidity cell testing. The tailings sample (HC-10) produced acidic leachates throughout the humidity cell test, with pH declining from 4.3 initially to pH~3 by week 40 and increased slightly from week 40 onwards to ~3.6. The iron leaching rates (up to ten mg/kg/week) indicate that active sulfide oxidation occurred in this sample. Several constituents were mobile under these acidic conditions, with iron and manganese consistently elevated above OGWQG throughout the duration of the test and copper was elevated above the guideline between weeks zero and 24. The tailings cell also showed an initial flush (week zero) for a few additional constituents, including sulfate, aluminum, cadmium, fluoride, nickel, selenium, sulfate, and zinc, which likely reflects the removal of soluble oxidation products from the material surfaces. Of these, constituents that exceeded the OGWQG in week zero included selenium, sulfate, and total dissolved solids (TDS). All other constituents that were elevated in week zero either did not have an associated water quality guideline (i.e., aluminum) or were not elevated relative to guidelines. These were typically flushed during the first couple of leach cycles. In addition, WAD cyanide was detected in the first two weeks of testing at 0.011 mg/L and was measured at below the detection limit of 0.003 mg/L every other week.

Table 27. Summary of Supernatant Results

Parameter	Oregon Groundwater Quality Guidelines	Samples					
		Arkose (1/2)	Arkose (2/2)	MLDWT (1/2)	MLDWT (2/2)	SLST (1/2)	SLST (2/2)
Arsenic	*0.05*	0.244	0.213	0.455	0.314	0.69	0.643
Barium	*1*	0.052	0.057	0.065	0.059	0.054	0.055
Cadmium	*0.01*	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Chloride	*250*	12.8	11.9	16.1	7.5	11.9	13.6
Chromium	*0.05*	0.001	0.001	0.001	0.001	0.001	0.001
Copper	*1*	0.0085	0.007	0.0076	0.0065	0.048	0.0468
Fluoride	*4*	0.24	1	0.31	0.25	0.31	0.29
Iron	*0.3*	0.02	0.02	0.04	0.04	0.02	0.03
Lead	*0.05*	0.0007	0.001	0.0004	0.0005	0.0007	0.0002
Manganese	*0.05*	0.0398	0.0366	0.038	0.0258	0.0375	0.0369
Mercury	*0.002*	0.0066	0.0007	0.036	0.0009	0.028	0.0072
Nitrate/Nitrite as N	*10*	0.21	0.21	0.24	0.21	0.21	0.21
pH, stu	*6.5-8.5*	8.1	8.1	8.2	8.1	8.4	8.4
Selenium	*0.01*	0.0625	0.0573	0.0527	0.0423	0.0277	0.0277
Silver	*0.05*	0.0003	0.0001	0.0014	0.0001	0.0001	0.0001
Sulfate	*250*	1370	1400	1640	1590	1450	1330
Total Dissolved Solids	*500*	2110	2140	2510	2450	2310	2170
Zinc	*5*	0.01	0.01	0.06	0.02	0.01	0.01

All units in mg/L except pH, which is in standard units (s.u.)
Pink shaded cells = Concentration exceeds Oregon Groundwater Quality Guidelines (OAR 340-40-020)
Source: Grassy Mountain Static Test Database Rev14

The Geochemistry Report conclusions are as follows:

Waste Rock and Ore: The Grassy Mountain underground waste rock shows variable geochemical behavior and each material type has a wide range of sulfide content and predicted acid generation from the static test results. Overall, the waste rock has very limited acid neutralizing capacity due to the low inorganic carbon content and as such the predicted acid generating potential is strongly related to sulfide content. The characterization results for the ore grade material are comparable to the waste rock material.

Based on the ABA results, the majority of samples tested (93 percent) show an uncertain potential for acid generation based on the BLM criteria (BLM 2004). Only two percent of samples tested meet the BLM criteria and can be classified as NAG forming materials based on a net neutralizing potential greater than 20 kg CaCO3 eq/ton and greater than three-fold excess of neutralizing capacity. Five percent of samples tested are clearly acid forming materials based on NPR values less than one (i.e., no excess neutralizing capacity) and an NNP of less than -20 kg CaCO3 eq/ton. The Grassy Mountain waste rock and ore materials have very limited acid neutralizing capacity due to the low TIC content. In the absence of NP, the acid generating potential of the materials is directly related to the sulfide content. Samples with a sulfide content greater than 0.5 wt% are acid generating with NNP values less than -20 kg CaCO3 eq/ton. There is a near linear relationship between NPR and sulfide sulfur content and the potential for acid generation increases with increasing sulfide sulfur.

The presence of sulfide sulfur in higher concentrations increases the potential for the materials to produce acid where insufficient neutralizing potential is present. However, both the NPR and NNP criteria are less meaningful in instances where both NP and AP are low or near detection (i.e., inert from an ABA perspective) and the low NNP and NPR values may be misleading. In these cases, kinetic testing is important to better understand the actual acid generating potential of the materials.

The NAG results are consistent with the ABA data and show that samples with sulfide sulfur greater than 0.5 wt% are predicted to have a higher capacity for acid generation with NAG values greater than 20 kg H2SO4 eq/ton. Samples with sulfide sulfur content between 0.05 and 0.5 wt% show a low to moderate potential for acid generation with NAG values between one and 20 kg H2SO4 eq/ton.

Based on the MWMP test, the majority of the samples have neutral to alkaline paste pH values (pH 6 - 8) indicating minimal readily soluble acid sulfate salts from prior oxidation of the core material. The exceptions are a few samples of mudstone and siltstone with the highest sulfide sulfur content that generated acidic leachate. Constituents above OGWQG under the low pH conditions include sulfate, arsenic, cadmium, chromium, copper, fluoride, iron, manganese, selenium and zinc. For samples with neutral pH (i.e., pH >7) all constituents were below the OGWQG.

Eight of the nine HCTs generated acidic leachate throughout the test and indicate that samples with an uncertain potential for acid generation from the ABA will generate acid under long term weathering conditions. The only two samples that maintained neutral conditions during the HCT program consisted of sinter material. All other material types are considered to be acid generating including the sandstone, siltstone, and mudstone. A comparison of the HCT leachate chemistry to OGWQG indicates the mudstone (HC-3 and HC-4) had the greatest number of parameters that exceeded guidelines and the sinter cells (HC-8 and HC-9) had the least. Most cells that developed acidic conditions leached copper, iron, manganese, arsenic, and sulfate at concentrations greater than the guidelines, indicating these elements are mobile under acidic pH conditions. Other constituents that were leached above OGWQG during the first few weeks of the test include cadmium, chromium, copper, fluoride, lead, selenium, silver, and zinc.

In summary, the results of the Grassy Mountain geochemical characterization program indicate that the majority of the waste rock and unprocessed ore material will generate acid and leach metals under long term weathering conditions. The exceptions to this include the sinter material that shows a low potential for acid generation. This can be attributed to the lower sulfide sulfur content associated with this material type.

Road Cut and Borrow Material: The borrow material from the proposed basalt quarry has no potential for acid generation with total sulfur values below the detection limit of 0.01 percent for all samples. In addition, all samples were classified as near-neutral, low metal waters in the MWMP tests and all parameters were below the OGWQG.

The results for the road cut materials were similar to the borrow material and total sulfur values were below the detection limit of 0.01 percent indicating bedrock that could be encountered during the access road development has no potential for acid generation. All road cut samples were classified as near-neutral, low metal waters in the MWMP tests and all parameters were below the OGWQG.

Tailings Material: Geochemical testing included tailings material from the 2015 metallurgical test program (one sample) and the 2018 metallurgical test program (three samples). The results indicate that despite low sulfide sulfur, the tailings material has a potential to generate acid due to the low NP. The potential for tailings material to generate acid and leach metals was confirmed by the HCT results for the unamended tailings sample from the 2015 metallurgical test program. Under low pH conditions, iron, manganese, and copper were mobile at concentrations greater than the OGWQG. In addition, there was an initial flush of several other constituents, including sulfate, aluminum, cadmium, fluoride, nickel, selenium, sulfate, and zinc, which likely reflects the removal of soluble oxidation products from the tailings material surfaces. Supernatant samples had slightly alkaline pH and exceeded the OGWQG for arsenic, selenium, sulfate, and TDS.

ABA test results were used to determine the amount of lime required to neutralize the tailings to meet the regulatory requirement of an NPR > 3 and an NNP > 20 kg CaCO3/t. The ABA results for the tailings material demonstrate that there is some inherent variation in the sulfide sulfur and NP content of the tailings materials that is likely to occur during mining operations. In order to take into account the slight variation in NP and sulfide sulfur in the tailings material, the amount of lime amendment needs to exceed the minimum amount required to ensure that the neutralization criteria specified in the OAR 340-043-0130 (2) is met. Based on the testing conducted to date, the lime amendment rate needs to include the amount of lime required to neutralize the tailings to meet the regulatory guideline.

Leach test results from tailings samples amended with lime indicate that selenium is leached under alkaline conditions at concentrations above the OGWQG. Sulfate and chromium were also slightly elevated above the OGWQG for one sample and all other parameters were below the OGWQG.

In summary, the tailings material associated with the Project requires lime amendment to achieve non-PAG characteristics. A tailings management plan will need to be developed to collect samples of tailings on a routine basis for geochemical testing in order to adjust the liming rate during operations.

Cemented Rock Fill: During operations, rock fill (RF) and cemented rock fill (CRF) will be placed as backfill in the underground workings to provide stability. Sources of aggregate include the borrow material (i.e., basalt) and waste rock. Due to the benign nature of the basalt, this material will be used as either RF or CRF aggregate. CRF will be used for waste rock and basalt where required, to produce a geochemically stable material.

Based on the waste rock characterization program described herein, the majority of the waste rock associated with the Project has a potential to generate acid and leach metals. Therefore, waste rock will only be used as aggregate for the CRF (i.e., not used as RF alone) and an estimated mix of five percent cement will be added to neutralize the waste rock material.

It is anticipated that a portion of the RF and CRF will be placed below the groundwater table. However, CRF containing waste rock will be placed above the saturated zone and will not become saturated once the groundwater recovers in the mine area, thereby minimizing the potential to impact groundwater.

2.6 Geology and Soils

The Grassy Mountain Mine Project Geology and Soils Baseline Report (Appendix B) was originally submitted to DOGAMI on October 18, 2018. The report was accepted by the TRT on December 17, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Geology Study Area includes the Mine and Process Area with a 4,000-meter buffer and the entire Access Road. The Soils Study Area includes the entire Permit Area (Mine and Process Area and Access Road Area).

Grassy Mountain is the largest of 12 recognized epithermal hot spring precious metal deposits of the Lake Owyhee volcanic field. The Lake Owyhee volcanic field occurs at the intersection of three tectonic provinces: the buried cratonic margin; the northern basin and range; and the Snake River Plain. During the mid-Miocene, large volume, peralkaline, caldera volcanism occurred in response to large, silicic magma chambers emplaced in the shallow crust throughout the region. The volcanic field includes several caldera-sourced ash-flow sheets and rhyolite tuff cones that were deposited from 15.5 to 15 million years ago. Volcanism during the mid to late Miocene is evidenced by small volume, metaluminous, high-silica rhyolite domes and flows, and small volume basalt flows and mafic vent complexes in north- and northwest-trending basin and range-type fracture zones and ring structures related to resurgent calderas. Regional extension and subsidence facilitated the formation of through-going fluvial systems and extensive lacustrine basins. Large volumes of fluvial sediments, sourced from the exhumed Idaho Batholith to the southeast, were deposited in conjunction with volcanism and hot spring activity during the waning stages of volcanic field development. The resulting regional stratigraphic section is a thick sequence of mid-Miocene volcanic rocks and coeval-to-Pliocene age non-marine lacustrine, volcaniclastic, and fluvial sedimentary rocks.

Figure 6 is the stratigraphic column at Grassy Mountain and Figure 7 shows North-South and East-West cross sections showing the local geology and mineralization. Bedrock outcrops near the Mine and Process Area are typically composed of olivine-rich basalt and siltstones, sandstones, and conglomerates of the late Miocene Grassy Mountain Formation (Tgb, Tgsn, and Tgs). These rocks are locally covered with relatively thin, unconsolidated alluvial and colluvial deposits (Qal). Erosion-resistant basalts cap local topographic highs. Arkosic sandstones have been encountered at the surface and at depth but have not been correlated across the vicinity of the Mine and Process Area, in part due to lateral discontinuity associated with sedimentary facies changes and structural offset. Surface and drill-defined stratigraphy near the Mine and Process Area reveals complex facies that were produced during the waning stages of deposition of the Lake Owyhee volcanic field.

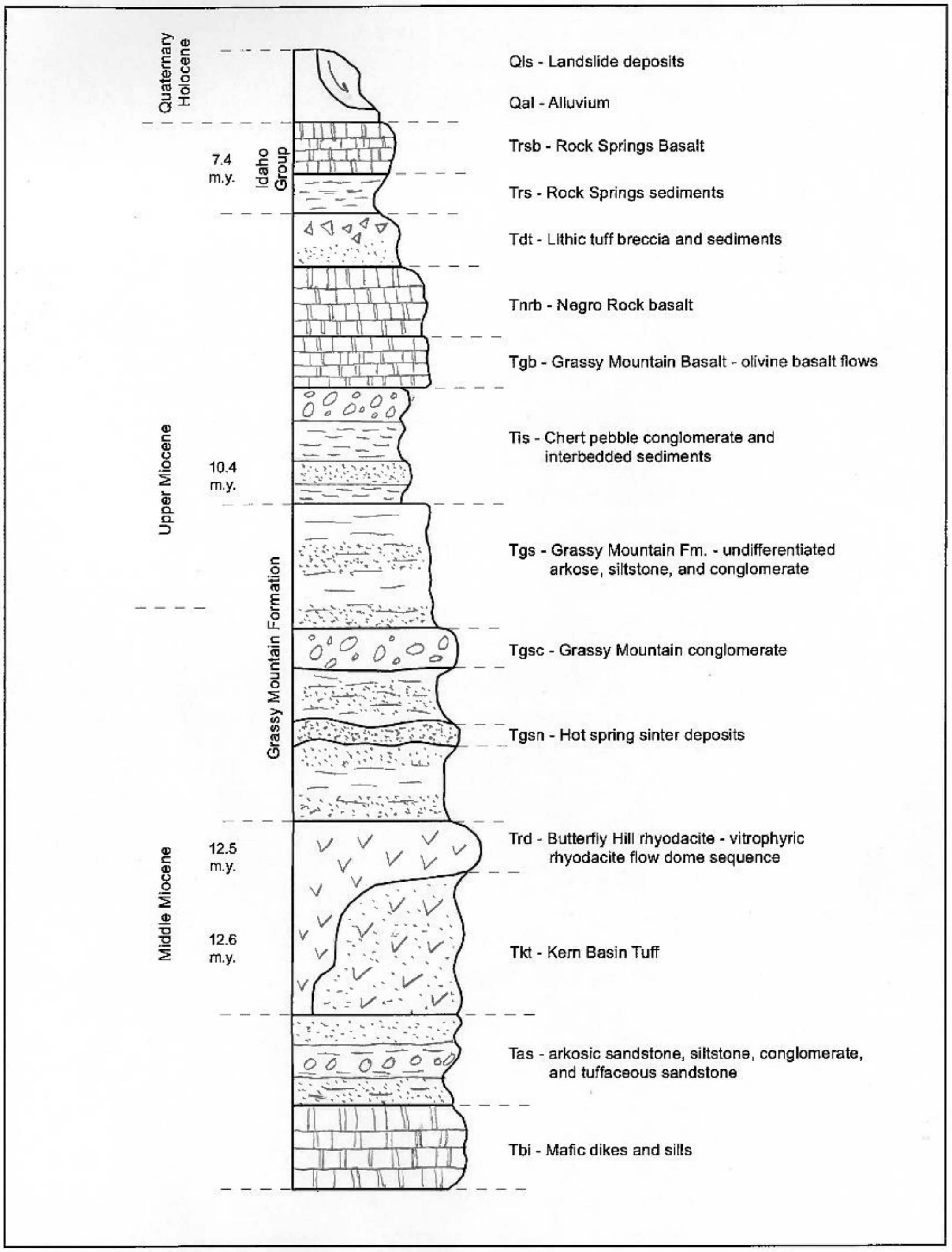


Figure 4. Stratigraphic Column at Grassy Mountain Permit Area

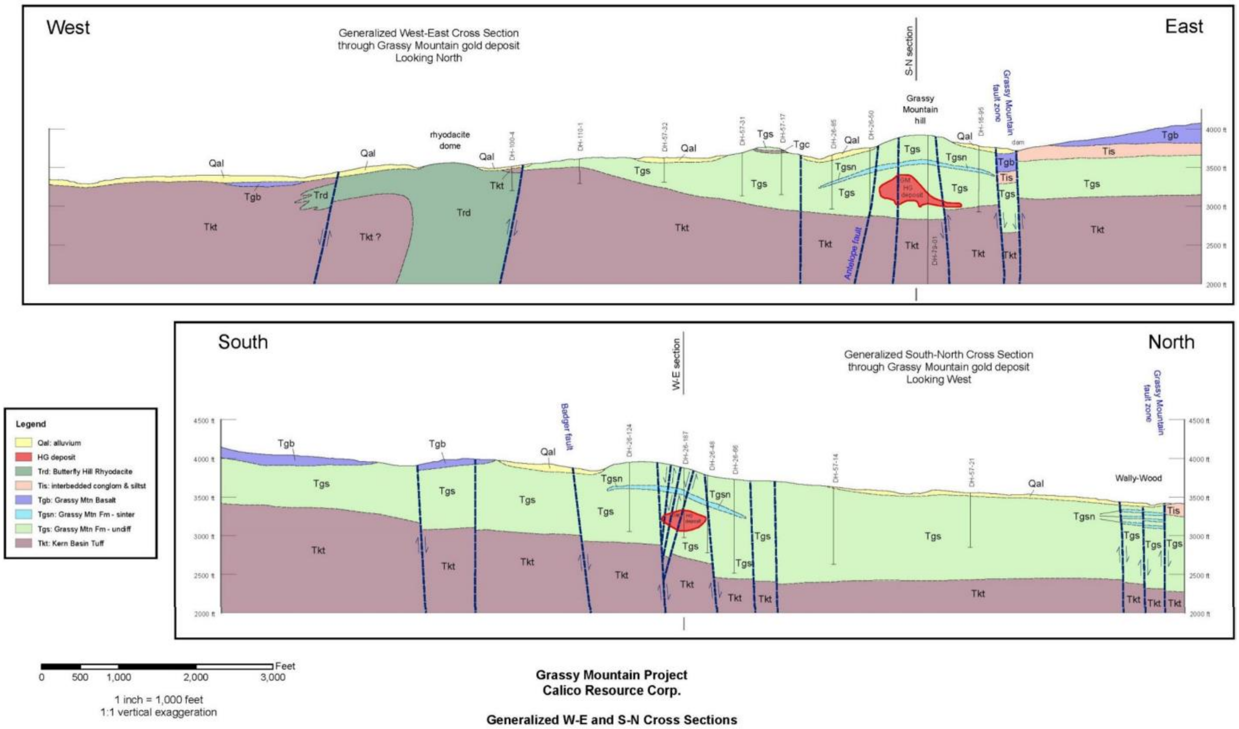


Figure 5. Geologic Cross Sections through the Grassy Mountain Geology Study Area Showing the Grassy Mountain Gold Deposit

The Grassy Mountain gold-silver deposit is located within an interpreted horst block that has been raised 50 to 200 feet in a region of complex block faulting and rotation. Faults at the Grassy Mountain deposit are mainly post-mineral 30 degrees west of north (N30°W) to ten degrees east of north (N10°E), striking normal faults developed during basin and range extension. On the northeast side of the deposit, these faults progressively downdrop mineralization beneath post-mineral cover. These offsets are suggested by interpreted offsets of a prominent white sinter bed in drill holes, as well as drill intersections with fault gouge. Silicification in the form of sinters and disseminated quartz is a prominent alteration type at Grassy Mountain and is largely controlled by hot-spring vents. Silicification occurs both pervasively as silica flooding, and as cross-cutting veins and stockworks. The silicified envelope has plan dimensions up to 3,000 feet (north-south) by 2,500 feet (east-west). Silicification is surrounded by widespread, barren, clay-rich (20- to 40-percent montmorillonite), tuffaceous siltstone and arkose with minor disseminated pyrite. Many of the sinters occur as sheets instead of mounds, which suggest that they are related to vents along faults rather than point sources. Potassic alteration occurs as adularia flooding with destruction of biotite. Orthoclase is unaffected by potassic alteration, and plagioclase is replaced by adularia.

Mineralization of the Grassy Mountain deposit includes: 1) low grade gold associated with hot springs silicification; 2) high grade gold associated with multi-stage quartz-adularia-gold-silver veins and stockworks; and 3) late remobilization within sub-vertical rubble zones defined by clay matrix breccias. The deposit is characterized by stacked sinter terraces capping acid-leached sediments and multiple generations of quartz veins, which suggest repeated eruption, brecciation, breeching, and sealing of the hydrothermal system. Ore minerals include native gold (50 to 600 microns), electrum, and minor pyrite (up to 80 microns). Gangue minerals include quartz, calcite, chlorite, epidote, orthoclase, plagioclase, illite, sericite, chalcedony, montmorillonite, goethite, and jarosite.

At a local scale and within the immediate vicinity of the Grassy Mountain gold deposit, fault orientations can be grouped into two major sets: 20 degrees west of north to ten degrees east of north (N20°W to N10°E) striking faults, and 70 degrees east of north (N70°E) striking faults. Joint and fractures orientations fall into three major groups: 1) strikes of north to 20 degrees east of north (N to N20°E) dipping to the east-southeast; 2) strikes of a general south direction with dips to the west; and 3) strikes with a general west direction dipping to the north.

Geologic Hazards evaluated in this study include seismicity/earthquake hazards, slope failures/landslides, volcanic eruptions and unsuitable soil/soil erosion. The Geology Study Area is located in a region of low seismic risk. No active or potentially active faults are known in the Geology Study Area. The closest fault with historic surface rupture, the Lost River Fault, is located near Challis, Idaho, approximately 110 miles northeast of the Geology Study Area. The closest potential Holocene age faults are located over 20 miles north of the Geology Study Area. The probability of the occurrence of an earthquake with a magnitude greater than 5.0 over the next ten years is less than 0.03.

Within a 50-mile radius of the Geology Study Area, only a few earthquakes have been recorded since 1900 (United States Geological Survey [USGS] 2018). Only two earthquakes within a 50-mile radius of the Geology Study Area were associated with known fault systems: a magnitude 3.2 earthquake associated with the Squaw Creek Fault in April 1978 (approximately 47 miles away from the Permit Area); and a magnitude 3.2 earthquake associated with the Cottonwood Mountain fault in July 2009 (approximately 31 miles away from the Permit Area). Approximately 27 miles southeast of the Permit Area, there was a 2.9 magnitude earthquake in November 2012, and it’s close to the Owyhee Mountains fault system. There were three other earthquakes that occurred within 50 miles of the Geology Study Area since 1900 that were not associated with any known faults or fault systems.

Using the USGS National Seismic Hazard Mapping Database, the peak ground acceleration at the facility resulting from a seismic event from one of the seismic sources was calculated. An earthquake that has a ten-percent probability of exceedance in 50 years (a nominal 500-year recurrence interval) is the maximum probable earthquake. An earthquake with a nominal 2,500-year recurrence interval (a two percent probability of exceedance in 50 years) is the maximum considered earthquake.

There are no known existing active landslides in the Geology Study Area.

Numerous volcanoes exist in the Cascade Range located approximately 200 to 250 miles west and northwest of the Geology Study Area. The recently active volcanoes are Mount Hood, Mount Jefferson and Mount Mazama (Crater Lake). Mount Hood has erupted three times over the past 2,000 years and has been active as recently as 400 years ago. Within the Geology Study Area, the most recent volcanic activity is dated at 7.4 million years before present. The most likely volcanic hazard that could occur in the Geology Study Area would be from effects of a volcanic eruption from one of the Cascade volcanos. The Geology Study Area could possibly be covered by volcanic ash if the prevailing winds were directed toward the area.

Soil surveys were performed by IMS, Inc. (IMS) near the Mine and Process Area and southern portion of the Access Road Area in 1989 and 1991. Eleven map units, comprised of seven soil types and one undifferentiated soil group, were identified in the soil surveys performed by IMS (1989 and 1991). Soil surveys were performed in June 2018 by Cascade Earth Sciences (CES) in the remainder of the Permit Area/Soils Study Area. Six additional soil types were identified during the June 2018 surveys. All 17 map unit descriptions are presented in Table 28. Each map unit description provides basic information about the map unit such as predominant soil or soils of the unit, slope, and rock fragment content.

Table 28. Soil Survey Map Legend

Map Unit	Name - Description
1[1]	Farmell-Rock outcrop complex, eight to 30 percent slopes
2[1]	Farmell-Chardoton very cobbly soil, 15 to 30 percent slopes
3[1]	Farmell-Chardoton very cobbly soil, four to 15 percent slopes
4[1]	Farmell-Chardoton extremely stony soil, four to 15 percent
5[1]	Farmell-Chardoton soil, eight to 15 percent slopes
6[1]	Ruckles very stony loam, eight to 30 percent slopes
7[1]	Shano silt loam, two to six percent slopes
8[1]	Soil A extremely gravelly sandy loam, 15 to 30 percent slopes
9[1]	Virtue loam, two to eight percent slopes
10[1]	Xeric Torriorthents, eight to 30 percent slopes
11[1]	Soil B very gravelly sandy loam, eight to 30 percent slopes
12[2]	Nyssa silt loam, two to six percent slopes
13[2]	Drewsey very fine sandy loam, two to six percent slopes
14[2]	Ruclick cobbly loam, four to 15 percent slopes
15[2]	Drewsey-Quincy-Solarview complex, eight to 30 percent
16[2]	Owsel silt loam, two to six percent slopes
17[2]	Powder silt loam, zero to three percent slopes

Source: [1]IMS 1989, 1991; [2]CES 2018

Erionite is a fibrous zeolite-group mineral often occurring as microscopic acicular, prismatic crystals in altered volcanic tuffs of late Cenozoic age. Erionite can also occur as bedded zeolites within a lacustrine environment containing sediments high in calcium and magnesium. Less commonly erionite occurs in vesicles or cavities within volcanic rocks such as basalt, andesite or rhyolite. Numerous studies have been conducted concerning the occurrence of zeolites in Oregon. Not all zeolite minerals are considered hazardous. A December 2011 report, *Naturally Occurring Hazardous Materials,* Final Report SPR 686 (DOGAMI 2011), identifies numerous occurrences of zeolites and erionite in Oregon. The erionite localities closest to the Project are

Durkee in Baker County, and Rome in southern Malheur County. Durkee is approximately 65 miles north of the Project while Rome is approximately 60 miles to the south-southwest. The erionite study was carried out by SRK and is incorporated in the Geochemistry Baseline Report (Appendix B).

The Wind Erodibility Group (WEG) is an arbitrary grouping of soils based on texture, structure, and carbonate content. WEG values range from 1 to 8 with the lower values indicating greater susceptibility to wind erosion. The WEG is typically applied only to the surface layer of a soil. Classes are defined by the Natural Resources Conservation Service's (NRCS') *National Soil Survey Handbook*, Part 618, Subpart B (NRCS 2017). Table 29 shows the calculated K-factors and WEG values for each soil type.

Table 29. Erosion Factors of Surface Soils

Soil Series	WEG (Wind Erosion Group)	K-Factor (Soil Erodibility Factor)
Chardoton[1]	8	0.13
Farmell[1]	8	0.10
Ruckles[1]	8	0.10
Shano[1]	5	0.37
Soil A[1]	8	0.07
Soil B[1]	8	0.07
Virtue[1]	5	0.16
Nyssa[2]	5	0.61
Drewsey[2]	3	0.34
Ruclick[2]	8	0.37
Owsel[2]	5	0.46
Powder[2]	5	0.52

Source: [1]IMS 1989, 1991; [2]CES 2018

In all the areas where mining and processing will take place, suitable topsoil will be stripped and stockpiled for reclamation. A topsoil suitability rating table was developed by IMS (1991) for the three dominant soils within the Soils Study Area. The locations were selected to most accurately represent the pedon sampled and its landscape position. (Pedon is a three-dimensional body of soil with dimensions large enough to permit the study of individual soil horizons.) Topsoil suitability for the soil types identified during the June 2018 surveys were also tested. Laboratory analyses results for soil samples were compared to suitability criteria for topsoil developed at Colorado State University's soil testing laboratory (Soltanpour and Workman 1981). These criteria are presented in Table 30.

Table 30. Soil Suitability Ratings

Parameter	Testing Method	Good Suitability	Marginal Suitability	Unsuitable
pH	S-2-10	6.0 to 8.4	5.5 to 6.0, 8.4 to 8.8	<5.5, >8.8
EC (dS/m)	S-2.10	<4.0	4.0 to 12.0	>12.0
Texture	S-14.10 ASTM D6913	Loamy sand, sandy loam, loam, silt; soil with <35% clay	Sand, loamy coarse sand; soil with <45% clay	Soils with >45% clay
Saturation %	S-10.20	25 to 80	25 to 80	<25 and/or >80
$CaCO_3$ %	Fizz	0 to 15	15 to 30	>30
Rock fragments %	Field Estimated	<35	35 to 60	>60
Erosion factor K	Calculated	<0.37	>0.37	
Organic Matter	S-9.10			

Source: IMS 1989,1991; CES 2018

In general, the topsoil sampled in and near the Mine and Process Area during the IMS surveys (IMS 1989, 1991) has a higher clay content and is shallower in the soil profile. This soil generally meets the "Marginally Suitable" category. The topsoil throughout the June 2018 survey area appear generally suitable for reclamation. The primary limitation is surficial and subsurface coarse fragments, which were encountered on ridge sides and summits. The Ruclick soils and Drewsey-Quincy-Solarview Complex exhibited high surface and subsurface coarse fragments. Steep slopes also limit reclamation suitability. The Drewsey and Owsel soils, which generally occur on the valley floors, exhibited marginal limitations for reclamation due to pH level and/or soil erodibility. The Nyssa soil, also located on valley floors, have unsuitable subsurface soil horizons that are cemented and exhibit increased sodium and carbonate levels (CES 2018).

2.7 <u>Grazing Management</u>

The Grassy Mountain Mine Project Grazing Management Baseline Report (Appendix B) was submitted to DOGAMI on January 11, 2018. The report was accepted by the TRT on March 9, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. There are three grazing allotments in the Grazing Management Study Area: Nyssa (10403); Sourdough (10404); and Dry Creek (10411). The Nyssa Allotment includes four pastures and six enclosures or exclosures that occur partly or wholly within the Grazing Management Study Area. The Sourdough Allotment includes three pastures that occur partly or wholly within the Grazing Management Study Area. The Dry Creek Allotment includes three pastures and one exclosure that occur partly within the Grazing Management Study Area. These allotments and their pastures are shown in Table 31.

Table 31. Pasture Allotments in the Grazing Management Study Area

Allotment Number	Allotment Name	Pasture Number	Pasture Name	Grazing System	Management Strategy	Total Pasture Acres	Pasture Acres within Study Area
10403	Nyssa	4	Sagebrush	Deferred	Improve	11,877.2	544.5
10403	Nyssa	5	Ryefield Seeding	Deferred rotation	Improve	3,720.3	3,471.3
10403	Nyssa	6	Grassy Mountain Seeding	Deferred rotation	Improve	3,035.5	1,771.4
10403	Nyssa	7	Grassy Mountain	Deferred	Improve	29,764.2	8,099.1
10403	Nyssa	9	Ryefield Reservoir Exclosure	Riparian exclosure	Improve	19.7	19.7
10403	Nyssa	15	North Grassy Mountain Reservoir Exclosure	Reservoir enclosure	Improve	4.3	4.3
10403	Nyssa	30	Ryefield Seeding Test Plot	Management exclosure	Improve	2.4	2.4
10403	Nyssa	31	Owyhee Ridge Trough Exclosure	Reservoir enclosure	Improve	1.8	1.8
10403	Nyssa	32	Government corral	Reservoir enclosure	Improve	0.2	0.2
10403	Nyssa	34	Grassy Reservoir Exclosure	Reservoir enclosure	Improve	1.2	1.2
10404	Sourdough	4	Canyon	Deferred rotation	Maintain	21,121.1	624.9
10404	Sourdough	7	Freezeout Lake	Deferred rotation	Maintain	22,214.8	443.5
10404	Sourdough	10	Rye Field Fenced Federal Range	Custodial area	Maintain	1,439.7	372.4
10411	Dry Creek	1	Cow Hollow Seeding	Deferred rotation	Maintain	1,598.5	17.5
10411	Dry Creek	2	Double Mountain	Deferred rotation	Maintain	12,639.6	285.1
10411	Dry Creek	5	Russell Fenced Federal Range	Custodial area	Maintain	5,386.0	146.0
10411	Dry Creek	10	Little DM Spring Exclosure	Riparian exclosure	Maintain	3.1	1.3

2.8 Groundwater

The Grassy Mountain Groundwater Baseline Report (Groundwater Report) (Appendix B) is being submitted with this Consolidated Permit. This Groundwater Report includes data previously submitted, quarterly monitoring data, new recently collected data, and interpretations as requested by DOGAMI. The report is designed to conform to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Groundwater Resources Study Area was established to develop an environmental baseline for assessing potential impacts from Project facilities, potential impacts of surface runoff from Project facilities, and to provide background data. The Groundwater Resources Study Area includes an area encompassing the Mine and Process Area and two separate non-contiguous, areas on the Owyhee River/Lake. All baseline well and spring sites are located within the Groundwater Resources Study Area.

This Groundwater Report includes baseline data, groundwater characterization, and dewatering estimates. The report is written in three volumes: Volume I—Groundwater Baseline Data; Volume II—Groundwater Characterization; and Volume III—Groundwater Numerical Model and Dewatering. This summary will describe each volume separately for ease of reference to the full Groundwater Report in Appendix B.

VOLUME I

The purpose of the Groundwater Report is:

- Provide baseline data of the quality and quantity of local groundwater resources.
- Develop a monitoring well network for the purpose of monitoring groundwater levels and water quality within each aquifer potentially affected by mining operations.
- Collect data of known and acceptable quality in accordance with project-specific methods and procedures for use in this baseline report and for permitting. Data compilation is intended for future use in mine development and operations, exploration, closure, and long-term remediation.

The Project is in the Sourdough Basin/Negro Rock Canyon watershed, which drains to the north. Grassy Mountain, located southeast of the Project, serves as the hydrologic divide between the Sourdough Basin/Negro Rock Canyon watershed and the watersheds draining south to the Owyhee River.

Four quarterly water quality sampling events occurred during 2013: March (1st Quarter); June (2nd Quarter); August (3rd Quarter); and November (4th Quarter). Three more quarterly sampling events occurred in 2014: March (1st Quarter); June (2nd Quarter); and September (3rd Quarter). Apart from quarterly water quality sampling events, additional one-time sampling events occurred from well 59762 and from the recently constructed monitoring wells GMW17-32, and GMW17-33. These sampling events occurred in December of 2017 with additional development and sampling of GMW17-32 in July and December of 2018. During each of the water quality sampling events described above, spring flow rates and the well/piezometer water levels were measured. With few exceptions, this flow and water level monitoring has continued on a voluntary, quarterly basis. This report includes all monitoring between 2013 and the 3rd Quarter of 2018. Quarterly reports will continue to be submitted to the TRT. In addition to the springs and wells used for water quality sampling purposes, flow rates from "background springs" and two flowing wells were measured on twice-yearly basis in 2013, 2014, and 2015. See Tables 32 and 33 below for details of the wells and springs.

At each of the monitoring wells the static water level was measured and recorded prior to purge pumping (if sampled) using a calibrated or non-stretch electric-line well sounder. Recording water level pressure transducers were installed in GW-1, GW-2, and GW-4 on March 26, 2013, during the 1st Quarter sampling event. This static water level measurement, along with the pressure transducer reading was used to establish an accurate height of water above the transducer. The continuous water level data were collected at one-hour intervals initially and then switched to 30 minutes for all remaining tests. Details of the installation and sampling of the wells and springs is available in the Groundwater Report (Appendix B).

Water-quality samples collected from wells and springs were analyzed for the list of approved water quality analytes. Table 34 lists the approved analytes, as well as the laboratory testing method, the laboratory minimum detection limit, and the reporting limit (five times the MDL). For metals, samples for both total and dissolved metals were collected. For the other parameters, only total samples were collected.

For the wells tested, field water quality parameters measured during purging of the wells allows for continuous measurement of field parameters (pH, temperature, electrical conductivity, and specific conductance) without significant aeration of the sample. These field parameters were monitored continuously during purging to ensure parameters were stable prior to sampling. Parameters are considered stable when consecutive measurements taken one casing volume apart meet the following conditions: temperature within one degree Celsius (C); pH within 0.3 standard pH units; and specific conductance measurements within ten percent of each other (ODEQ 2009). Dissolved oxygen was measured in a separate purge water container (clean plastic bucket). Water quality samples collected from monitoring wells were analyzed for the constituents shown in Table 34 (Water Quality Analytes). Sampling from the continuously flowing artesian well (Prod-1) was conducted in the same manner as spring water samples. Analytical methods meet ODEQ reporting and detection limits. Complete descriptions of the well sampling are included in the Groundwater Report.

Well and piezometer groundwater level monitoring throughout the monitoring well network are used in the following data analysis and interpretation. Groundwater level monitoring has focused predominantly on the shallow (typically above 500 feet depth) aquifer zone, where the majority of wells are completed. More recently, water levels in Well GMW17-32 were monitored in 2018. Groundwater levels within the deep zone were also monitored using Vibrating Wire Piezometer (VWP) sensors installed within the deposit. Detailed descriptions of

Table 32. Well Completion Details

Calico Well ID	OWRD Well Tag Number	OWRD Name	Alternate Name	Drill Method	Depth of First Water (ft)	Well Const. Depth (ft)	Screened Interval (ft)	Well Casing Diameter (in)	TOC Elevation[4]	Elevation Screened Interval (ft)	Water Level Elevation (9/26/2018)	Production (gpm)[2]	Screened Lithology[1]
59760	107462	MALH 2974	Middle Sweizer, TW-1	air rotary	160	203	163-203	6	3762.1	3599-3559	3673.43	+10	fractured basalt
59761	109400	MALH 2993	Lower Sweizer, MW-2	air rotary	100	118	97-117	4	3762.2	3665-3645	3673.48	+50	fractured basalt
59762	109371	MALH 2976, 2985	MW-3	air rotary	626	700	550-660	4	3724.8	3175-3065	3103.4	<1	siltstone
59763	109356	MALH 2994	TW-4	air rotary	277	323	293-323	6	3519.4	3226-3196	3239.03	+5	fractured volcanics
59764	107466	MALH 2986	MW-5	air rotary	270	300	279-299	4	3511.9	3233-3213	3238.24	+10	fractured sandstone
59765		MALH 2979	MW-6	air rotary	29	36	28-36	4	3446.5	3418-3410	dry	dry	shallow sandstone
59766	107468	MALH 2980	MWS-8	air rotary	only damp when drilled	45	25-45	4	3459.7	3435-3415	3426.68	+10	shallow sandstone
59767		MALH 2995	MWS-9	air rotary	dry	40	20-40	4	3495.3	3475-3455	dry	dry	shallow sandstone
59768		MALH 54197	MWS-10	air rotary	21	25	10-25	4	3480.6	3471-3456	3463.46	0.5	shallow sandstone
59770		MALH 2983	MW-11	air rotary	dry when drilled	424	374-424	4	3389.0	3015-2965	3241.71	+0.5	volcanic tuff
59772	109352	MALH 2984	Upper Sweizer, MWS-13	air rotary	125	207	165-205	4	3768.2	3603-3563	3673.5	+50	fractured basalt
26-092-915	109354	MALH 54071		unknown	unknown	915	228-268	2	3710.0	3482-3442	3633.55	unk	unk
57-1		MALH 54195		unknown	unknown	765	108-138	1.25	3770.6	3663-3633	3699.1	unk	unk
57-10		MALH 54196		unknown	unknown	500	126-156	1	3681.1	3555-3525	3635.67	unk	unk
89-2	109360	MALH 54072		unknown	200	425	386-406	2	3293.5	2907-2887	3235.54	unk	unk
Bishop	None	MALH 54046	Rye Field	cable	unknown	482	135-145	12	3391.5	3257-3247	3281	50	coarse gravel
BLM	109398	MALH 2277	Owyhee Ridge	cable	unknown	175	159-166	6	3579.6	3421-3414	3423.95	+12	white sand
GMW17-31	125168	MALH 54404		air rotary	dry when drilled	498	458-498	5	3722.0	3262-3222	3222.6	0	siltstone, sinter, clay
GMW17-32	125169	MALH 54405		air rotary	244	718	678-718	5	3702.1	3026-2986	3082.1	<1	Arkose, siltstone, Clay
GMW17-33	125170	MALH 54406		air rotary	243	338	238-338	5	3702.7	3465-3365	3452.16	<30	sinter, siltstone, tuff
GMW18-34	130031	MALH 54437		air rotary	dry	950	830-890	5	3953.3	3127-3067	dry	dry	Arkose, siltstone, Clay
GW-1	107469	MALH 2281	47-1	air rotary	140	155.5	135.5-155.5	4	3709.1	3573.5-3553.5	3654.18	60	gravel
GW-2	109357	MALH 2279	47-2	air rotary	dry when drilled	325	290-320	4	3827.5	3537-3507	3662.91	0	blue and grey clay
GW-3	107467	MALH 2278	47-3	air rotary	dry when drilled	350	320-350	4	3633.6	3314-3284	3401.68	<1	blue and grey clay
GW-3A		MALH 2579		air rotary	dry	420	380-420	2	3655	3275-3235	dry	dry	silt and clay
GW-3B		MALH 2576		air rotary	dry	340	80-100	2	3626	3546-3526	dry	dry	clay
GW-4	107460	MALH 54073		unknown	50	370	280-350	4	3342.7	3063-2993	3260.85	100	sandstone, congl, clay
GW-5		MALH 54194		air rotary	unknown	265	204-224	2	3413.0	3209-3189	3221.45	<1	tuff, clay
GW-6	109368	MALH 2578		air rotary	145	340	300-340	2	3377.3	3077-3037	3236.16	3-4	sandstone, congl, clay
Prod 1	107457	MALH 2275, 2511		air rotary	145	425	145-255, 325-355, 380-420	6	3436.4	3291-3181, 3111-3081, 3056-3016	3436.41	30-100[3]	sandstone, blue clay, and hard sandstone
PW-1	109353	MALH 2276		air rotary	320	520	320-340, 400-420	6	3709.1	3389-3369, 3309-3289	3654.66	25-35[3]	brown clay and sand; coarse sandstone
PW-4	109351	MALH 2206		air rotary	280	375	280-300, 340-360	6	3341.4	3061-3041, 3001-2981	3261.39	175-250[3]	sandstone and conglomerate

1 - as reported on the drillers log
2 - based on short-term testing by driller during or following construction
3 - based on long-term test pumping
4 - surveyed with the exception of GW-3A, GW-3, GMW-17-31, GMW17-32, GMW17-33, and GMW18-34

Table 33. List of all Wells and Springs with GPS Coordinates

Type	Site Name	Northing (ft, OR State Plane South)	Easting (ft, OR State Plane South)	MP Elevation (ft asl)
Monitoring Wells	59760	745645.981	5753551.517	3762.10
	59761	745772.825	5753658.537	3762.22
	59762	747093.548	5751854.980	3724.79
	59763	744833.301	5745691.957	3519.42
	59764	744814.369	5745502.507	3511.86
	59765	749408.542	5748338.635	3446.47
	59766	749128.353	5748254.792	3459.75
	59767	750823.434	5750882.309	3495.26
	59768	751987.933	5752488.768	3480.58
	59770	742710.937	5741955.406	3388.98
	59772	745572.389	5753583.613	3768.16
	26-092-915	746617.799	5752915.771	3710.00
	57-1	744890.820	5750760.310	3770.64
	57-10	747741.058	5753164.928	3681.14
	89-2	750181.789	5741874.789	3293.50
	Bishop	739450.422	5737602.762	3391.51
	BLM	747633.586	5749895.135	3579.64
	GW-1	746929.696	5753379.246	3709.10
	GW-2	741642.053	5750108.395	3827.46
	GW-3	746644.651	5750449.625	3633.59
	GW-3A	747154.659	5751260.753	3657.50
	GW-4	756961.961	5749996.486	3342.71
	GW-5	750443.408	5747915.292	3412.98
	GW-6	746405.775	5743134.903	3377.33
	Prod-1	753540.873	5751275.237	3436.41
	PW-1	746870.021	5753289.854	3709.10
	GMW17-31	747062.1437	5751890.41	3722.00
	GMW17-32	746507.8151	5751400.075	3702.00
	GMW17-33	746468.9358	5751387.606	3702.70
	GMW18-34	745311.4955	5752293.667	3953.26
	PW-4	757070.919	5749908.325	3341.40
Baseline Springs	Deposit Stock Tank	748376.460	5750879.694	3552.77
	Government Corral	756975.556	5757863.847	3456.01
	Grassy Spring	741738.614	5750275.765	3822.84
	Lowe Spring	761799.478	5753456.679	3278.96
	Poison Spring	759368.751	5740634.211	3213.85
	Sagebrush Spring	759029.757	5761380.835	3481.86
	Sourdough Lower	737582.250	5731598.434	3565.36
	Sourdough Upper	737587.997	5728058.732	3754.05
	Twin Springs North	726474.288	5737016.696	3240.02
	Twin Springs South	725277.033	5737632.836	3210.32
	Whiskey Spring	725895.946	5746824.847	3230.04
Background Springs and Wells (corrdinates from non-survey grade GPS, elevations estimated using Goole Earth)	Bull Spring Tank	731798.684	5730323.895	3727
	Central Grassy Mountain Spring	737920.331	5756588.347	3489
	Dark Rock Well	756210.058	5732296.357	3391
	East Grassy Mountain Spring	738055.897	5757538.706	3489
	Flowing Well	761550.474	5727332.014	3532
	Negro Rock Canyon Spring	767800.835	5735633.314	3117
	Negro Rock Spring Tank	754844.533	5737277.024	3319
	Oxbow Spring Tank	729591.481	5756563.613	3065
	Oxyoke Spring Tank	726801.090	5757094.644	3029
	Red Tank #3	756212.707	5753206.759	3389
	Spring in Sec13 T22S R44E	739203.805	5773378.134	3005
	Spring in Sec23 T21S R43E	769162.951	5732244.787	3297
	Spring North of Lowe Reservoir	764826.923	5752193.554	3247
	Spring South of Poison Spring	758410.107	5741317.082	3232
	Tank E of Negro Rock	752204.327	5742408.207	3273
	West Grassy Mountain Spring	738802.552	5755880.217	3619
	West Whiskey Spring	757611.371	5728513.411	3547
	Wildcat Spring	757839.970	5732821.848	3366

Table 34. List of Water Quality Analytes

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Aluminum, Al	EPA 200.7	0.03 mg/L	0.15 mg/L	total and dissolved
Total Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Barium, Ba	EPA 200.7	0.003 mg/L	0.015 mg/L	total and dissolved
Cadmium Low	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Calcium, Ca	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Chromium Low	EPA 200.8	0.0005 mg/L	0.002 mg/L	total and dissolved
Copper Low	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Iron, Fe	EPA 200.7	0.02 mg/L	0.05 mg/L	total and dissolved
Lead Low	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Magnesium, Mg	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Manganese Low	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Mercury, Hg (Low Level)	1631E	0.2 ng/L	0.5 ng/L	total and dissolved
Nickel Low	EPA 200.8	0.0006 mg/L	0.003 mg/L	total and dissolved
Potassium, K	EPA 200.7	0.3 mg/L	1.5 mg/L	total and dissolved
Selenium Low	EPA 200.8	0.0001 mg/L	0.00025 mg/L	total and dissolved
Silver Low	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Sodium, Na	EPA 200.7	0.3 mg/L	1.5 mg/L	total and dissolved
Zinc, Zn	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	total and dissolved
Boron	EPA 200.8	0.0005 mg/L	0.001 mg/L	total and dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Lithium	EPA 200.7	0.02 mg/L	0.1 mg/L	total and dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Strontium	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Tin	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	total and dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Nitrate+Nitrite (as N)	EPA 353.2	0.02 mg/L	0.1 mg/L	total
Ammonia Direct (as N)	EPA 350.1	0.05 mg/L	0.5 mg/L	total
Alkalinity	SM 2320B	2 mg/L	20 mg/L	total
Bicarbonate	SM 2320	2 mg/L	20 mg/L	total
Carbonate	SM 2320	2 mg/L	20 mg/L	total
Chloride, Cl	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Conductivity	SM 2510B	1 umhos/cm	10 umhos/cm	total
Cyanide, Total	EPA 335.4	0.003 mg/L	0.01 mg/L	total
Cyanide, Weak Acid Digestion	SM 4500	0.003 mg/L	0.01 mg/L	total
Fluoride, F	EPA 300.0	0.1 mg/L	0.5 mg/L	total
Hardness	SM 2340 B	calc	calc	total
pH	SM 4500-H B	0.1 C	0.1 C	total
Sulfate, SO4	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Total Dissolved Solids	SM 2540C	10 mg/L	20 mg/L	total
Total Suspended Solids	SM 2540D	5 mg/L	20 mg/L	total
Total Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	total

mg/L = milligrams per liter; ng/L = nanograms per liter; umhos/cm = microhoms per centimeter the wells into the shallow and deep aquifers are in the Groundwater Report (Appendix B). Deep zone water levels have been monitored in Well 59762 since 2013. A total of 15 VWP sensors were installed in five boreholes during the 2017 mineral resource and reserve program (three sensors per borehole). Sensors were installed predominantly on the eastern side of the Proposed Project at shallow, intermediate, and deep intervals, intended to bracket the reserve ore body. The hydrographs and data for these are also in the Groundwater Report (Appendix B).

For the spring monitoring/sampling, springs with a minimum flow of ¼ liter per minute were sampled. Any flow less than that is considered unsuitable for collecting samples. For those springs that flow continuously, conditions were considered steady state and only one set of field parameters (pH, electrical conductivity, specific conductance, dissolved oxygen) were collected. The same meters were used as for groundwater sampling. Readings were recorded once the measurements had stabilized.

Water quality samples collected from springs were analyzed for the same constituents as for samples collected from monitoring wells (see Table 34, Water Quality Analytes). For non-filtered samples (non-metals), water quality samples were collected directly from each spring. For filtered samples (metals), a water sample was collected from the spring in a clean plastic container.

Groundwater quality of wells and springs was completed with the objective of providing a baseline characterization prior to the proposed mining activities. Well and spring water quality results are compared to both primary drinking water standards and secondary drinking water standards. The primary drinking water standards are legally enforceable standards due to potential human health concerns and are expressed as maximum contaminant levels (MCLs). The MCL is the highest level of an analyte allowed in drinking water. Secondary drinking water standards are non-enforceable recommended standards established to limit cosmetic or aesthetic effects (not health-related) in drinking water, expressed as secondary maximum contaminant levels (SMCLs). Spring water quality data is also compared to ODEQ water quality standards as described in OAR 340-041.

Tables 35 and 36 from Volume I show a summary of values above the MCL for springs and wells respectively.

The predominant hydrogeochemical facies noted for springs and wells within the Grassy Mountain Project vicinity are:

- Calcium bicarbonate (Ca-HCO3) for 59760, 59761, 59722, and GW-1.
- Sodium-potassium bicarbonate (Na/K-HCO3) for Bishop, GW-4, Prod-1, and PW- 1.
- Sodium-potassium sulfate (Na/K-SO4) for 59763, 59766, BLM, 59762, and GMW17-32.

Table 35. Grassy Mountain Baseline Spring Water Quality Results (Above Drinking Water MCLs)

MCL column has secondary MCL values indicated by an *		DEPOSIT STOCK TANK								GOVERNMENT CORRAL SPRING	LOWE SPRING		POISON SPRING							SOURDOUGH SPRING LOWER			
ANALYTE	MCL	3/17/13	6/20/13	8/13/13	11/22/13	3/16/14	3/16/14	6/24/14	9/17/14	11/22/13	3/13/13	6/26/13	6/26/13	8/13/13	11/21/13	3/16/14	6/24/14	9/16/14	3/26/13	3/17/14	8/14/13	6/27/13	11/23/13
Aluminum, dissolved	0.05*																						
Aluminum, total	0.05*									0.06													
Antimony, dissolved	0.006																						
Antimony, total	0.006																						
Arsenic, dissolved	0.010	0.0257	0.0287	0.033	0.0249	0.0301	0.0299	0.0262	0.0262				0.0364	0.0352	0.0356	0.0396	0.0348	0.034	0.036	0.0264	0.0232	0.0234	0.0238
Arsenic, total	0.010	0.0265	0.029	0.0307	0.0252	0.0257	0.0252	0.0278	0.027				0.0333	0.0335	0.0371	0.0337	0.035	0.0343	0.036	0.0229	0.0227	0.0227	0.0231
Chromium, total	0.1																						
Iron, dissolved	0.3*																						
Iron, total	0.3*																						
Lead, total	0.015																						
Manganese, dissolved	0.05*																						
Manganese, total	0.05*																						
Total Dissolved Solids (TDS)	500*										570	540											
Sulfate	250*																						

MCL column has secondary MCL values indicated by an *		SOURDOUGH SPRING UPPER						TWIN SPRINGS NORTH							TWIN SPRINGS SOUTH								
ANALYTE	MCL	6/27/13	3/17/13	11/23/13	3/17/14	6/23/14	9/16/14	3/13/13	6/20/13	8/14/13	11/22/13	3/16/14	6/23/14	9/16/14	3/13/13	3/13/13	6/20/13	8/14/13	11/22/13	3/16/14	6/23/14	6/23/14	9/16/14
Aluminum, dissolved	0.05*							0.11															
Aluminum, total	0.05*													0.3									
Antimony, dissolved	0.006																						
Antimony, total	0.006																						
Arsenic, dissolved	0.010	0.0283	0.0279	0.0311	0.0319	0.0276	0.0276	0.0607	0.0441	0.0463	0.045	0.0522	0.0401	0.0497	0.0433	0.0413	0.0434	0.043	0.0412	0.0489	0.038	0.0394	0.0418
Arsenic, total	0.010	0.0272	0.0276	0.0279	0.0278	0.0268	0.0278	0.061	0.0479	0.0442	0.0449	0.0444	0.0417	0.0466	0.0445	0.0436	0.044	0.0422	0.0435	0.0422	0.0409	0.0409	0.0396
Chromium, total	0.1																						
Iron, dissolved	0.3*																						
Iron, total	0.3*																						
Lead, total	0.015																						
Manganese, dissolved	0.05*								0.0809					0.1613									
Manganese, total	0.05*								0.101	0.053				0.216									
Total Dissolved Solids (TDS)	500*																						
Sulfate	250*																						

MCL column has secondary MCL values indicated by an *		WHISKEY SPRING							
ANALYTE	MCL	6/27/13	6/27/13	8/14/13	11/23/13	3/16/14	6/24/14	9/16/14	3/17/13
Aluminum, dissolved	0.05*								
Aluminum, total	0.05*								
Antimony, dissolved	0.006								
Antimony, total	0.006								
Arsenic, dissolved	0.010	0.0898	0.0889	0.0854	0.0922	0.1039	0.0853	0.0854	0.0861
Arsenic, total	0.010	0.0846	0.0821	0.0867	0.089	0.0867	0.0826	0.086	0.0874
Chromium, total	0.1								
Iron, dissolved	0.3*								
Iron, total	0.3*								
Lead, total	0.015								
Manganese, dissolved	0.05*								
Manganese, total	0.05*								
Total Dissolved Solids (TDS)	500*								
Sulfate	250*								

Table 36. Grassy Mountain Baseline Wells Water Quality Results (Above Drinking Water MCLs)

MCL column has secondary MCL values indicated by an *		59760								59761							59762	59763								59766						
ANALYTE	MCL	3/26/13	6/18/13	8/8/13	11/24/13	3/24/14	3/24/14	6/25/14	9/11/14	3/18/13	6/18/13	8/6/13	11/21/13	3/18/14	6/27/14	9/15/14	12/6/17	3/18/13	6/18/13	8/7/13	11/24/13	3/24/14	6/27/14	9/15/14	9/15/14	3/14/13	6/17/13	8/8/13	11/24/13	3/18/14	6/25/14	9/11/14
Aluminum, dissolved	0.05*																															
Aluminum, total	0.05*	0.12		0.15	0.37	0.59	0.37	0.22	0.74								3.37	2.07	0.1		0.14	0.12		0.09	0.12	25.6	8.36	1.84	3.7	2.9	4.36	7.26
Antimony, dissolved	0.006																0.298															
Antimony, total	0.006																0.21															
Arsenic, dissolved	0.010	0.0278	0.0263	0.0237	0.0285	0.0282	0.0221	0.0268	0.0271	0.0246	0.0234	0.0243	0.024	0.0227	0.0228	0.0223	0.018	0.0839	0.0609	0.0643	0.0713	0.0688	0.0578	0.0621	0.066	0.204	0.2094	0.1836	0.1958	0.1887	0.187	0.1644
Arsenic, total	0.010	0.0283	0.0268	0.0267	0.0275	0.0245	0.0251	0.0268	0.0258	0.0241	0.024	0.024	0.0244	0.0219	0.0228	0.0232	0.163	0.0787	0.0606	0.06	0.0658	0.0614	0.0624	0.0664	0.0669	0.276	0.259	0.206	0.202	0.191	0.1847	0.1927
Chromium, total	0.1																															
Iron, dissolved	0.3*																										0.97	0.9	1.06	0.89	0.86	0.71
Iron, total	0.3*								0.37								4.54	1.45								23	9.12	2.77	5.38	3.9	5.04	7.31
Lead, total	0.015																									0.019						
Manganese, dissolved	0.05*																0.535		0.1974	0.1098	0.096	0.0838	0.0856	0.0867	0.0857	0.263	0.475	0.422	0.442	0.432	0.407	0.389
Manganese, total	0.05*																0.589	0.23	0.205	0.1179	0.1235	0.1029	0.1007	0.0997	0.0992	0.73	0.688	0.452	0.506	0.49	0.486	0.519
Total Dissolved Solids (TDS)	500*																648	1090	1130	1220	1130	1170	1130	1160	1170	660	650	674	650	650	640	670
Sulfate	250*																333	575.7	568	626	569	580	612	582	377	308.57	311	307	302	305	320	300

MCL column has secondary MCL values indicated by an *		59772								BISHOP	BLM							BLM 12 VOLS	BLM 6 VOLS	GMW 17-32	GMW 17-33	GW-1							
ANALYTE	MCL	3/18/13	3/18/13	6/18/13	8/8/13	11/24/13	3/24/14	6/25/14	9/11/14	9/15/14	3/18/13	6/18/13	8/8/13	11/24/13	3/24/14	6/27/14	9/15/14	3/18/13	3/18/13	12/5/18	12/14/17	3/14/13	6/17/13	8/6/13	11/21/13	3/18/14	6/25/14	9/11/14	6/17/13
Aluminum, dissolved	0.05*																												
Aluminum, total	0.05*																			0.07									
Antimony, dissolved	0.006																			0.0371	0.0217								
Antimony, total	0.006																			0.0374	0.0244								
Arsenic, dissolved	0.010	0.041	0.0398	0.0376	0.0367	0.0394	0.0372	0.0366	0.0381		1.46	1.57	2.88	3.42	3.63	3.9	4.44	2.98	2.22	0.0789	0.106	0.0312	0.0304	0.0307	0.0317	0.0294	0.0309	0.0304	0.031
Arsenic, total	0.010	0.0366	0.0374	0.038	0.0368	0.038	0.0348	0.037	0.0352	0.0101	1.54	1.63	2.83	3.27	3.75	4.63	4.54	3.38	2.41	0.0799	0.107	0.0306	0.03	0.0296	0.0313	0.0283	0.0302	0.0268	0.0297
Chromium, total	0.1																												
Iron, dissolved	0.3*										55	54.6	113	146	163	189	200	131	92.2										
Iron, total	0.3*										47.4	47.6	111	139	156	186	201	129	88.9	0.52									
Lead, total	0.015																												
Manganese, dissolved	0.05*										0.57	0.532	1.05	1.28	1.31	1.53	1.67	1.29	0.93										
Manganese, total	0.05*										0.43	0.48	0.99	1.2	1.34	1.6	1.65	1.24	0.9										
Total Dissolved Solids (TDS)	500*										1130	1080	1570	1450	1640	1800	1850			830									
Sulfate	250*										578.3	541	941	1040	1070	1220	1200	830	1130	532									

MCL column has secondary MCL values indicated by an *		GW-4								PROD-1							PW-1							PW-4							
ANALYTE	MCL	3/14/13	6/17/13	8/6/13	11/21/13	3/18/14	6/27/14	9/11/14	11/21/13	3/17/13	6/20/13	8/13/13	11/22/13	3/16/14	6/24/14	9/16/14	3/26/13	6/17/13	8/6/13	11/21/13	3/18/14	6/25/14	9/11/14	3/14/13	6/17/13	8/6/13	11/21/13	3/18/14	6/25/14	9/11/14	6/25/14
Aluminum, dissolved	0.05*					0.06	0.07										0.08							0.08		0.07		0.11		0.08	0.08
Aluminum, total	0.05*	1.68	0.95	0.68	1.13	1.09	0.6	0.83	0.84								0.23		0.06	0.08				8.11	7.75	5.98	6.52	6.11	5.82	4.7	3.94
Antimony, dissolved	0.006																														
Antimony, total	0.006																														
Arsenic, dissolved	0.010	0.0119	0.0115	0.012	0.0118	0.0109	0.0109	0.0109	0.0119	0.0631	0.0604	0.0616	0.0629	0.071	0.0581	0.0624	0.0317	0.0309	0.0302	0.0315	0.0286	0.0313	0.0267	0.013	0.0126	0.0137	0.0133	0.0127	0.0131	0.0116	0.0129
Arsenic, total	0.010	0.0118	0.0118	0.0126	0.0116	0.0111	0.0114	0.0116	0.0113	0.061	0.0602	0.0598	0.0615	0.0589	0.0581	0.0579	0.0331	0.0307	0.0294	0.031	0.0282	0.0288	0.0304	0.0183	0.017	0.0168	0.0221	0.0148	0.016	0.0157	0.0148
Chromium, total	0.1																														
Iron, dissolved	0.3*																														
Iron, total	0.3*	0.59	0.36		0.42	0.41		0.36	0.33								1.04	0.68		0.32				7.99	7.3	5.82	23.5	6.06	5.96	4.85	3.98
Lead, total	0.015																														
Manganese, dissolved	0.05*													0.0513																	
Manganese, total	0.05*																							0.0971	0.0753	0.0689	0.1679	0.064	0.0602	0.0522	0.0509
Total Dissolved Solids (TDS)	500*																							570	590	550	540		510	510	
Sulfate	250*																														

The predominant water types appear to have a spatial distribution, attributed to local geologic conditions and areas of recharge/discharge. Predominantly Ca-HCO3 and Na/K-HCO3 water types are noted in areas hydraulically upgradient of the deposit and downgradient within the basin. Groundwater sampled from wells located hydraulically downgradient of the deposit appear to exhibit Na/K-SO4 and Ca-SO4 water types. The presence of calcium may be attributed to areas with basalt deposits, and sodium may be associated with volcanic tuff and sedimentary deposits. Sulfate may be associated with areas downgradient of the ore body and potentially attributed to longer residence times due to lower hydraulic conductivity and/or oxidation and leaching of the ore deposit.

The following conclusions are from Volume I of the Groundwater Report (Appendix B):

- Seven quarterly sampling events occurred from 2013 to 2014 in ten springs (when ample flow available) and twelve wells on a schedule in accordance with the Work Plan.
- After the development of 59762 and construction and development of GMW17-32 and GMW17-33, these wells were sampled during test pumping. Two additional development and sampling events occurred in GMW17-32 to obtain more representative results.
- Quarterly manual static water level or flow measurements were obtained from 24 monitoring wells and 11 background springs. The quarterly measurements were maintained from 2013 through 2018 for 19 wells and from the 3rd Quarter 2014 through 2018 for another five wells. Due to ownership changes, no monitoring occurred during the first and second quarters of 2016.
- Groundwater elevation trends appear relatively stable over time in wells throughout the Project Area, based on a monitoring period that spans several years. Some wells show influence of seasonal recharge, particularly during periods of above average precipitation. Other wells show fluctuations attributed to groundwater pumping or to drilling activities.
- Groundwater flow generally occurs from the southeast to the northwest in the vicinity of the Project, from higher elevations along the base of Grassy Mountain (~4,000 feet above mean sea level [amsl]) to lower elevations along Negro Rock Canyon (~3,200 feet amsl).
- Potentiometric surface maps based on shallow wells support a consistent flow direction without seasonally influenced variations. Groundwater flow appears to follow surface topography, generally to the northwest. The pattern of groundwater flow shows local variations attributed to the presence of faults, fractures, lithologic facies changes, vertical gradients, or some combination of these influences.
- Arsenic is present in groundwater within the Grassy Mountain vicinity. Concentrations exceeded the drinking water MCL at all of the 15 sampled well locations and at eight of the ten sampled spring locations.
- Other exceedances of the drinking water MCL included antimony (two samples), chromium (GMW17-32 prior to additional development), and lead (three samples, including one from GMW17-32 prior to additional development).
- Numerous samples from wells and springs exceeded the drinking water SMCLs for aluminum, iron, manganese, TDS, and sulfate. Most, but not all, exceedances for aluminum and iron appear to be associated with sediment in groundwater samples.

- Groundwater within the Grassy Mountain vicinity exhibits different water quality types (Ca-HCO3, Na/K-HCO3, or Na/K-SO4) based on spatial distribution, uted to subsurface lithology/facies characteristics.

VOLUME II

The geologic setting of the Project and surrounding area is an important factor in the groundwater flow. The aquifer system generally occurs within the Grassy Mountain Formation, described in Abrams (2018) as:

"Arkosic sandstones and channel-fill granite clast conglomerates. Mainly white to tan arkosic sandstones. Includes Tgsc, channel fill conglomerates with abundant granite and rhyolite clasts in the upper part of the unit. Uppermost conglomerates locally contain rounded obsidian clasts and rare black chert clasts. Unit Tgs generally becomes finer grained upward and includes white bentonitic clays near the top of the section which, where overlain by unit Tgb often generated large landslide masses. Hot spring activity contemporaneous with the deposition of the arkoses is indicated by sinter beds Tgsn, and sinter boulders containing silicified reeds and wood near the Grassy mountain gold deposit. Unit Tgs is the host for both the Grassy Mountain and Crabgrass gold deposits."

The monitoring well network describes the complex aquifer system:

- To the northeast of the Project at PW-1, the well log describes the water-bearing formation as brown clay and sand and coarse sandstone. The water-bearing zone is overlain by basalt and alluvium.
- To the south and west of the Project at GW-2 and GW-3, thick beds of clay were encountered to the completed depth of 400 feet. No water was encountered during drilling of the well, but water eventually entered the well.
- Farther to the southwest of the Project at 59763, the driller encountered tuff and rhyolite to a depth of 324 feet, with no water noted during drilling. The tuff and rhyolite were screened, and water eventually entered the well.
- To the west of the Project at GW-6, sand and clay with sandstone were encountered to 340 feet.
- To the northwest of the Project at GW-5, tuff was encountered to a depth of 260 feet.
- To the north of the Project at Prod-1, the water-bearing zone was sandstone with blue clay to a depth of 425 feet.
- Farther to the north at PW-4, layers of clay and sandstone were encountered to a depth of 375 feet, with sandstone being the water-bearing formation.

In and near the Project, most of the sedimentary units are silicified and strongly indurated (Abrams 2018). This silicification is noted in the exploratory drilling logs and the driller's logs for wells near the Project (59762, GMW17-31, GMW17-32, GMW17-33, and GMW18-34).

In 2012, a CSAMT survey was conducted by Zonge Geosciences Inc. While the intent of the CSAMT survey was for mineral exploration, the survey is also useful for locating areas of low permeability relative to groundwater flow. From the survey, values of high resistivity can be correlated to low porosity. In general, the silicification appears to have a negative effect on porosity and hydraulic conductivity as evidenced by wells and drill holes completed in the zone of silicification. Hydraulic conductivity increases moving away from the main Project.

The Project consists of highly silicified sediments of the Grassy Mountain Formation. The Project lithology is described by Abrams (2018):

"Silicification in the form of sinters and disseminated quartz is a prominent alteration type at Grassy Mountain and is largely controlled by hot-spring vents. Silicification occurs both pervasively as silica flooding, and as cross-cutting veins and stockworks. The silicified envelope has plan dimensions up to 3,000 feet (north-south) by 2,500 feet (east-west). Silicification is surrounded by widespread, barren, clay-rich (20- to 40-percent montmorillonite), tuffaceous siltstone and arkose with minor disseminated pyrite. Many of the sinters occur as sheets instead of mounds, which suggest that they are related to vents along faults rather than point sources."

The presence and quantity of groundwater within the Project can be described based on water reported during exploratory drilling, monitoring well construction and testing, and VWP water level data. The deeper wells screened below an elevation of about 3,200 feet are dry or poor producers. The monitoring well GMW18-34 drilled to a depth of 950 feet up-gradient of the Project did not encounter water during drilling in the spring of 2018. No water has been detected in the well since it was completed.

Groundwater elevations measured within the Project are often deeper than groundwater elevations measured immediately outside the Project. The deeper groundwater elevations, and associated large vertical gradients, are related to the geology of the Project. Specifically, decreased hydraulic conductivity associated with silicification, and the compartmentalization created by faulting, impedes groundwater flow into the Project from adjacent and upgradient portions of the Grassy Mountain Formation. Thus, the rate of groundwater flow into the Project is believed to be much less than the rate of flow through the permeable zones of Grassy Mountain Formation surrounding the Project.

The Project is located within an interpreted horst block, structurally affected by complex block faulting and rotation (Abrams 2018). From a two-dimensional perspective, faults surrounding the Project appear to act as lower permeable barriers to groundwater flow. There are typically higher flows south and east of the Badger and Schweizer faults and north of the Cherokee and Coyote faults. The geologic cross-sections in the Groundwater Report also provide insight into the effect of faulting on the presence of groundwater within the Project. These cross-sections help visualize the amount of compartmentalization caused by the significant amount of intersections between the faults and lower permeable sedimentary facies (clay, sinter, and siltstone). They also show the inconsistent nature of the encountered water during drilling.

Potentiometric surface maps are two-dimensional depictions of groundwater flow (See Groundwater Report, Volume II, Appendix B). In reality, groundwater flow occurs in three-dimensions. These maps, however, are useful for providing an indication of the overall, general groundwater flow direction and hydraulic gradient. Potentiometric surface maps of both shallow and deep surfaces are included in the Groundwater Report.

The horizontal hydraulic gradient is calculated from the change in groundwater elevation over distance between two locations. The shallow potentiometric surface generally shows a relatively high and somewhat uniform horizontal hydraulic gradient in the vicinity of the Project. The hydraulic gradient is a manifestation of flow resistance; higher gradients are an indication of higher resistance to groundwater flow. In the area of the Project, the high gradient most likely is a result of low hydraulic conductivity. The steep topography may also be a contributing factor. The gradient lessens where aquifer permeability increases in areas coinciding with flatter topography. The vertical hydraulic gradient is calculated from the change in groundwater elevation over difference in well completion depth.

Aquifer hydraulic properties in the vicinity of the Project can be estimated from aquifer pumping tests conducted during the late 1980s and early 1990s and more recently on 59762, GMW17-32 and GMW17-33 in 2017. The latter wells are located near the Project. Detail of the historic and recent pumping tests are included in the Groundwater Report (Appendix B). Overall, the historic and recent aquifer testing (i.e., PW-1, PW-4, Prod-1, GMW17-33) indicates that portions of the aquifer with higher transmissivity occur locally in proximity to the wells and that, as testing progresses over time, lower transmissivity regions are encountered based on negative boundary effects. These results suggest the conductive portions of the aquifer system are either compartmentalized or limited, with flow provided to wells initially via permeable zones (i.e., sand, sandstone, fractured basalt, etc.) that are limited in spatial extent.

Hydraulic conductivity in the vicinity of the Project increases to the north away from the Project, likely due to silicification in and near the Project. Testing of the most northern well, PW-4, suggests a hydraulic conductivity of approximately three feet per day (ft/d). Testing of PW-1, near the Project, suggests a hydraulic conductivity 100 times lower, approximately 0.03 ft/d. The deep wells 59762 and GMW17-32 exhibit low transmissivity and hydraulic conductivity assumed to representative of the silicified sediments at or near the Project, with hydraulic conductivities ranging from 0.0004 ft/d (GMW17-32) to 0.02 ft/d (59762). Estimates of hydraulic conductivity are sensitive to the assumed saturated aquifer thickness, with lower values obtained for thicker saturated aquifer extents. For the deep wells, the aquifer thickness is difficult to estimate as there is no information from drilling or lithology to develop an estimate. Based on previous investigations, aquifer thickness typically has been estimated on the order of 200 feet to 300 feet.

Drilling, test pumping, water level monitoring, and geophysical data all indicate that average hydraulic conductivities and corresponding aquifer transmissivities in the vicinity of the Project are very low. As a result, groundwater inflows to proposed mine workings should also be low.

A water balance is determined from the amount of groundwater recharge derived from infiltration during precipitation events and inflow from surface water and groundwater minus the amount of evapotranspiration and outflow from surface water and groundwater, accounting for any changes in storage (Fetter 1980). Available information to date on the water balance for the Grassy Mountain vicinity is largely based on previous investigations. Annual recharge to groundwater in the vicinity of Grassy Mountain has been estimated in the range of 0.25 to one inch based on climatic and topographic conditions (ABC 1992). Grassy Mountain serves as the groundwater divide between Negro Rock Canyon and the Owyhee River, supported by topography and geology. Ultimately Negro Rock Canyon discharges to the north to the Malheur River. While the Owyhee Reservoir and Owyhee River are the predominant regional drainage features near the Project, regional groundwater flow is to the north towards the Malheur River.

Geochemical characteristics of the groundwater (wells and springs) were evaluated using Trilinear diagrams and Stiff diagrams, with major ions expressed as mEq/L. These diagrams are useful for evaluating the geochemical signature of the water, to illustrate general differences in water chemistry using major ions, and to group waters with similar chemical signature into identifiable groups (or hydrochemical facies). Geochemistry results from all of the sampled springs and wells are presented in Volume I. The geochemical conclusions are presented above in the summary for Volume I.

The following are the geochemical interpretations based on the data presented in Volume I and Volume II of the Groundwater Report are:

- The aquifer to the east and northeast of the Project generally has a Ca-HCO3 signature, likely associated with volcanics.
- The aquifer immediately downgradient of the Project is predominantly a Na/K-SO4 water type. The presence of sulfate could be related to very low permeability near the Project and/or oxidation and leaching of the ore deposit (ABC 1992).
- Whiskey Spring exhibits geochemistry similar to the groundwater immediately downgradient of the Project. This spring appears to originate where the Kern Basin Tuff surfaces. Even though this spring is at a higher elevation than the presumed water surface within the Project and in a different hydrologic basin, the groundwater appears to be influenced by the same type of silicification associated with the Project.
- The groundwater located in the main regional flow system downgradient of the Project exhibits a Na/K-HCO3 chemistry. Sodium may be associated with volcanic tuff and sedimentary deposits.
- The data collected generally supports the idea of a single aquifer system, with chemistry influenced by lithology. Wells immediately downgradient of the Project exhibit the same geochemical signature and appear to be affected by the deposit characteristics, regardless of well depth.
- Groundwater farther from the Project also exhibits its own signature influenced by lithology, regardless of well depth.

- It is apparent that as the groundwater moves away from the volcanic formations it tends to decrease in calcium concentration.
- As groundwater moves away from areas with sulfate and the silicified areas of the Grassy Mountain Formation it tends to decrease in calcium concentration. The groundwater upgradient (or not in the downgradient path) of the groundwater flowing through silicified and mineralized sediments (Bishop, 59761, 59760, 59772, PW-1, and GW-1) has the least amount of sulfate. The groundwater downgradient of the silicified sediments (Prod-1, GQ-4, PW-4, GMW17-33) shows an increase in sulfate. Even though GMW17-33 is located near the Project, it is completed in the middle of what appears to be a section of unsilicified material. The wells located in silicified media appear to have the highest concentrations of sulfate and relatively the least desirable water quality from a drinking water standpoint. The trend of the cations presented on the trilinear diagrams indicates ground water movement throughout the aquifer system.

Summary of the conceptual model:
The aquifer system in the vicinity of the Project occurs within the Grassy Mountain Formation, generally consisting of arkosic sandstone, siltstone, and conglomerate. The unit includes interbedded fine-grained sediments. The Grassy Mountain Formation is the host unit for the Project. The unit is underlain by the Kern Basin Tuff, a fine-grained lithic tuff. Groundwater is typically found within the Grassy Mountain Formation in unconsolidated or weakly consolidated sandstone and conglomerate units and interbedded sediments. The water-bearing zones appear to be somewhat compartmentalized due to faults, sedimentary facies changes, and silicification in and around the Project.

Water levels in the area are typically stable, with some seasonal variations evident in shallow wells or wells otherwise subject to more direct recharge. There is some evidence of a general decline in the shallow aquifer zone in several wells in the vicinity of the Project, which may be due to inadequately sealed boreholes at or near the Project allowing shallow aquifer zones to drain to deeper zones. The observed decline is on the scale of a few feet over several years.

The Grassy Mountain Formation in and near the Project is silicified and strongly indurated. Geophysical data indicates that the zone of silicification increases with depth. Based on available information, a saturated zone occurs within the Project at an elevation ranging from 3,300 to 3,100 feet, which is above the expected maximum depth of the proposed mine (approximately 3,050 feet). However, this zone does not appear to be consistent throughout the Project. While portions of the Project are understood to be saturated, hydraulic conductivity and resultant groundwater flow appear to be severely restricted by silicification and/or faulting. Testing of GMW17-32 completed in silicified sediments near the Project suggests a very low hydraulic conductivity on the order of 10^{-6} to 10^{-7} centimeter per second (cm/s). A long recovery period after testing this well also is an indication of very low hydraulic conductivity.

Near the Project there are isolated pockets of less-silicified material with higher conductivity, and faults in these areas may act as conduits for groundwater flow. There is not an obvious relationship between groundwater occurrence and depth within the Project, suggesting a complex heterogeneous system heavily influenced by silicification and faulting. Given the location of the Project relative to the groundwater divide, the available groundwater recharge to the area appears to be limited as well. The silicified nature and faulting of the sediments in and around the Project has a strong effect on hydraulic conductivity but may also result in a strong downward vertical gradient within the aquifer system.

In the general area of the Project, faults appear to act as barriers to groundwater flow on the south and east sides but the true impact of faulting on groundwater flow is hard to differentiate from the effects of deposit silicification. The silicification and faulting seems to decrease the hydraulic conductivity of the arkosic sandstone but potentially increase the hydraulic conductivity of the underlying tuff. It is possible with the combination of the silicification, steeply dipping interbedded clay, siltstone, and sinter, and the faulting near the Project allows some groundwater from the Project to flow into (or through) the tuff.

The Kern Basin Tuff, like the Grassy Mountain Formation, surfaces at higher elevations on the southern and eastern sides of Grassy Mountain and dip towards the north and northwest directions towards Negro Rock Canyon.

Downgradient of the Project, the strata are less silicified, and the horizontal and vertical gradients are not as pronounced. It is still likely that horizontal and vertical connectivity between aquifer zones is affected by low permeability, discontinuous, interbedded layers of clay and siltstone. Hydraulic conductivity is higher downgradient of the Project, but lithologic variations and faulting affect groundwater flow and occurrence. Hydraulic conductivity values downgradient of the Project derived from test pumping are on the order of 10^{-3} cm/s to 10^{-5} cm/s, representative of sandstone and conglomerate aquifers. Consistent piezometric head in wells completed at different elevations would suggest a single aquifer system.

The geochemistry of the groundwater appears to be strongly influenced by lithology. The main regional aquifer displays a Na/K-HCO3 geochemical identity, associated with volcanic tuff and sedimentary deposits. Groundwater originating from volcanics shows a Ca-HCO3 signature. Water chemistry changes are evident in the immediate vicinity of the Project.

While limited in spatial extent and hydraulic connectivity, the water-bearing zones within the Grassy Mountain Formation are proposed to constitute a single, heterogeneous and locally complex aquifer system. This conclusion is supported by lithology, piezometric surface, and geochemical signature. The aquifer system is defined by low hydraulic conductivity and high hydraulic gradient in and near the Project and higher hydraulic conductivity and lower hydraulic gradient away from the Project. Groundwater conditions appear to be mostly influenced by silicification and/or faulting near the Project and sedimentary facies changes and faulting downgradient of the Project.

The aquifer system is characterized by the following:

- Groundwater is found within permeable sediments and fractured rock within the Project Area. The Grassy Mountain Formation, consisting of arkosic sandstone, conglomerate, and tuffaceous siltstone is the primary water-bearing unit.
- Although there are different piezometric surfaces near and within the Project, available data suggest a single aquifer system with high vertical gradients in upland areas, including the vicinity of the Project.
- Groundwater elevations in most wells within the project area are relatively stable over time, based on a monitoring period that spans several years. Some wells show influence of seasonal recharge, particularly during periods of above average precipitation. Other wells show fluctuations attributed to groundwater pumping or to drilling activities.
- Groundwater flow is to the northwest, from areas of higher to lower ground surface elevation.
- Potentiometric surface maps based on wells and VWPs support a consistent flow direction without seasonally influenced variations. The pattern of groundwater flow shows local variations attributed to the presence of faults, fractures, lithologic facies changes, vertical gradients, or some combination of these influences.
- Aquifer hydraulic conductivity is low within the immediate vicinity of the Grassy Mountain ore body, attributed low permeability materials (i.e., clay and siltstone, competent bedrock, and silicified deposits). Faults appear to generally function as negative hydraulic boundaries. Spatially discontinuous aquifer zones with higher permeability are apparent, particularly to the north of the Project, based on borehole drilling and aquifer testing. However, the apparent higher permeability is also thought to reflect compartmentalized aquifer conditions, within an overall aquifer of lower, aggregate permeability.
- The low hydraulic conductivity in the vicinity of the Project is anticipated to significantly restrict groundwater flows into underground mine workings. Groundwater supply for mining purposes will need to be developed away from the silicified zones in the proximity of the ore body.

The water quality is characterized as follows:

- Arsenic is present in groundwater within the Grassy Mountain vicinity. Concentrations exceeded the drinking water MCL at all of the 15 sampled well locations and at eight of the 11 sampled spring locations. Higher arsenic concentrations hydraulically downgradient of the Project are likely due to mineralized areas associated with the ore body.
- Other exceedances of the drinking water MCL included antimony (two samples), chromium (one sample), and lead (two samples).
- Groundwater within the Grassy Mountain vicinity exhibits different water quality types (Ca-HCO3, Na/K-HCO3, or Na/K-SO4) based on spatial distribution, attributed to subsurface lithology/facies characteristics and proximity to the Project.

Volume III

Underground mine workings developed as part of the proposed Grassy Mountain gold mine will intercept the regional water table and require dewatering. Pumping from wells outside the mine area to supply mine water demands will result in water table drawdown outside of the mine. This report describes modeling efforts used to characterize pumping rates required for dewatering and impacts from groundwater pumping for mine water supply.

Theoretical groundwater inflow rates into the mine workings are on the order of 20 gallons per minute (gpm) to 100 gpm for sustained pumping, and up to 500 gpm for short-duration pumping and reflect the wide span of aquifer parameters and model assumptions utilized for predictive analyses. Actual inflow rates of several tens to a few hundred gpm should be anticipated based on median aquifer parameters and model assumptions. Based on drilling observations (within the resource) and aquifer testing performed (outside the resource) to date, the higher-end range of potential inflow rates (associated with higher hydraulic conductivity) are unlikely to be encountered during mining activities and, if encountered, the associated high dewatering rates would be anticipated for relatively short durations (i.e., likely on the order of days or weeks). Due to the proposed underground mining approach, the entire groundwater table will not be intercepted at once. Rather, the exposure to groundwater is anticipated to be restricted to subsurface workings that encounter groundwater; where groundwater is present, such inflow can be managed or mitigated as the conditions arise.

The lower range of inflow rates represents longer-term predicted dewatering as steady-state conditions are approached and reflects lower overall permeability of the aquifer system over a greater area (and likely within the resource). The higher inflow rates reflect shorter-duration flow rates resulting from dewatering of zones with higher permeability that appear to be laterally discontinuous throughout the area based on borehole drilling and aquifer testing. Based on borehole drilling and well (aquifer) testing performed to date in the vicinity of the ore body, higher permeability areas are thought to more likely be encountered away from the silicified ore body (i.e., to the north of the ore deposit and in basin areas characterized by greater amounts of sediment as compared to silicified and/or competent bedrock deposits). Direct long-term testing of aquifer properties within the ore body has not been performed to date as verification, but extensive anecdotal evidence from mineral exploration drilling and the drilling on GMW18-34 supports the concept of low permeability materials within the near vicinity of the ore body.

These estimates are within the range of previous estimates prepared by ABC (1992) for an open pit mining scenario, on the order of 30 gpm to 3,000 gpm (described in Section 2.1 of the Groundwater Report [Appendix B]). Variations in the estimates are attributed to aquifer property assignment, model assumptions and techniques, and time frames evaluated.

Potential water level impacts caused by groundwater pumping for mine water supply (estimated to be 320 gpm for ten years) are projected to range from approximately zero to 12 feet of drawdown at the closest named spring (Lowe Spring) to the main production wells. The high end of impact is possible given the estimated aquifer properties if Lowe Spring is directly connected to the Grassy Mountain Formation aquifer from which the water is being produced from, and there are no compartmentalization affects caused by faulting. Drawdown effects are observed up to approximately 2 miles from the current highest producing well (PW-4), using a threshold of 0.5 feet of drawdown.

Calico seeks to characterize hydrogeology at the Grassy Mountain Project mine site to design dewatering and pumping systems. SPF Water Engineering, LLC (SPF), at Calico's request, has collected and compiled baseline hydrogeologic data (SPF 2019a) and developed a hydrogeologic conceptual model of the general mine area (SPF 2019b). This Groundwater Report describes the use of – and results from – analytical and numerical models to predict: 1) dewatering requirements of the active mine-site area; and 2) potential impacts of groundwater production on local groundwater levels.

Specific objectives of this modeling effort included the following:

- Identify and use appropriate analytical methods to predict dewatering pumping rate requirements and production well pumping groundwater-level impacts.
- Develop a numerical model to simulate groundwater flow in the vicinity of the Project.
- Simulate dewatering requirements and the effects of groundwater production on local springs using a range of hydraulic parameter values.
- Conduct sensitivity simulations to help evaluate uncertainty associated with hydraulic-parameter choices.

This modeling effort builds on a preceding conceptual model of groundwater flow (SPF 2019b) and supporting data sets. Other information used in developing the groundwater flow model includes the following:

- Monitoring Wells Completion Reports (SPF 2018a, SPF 2018b) – These documents present a summary of drilling, installation, and testing of three groundwater monitoring wells completed during 2017 and one additional upgradient monitoring well completed during 2018.
- Groundwater Resources Baseline Data Report (SPF 2019a) – This document presents a summary of groundwater baseline data collected since 2013, including groundwater levels, groundwater quality data from wells, spring discharge rates, and spring water quality data.
- Groundwater Characterization Report (SPF 2019b) – This document focuses on elements of the conceptual model. Specifically, the conceptual model report addresses the TRT Water Resources Subcommittee request for a conceptual model and specific questions raised about the conceptual model (Lynch 2014).
- Well Field Design Report (SPF 2019c) – This document provides a preliminary water supply evaluation, outlining projected water demands and proposed and existing water supply wells.

The numerical model simulating groundwater flow in the Grassy Mountain mine site area was built using existing hydrogeologic data. The existing hydrologic data are based on a limited number of measurements and observations. As such, the model and resulting projections has inherent uncertainty. Nonetheless, the model forms a foundation for incorporating future data, which, in turn, should reduce model uncertainty and improve model projections.

Two two-dimensional analytical methods were used to evaluate steady-state and transient dewatering effects:

- The steady-state two-dimensional method (Marinelli and Niccoli 2000) incorporated both horizontal shallow flow and vertical, deeper flow contributions into the resource area. This method uses two steady-state analytical solutions useful for predicting the groundwater inflow to a mine pit excavated below the water table. Although the proposed mining method is drift-and-fill (D&F), calculating the inflow to the entire Project area provides a conservative dewatering estimate. The total inflow rate was the sum of the estimated flow rate from both the horizontal and vertical flow components.
- The transient method used the Theis equation (Theis 1935) to simulate the effects of pumping on drawdown over time with distance from a pumping well. Assumptions inherent to the use of the non-equilibrium Theis equation are that the aquifer is homogeneous and isotropic, uniform in thickness and areal extent, and receives no recharge; the pumping well penetrates the full aquifer thickness; water removed by discharge is removed instantaneously; the pumping well is 100 percent efficient; laminar flow exists throughout the aquifer; and the water table or potentiometric surface has no slope. Some of these assumptions are rarely completely satisfied under field conditions, but this method is commonly used for evaluating pumping (or dewatering) questions. In this case, some of the assumptions are clearly not met (e.g., the aquifer is not homogeneous and isotropic, uniform in thickness and areal extent) but nonetheless use of the method gives insight to possible dewatering rates.

Numerical groundwater flow modeling under steady state and transient conditions was performed using the MODFLOW code (Harbaugh, A.W. et al. 2000). Developed by the USGS, MODFLOW is a finite difference code capable of simulating three-dimensional groundwater flow. The code allows for representation of greater complexity than the analytical methods described above and is commonly used for simulating groundwater flow.

In general, dewatering was simulated in the MODFLOW model by assigning pumping wells along the perimeter and inside the Project, and the groundwater elevation during pumping was compared to the target dewatering elevation. Pumping wells were assigned in the analytical and numerical models to simulate the overall magnitude of aggregate dewatering rates. In reality, dewatering of the underground workings may be performed by booster pumps, sumps, or dewatering galleries, as needed. A limited sensitivity analysis was performed to evaluate the effects of hydraulic conductivity, storativity, and recharge on the results.

The conceptual model described above in Volume II is used as a basis for the modeling in Volume III of the Groundwater Report. The presence and quantity of groundwater within the Project can be described based on water reported during exploratory drilling, monitoring well construction and testing, and VWP water level data. The quantity of water is that air-lifted from the hole during drilling; there is not an indication of duration of flow in the driller notes. Within the footprint of the Project, most of the drill holes did not encounter any water. Of the holes that did encounter water, flows were less than 25 gpm and often from a depth of more than 800 feet (below an elevation of 3,000 feet). When drill holes encountered water outside the Project, higher flows in excess of 50 gpm were occasionally noted, generally east of the Project. This area is typically less silicified, and it is also possible that the Badger and Schweizer faults act as barriers to groundwater flow on the east and south sides of the Project. Higher well yields are likely associated with less silicified materials. The deeper wells screened below an elevation of about 3,200 feet are dry or poor producers. GMW17-33 (screen interval 3,466-3,366 feet) is a moderately productive well; the well was test pumped at an average rate of 28 gpm for about two days before a negative boundary caused the pumping water level to reach the pump.

Two analytical approaches were used to evaluate potential dewatering needs; Inflows under steady-state conditions were projected using analytical equations by Marinelli and Niccoli (2000); inflows under transient conditions were evaluated using the Theis equation. Please refer to the Groundwater Report for the details, assumptions and calculations for each approach.

The steady-state analysis used potential groundwater inflow into the proposed mine workings, which were estimated from: 1) Shallow aquifer zones present at the same elevation as the mine workings; and 2) A deeper zone within the aquifer beneath the mine workings. Three general scenarios (i.e., 1, 2, and 3) were used to evaluate potential steady-state inflows. These scenarios are distinguished by low, intermediate, and high hydraulic conductivity values (ranging from 10-6 cm/s to 10-4 ft/d) for the shallow aquifer zone, and low hydraulic conductivity (10-6 cm/s, or 0.003 ft/d) for the deep zone (Table 37). These values reflect the typical measured range in transmissivity (and hydraulic conductivity) from historical and recent pumping tests.

The results suggest half an order of magnitude variation in the inflow rate between each of the three scenarios (i.e., approximately 25 gpm for Scenario 1; 80 gpm for Scenario 2; and 475 gpm for Scenario 3). Lowering the recharge rate did not significantly change the predicted inflow. Supporting equations for Zones 1 and 2 and calculations for each scenario are provided in the Groundwater Report (Volume III Appendices).

Transient analysis used the Theis analytical method (Theis 1935) yields a theoretical projection of potential drawdown effects associated with pumping to achieve mine dewatering over a period of time. In contrast, the steady state method described above does not account for variations in drawdown over time. Thus, the Theis method was used to evaluate the amount of time that may be necessary to dewater the mine workings to the target elevation of approximately 3,100 feet.

Table 37. Steady-State Estimated Groundwater Inflow Rates

Scenario	Description	Shallow Hydraulic Conductivity, K (Zone 1)	Deep Hydraulic Conductivity, K (Zone 2)	Recharge (in/yr)	Estimated Discharge (gpm)		
					Shallow (Zone 1)	Deep (Zone 2)	Combined Zones
1	Low K (shallow); High Rch	$1x10^{-6}$ cm/s (0.003 ft/d)	$1x10^{-6}$ cm/s (0.003 ft/d)	0.5	12	15	27
1a	Low K (shallow); Mid Rch			0.25	10	15	26
1b	Low K (shallow); Low Rch			0.07	8	15	23
2	Mid K (shallow); High Rch	$1x10^{-5}$ cm/s (0.03 ft/d)	$1x10^{-6}$ cm/s (0.003 ft/d)	0.5	70	15	85
2a	Mid K (shallow); Mid Rch			0.25	64	15	80
2b	Low K (shallow); Low Rch			0.07	53	15	68
3	High K (shallow); High Rch	$1x10^{-4}$ cm/s (0.3 ft/d)	$1x10^{-6}$ cm/s (0.003 ft/d)	0.5	501	15	516
3a	High K (shallow); Mid Rch			0.25	457	15	472
3b	High K (shallow); Low Rch			0.07	394	15	410

For this analysis, it was assumed that a single pumping well placed at the center of the mine workings could be used to evaluate the predicted drawdown at a distance from the pumping well that coincided with the perimeter of the mine workings. In reality, dewatering of the underground workings may utilize booster pumps or sumps placed as needed as opposed to a vertical well. Based on an approximate radius of 450 feet (roughly 0.1 mile), the pumping rate was adjusted to achieve the maximum projected drawdown of roughly 600 feet (i.e., 3,700 feet elevation minus 3,100 feet elevation) at 0.1 mile.

For scenario 2a, the most likely scenario (mid T, mid S), we assumed an aquifer transmissivity of 100 gallons per foot per day (gpd/ft), which is within the typical range based on aquifer testing (i.e., on the order of a few 10s to 250 gpd/ft, excluding PW-4 outlier), and storativity of 0.005 (upper range for confined conditions). Assuming a saturated aquifer thickness of 200 feet, the 100 gpd/ft transmissivity is equivalent to a hydraulic conductivity of 0.07 ft/day (2×10^{-5} cm/s) and is within the range of estimated values derived from pumping tests conducted within the vicinity of the resource area. The actual aquifer thickness varies across the resource area; however, this assumed value provides an upper end of expected drawdown. The storativity of 0.005 represents the upper range for confined aquifers (0.005 to 0.00005) based on literature reported values (Freeze and Cherry 1979).

Based on the Theis analysis, the predicted pumping rate needed to achieve the total drawdown in the pumping well was estimated to be roughly 250 gpm for one year. Actual drawdown effects will vary depending on actual aquifer conditions encountered within the resource area and the well efficiency. The predicted drawdown after one year of continuous pumping was approximately 600 feet at 0.1 mile from the pumping location in the center of the mine workings. Multiple scenarios were used to examine different hydraulic conductivity and storativity assumptions (aquifer thickness was assumed to remain the same). Results of the multiple scenarios are provided in Table 38 below.

Table 38. Theis Analytical Model Predicted Dewatering Flows

Scenario	Description	Transmissivity, T (gpd/ft)	Storativity, S (dimensionless)	Approximate Flow Required to Dewater 500 Feet at a Distance of 1 Mile After One Year (gpm)
1	Low T; Low S	4	0.00005	6
1a	Low T; Mid S	4	0.005	380
1b	Low T; High S	4	0.05	>1,000,000
2	Mid T; Low S	100	0.00005	80
2a	Mid T; Mid S	100	0.005	245
2b	Mid T; High S	100	0.05	1,450
3	High T; Low S	400	0.00005	260
3a	High T; Mid S	400	0.005	605
3b	High T; High S	400	0.05	1,600

The Theis method used for estimating dewatering rates was also used to project the aquifer impacts due to production well pumping over the life of the mine. The same limitations and assumptions described above for mine dewatering also apply to the estimation of aquifer impacts from production water pumping. The predicted drawdown from production well pumping calculated by the Theis analytical model is presented as Table 39 below.

Table 39. Theis Analytical Model Predicted Production Well Drawdown

Scenario	Description	Transmissivity, T	Storativity, S	Calculated Drawdown After Ten Years (feet)		
				One Mile	Four Miles	Seven Miles
1	Low T; Low S	1,500 gpd/ft	0.00005	172.92	105.31	78.33
1a	Low T; Mid S		0.0005	116.74	50.66	26.86
1b	Low T; High S		0.005	61.48	8.14	0.60
2	Mid T; Low S	4,000 gpd/ft	0.00005	73.84	48.44	38.23
2a	Mid T; Mid S		0.0005	52.74	20.45	17.83
2b	Mid T; High S		0.005	31.78	8.64	2.49
3	High T; Low S	10,000 gpd/ft	0.00005	32.89	22.73	18.63
3a	High T; Mid S		0.0005	24.45	14.32	10.31
3b	High T; High S		0.005	16.03	6.25	2.91

A numerical model was constructed to further evaluate potential dewatering requirements and groundwater production impact. The USGS code MODFLOW 2000 (Harbaugh, A.W. et al. 2000) was used for performing numerical groundwater flow modeling and dewatering projections. MODFLOW uses a modular finite-difference approach for simulating groundwater flow in three dimensions. MODFLOW is considered as the industry standard and is widely accepted within the hydrologic community for dewatering applications. Groundwater Vistas (GV) was used to construct and execute MODFLOW simulations. GV was developed by Environmental Simulations

Incorporated (ESI) as a graphical user interface for pre- and post- processing of MODFLOW files (ESI 2011). GV supports geographic information system (GIS) files for data visualization.

The model extent was approximately ten by ten miles, centered on the Project. The southern model boundary extended to portions of Owyhee Reservoir and the Owyhee River. The northern boundary extended north of Poison Creek. Eastern and western boundaries were set to comparable distances from the proposed resource and did not necessarily coincide with physical features. This domain was selected to minimize the potential effects of setting the boundary and assigned conditions too close to the proposed resource and thereby influencing the model's prediction of groundwater levels and drawdown from pumping in the resource area.

The model grid was comprised of 264 rows and 264 columns with uniform grid cell dimensions of 200 feet by 200 feet. The model was rotated 45 degrees counterclockwise to approximate the general, predominant direction of groundwater flow to the northwest in the vicinity of Grassy Mountain and the resource area. This rotation effectively allows groundwater flow to be simulated in three dimensions. The coordinate system for the model was North American Datum (NAD) 1983, State Plane Oregon, South, FIPS 3602 in feet with Lambert Conformal Conic projection.

The model consisted of three layers (layer 1, layer 2, and layer 3) defined to reflect topographic influences on groundwater flow:

- Layer 1 was typically 100 feet in thickness and formed the uppermost layer defined by the topographic surface. This layer represents surficial and shallow lithology and contains boundary conditions for select surface water features represented in the model (drain and river cells) described in the next section. Layer 1 was simulated as an unconfined layer (Type 3) condition, where transmissivity was allowed to vary.
    - The surface of the model was created from a digital elevation model (DEM) of topography with 30-meter resolution (USGS 2017). The USGS created the DEM from surface topography maps converted into digital format. Once the DEM was imported into the model, the top elevation of Layer 1 ranged from approximately 2,115 feet to 4,733 feet amsl.
- Layer 2 was the middle layer, intended to represent the shallow aquifer system and has a non-uniform thickness, ranging from less than 100 feet in lower- topography areas to nearly 1,000 feet at the center of the model. This layer contains most of the monitoring wells used as calibration targets for the model. This layer was assigned a uniform bottom elevation of 3,100 feet in the resource area as the target depth for dewatering. Pumping simulations were evaluated by comparing the predicted groundwater elevation to the 3,100-foot elevation level to assess magnitude of dewatering needs to achieve 100 percent dewatering in the resource area. Layer 2 was simulated as a confined (Type 0) condition.
- Layer 3 was the lowest layer in the model, with non-uniform thickness and an assigned uniform model base of 2,000 feet amsl. The bottom of this layer is implicitly a no-flow boundary. Layer 3 was simulated as a confined (Type 0) condition.

Numerical model simulations were performed under steady-state and transient conditions. The steady-state system reflects the groundwater flow regime once equilibrium has been established and does not account for changes in groundwater levels over time, which may occur on the order of decades or longer. Initial conditions were considered Layer 1. The boundary conditions considered are; constant head, river, drain, and no flow. The hydraulic properties assigned in the model are hydraulic conductivity, storativity and recharge. The model hydraulic conductivity is shown in Table 40. The storativity is shown in Table 41. The recharge is assigned to Layer 1 to simulate infiltration that reaches the groundwater table

Table 40. Model Hydraulic Conductivity (ft/d)

Zone	Description	Kx = Ky	Kz
1	Basin deposits (siltstone, sandstone, unconsolidated)	0.214	0.105
2	Alluvium (Qal, Qls)	5.57	2.18
3	Siltstone, sandstone (Tis)	0.676	0.347
4	Resistent topography and basalt	0.001	0.001
5	Altered zones (within and near deposit)	0.0031	0.0031
6	Rhyodacite dome	0.0007	0.0007
7	Deeper deposits and Kern Tuff (Tkt)	0.0025	0.0013
8	Higher topography region to south	0.0025	0.0025

Table 41. Model Storativity Values (Dimensionless)

Zone	Description	Specific Storage	Specific Yield	Porosity
1	Basin deposits (siltstone, sandstone, unconsolidated)	2.62E-04	0.30	0.20
2	Alluvium (Qal, Qls)	5.00E-03	0.13	0.30
3	Siltstone, sandstone (Tis)	5.00E-03	0.30	0.20
4	Resistent topography and basalt	5.00E-05	0.05	0.08
5	Altered zones (within and near deposit)	5.00E-05	0.11	0.10
6	Rhyodacite dome	7.14E-05	0.08	0.08
7	Deeper deposits and Kern Tuff (Tkt)	1.74E-03	0.30	0.06
8	Higher topography region to south	3.35E-03	0.05	0.06

Overall, the model simulates groundwater flow on a regional scale that generally follows topography. Groundwater flow from the resource area is predominantly to the northwest within the hydraulic basin north of Grassy Mountain. The model also represents the general direction of groundwater flow and horizontal hydraulic gradient within the resource area in the shallow zone, based on comparison of 2016 groundwater contours to model simulated heads within Layer 2. Model simulated contours are shown in blue, overlain on the 2016 contours in red. Layer 1 was predominantly dry in most areas of the model, attributed to the relatively thin layer, effects of boundary condition assignment in the model (particularly drains), and hydraulic conductivity values. For example, vertical hydraulic conductivity is not well represented in the model. Layer 3 does not contain head calibration targets; therefore, the overall degree to which model heads represent actual conditions could not be evaluated. However, the model does not simulate the observed heads in the deep wells and VWP units. In general, the model typically simulated measured heads within +/- 45 feet, with some outliers with more or less associated error. The lowest error was less than one foot, and the highest error was 113 feet. The targets assigned to Layer 1 also contribute to the errors in the model.

A limited sensitivity analysis was performed by varying hydraulic conductivity and recharge from the base model case. The purpose of the sensitivity assessment was to bracket the model predictions within a reasonable range of model input values. This analysis was used prior to transient calibration and the base target statistics are slightly different than values presented above. This evaluation was intended to provide some additional context for the model predictions. Four, separate scenarios were evaluated:

- Sensitivity Run 1 – Hydraulic conductivity for all zones was increased by 2x. This run resulted in model simulated heads under-predicting measured heads at all locations.
- Sensitivity Run 2 – Hydraulic conductivity for all zones was decreased by 2x. This run resulted in model simulated heads over-predicting measured heads at nearly all locations.
- Sensitivity Run 3 – Recharge was increased by 2x. This run resulted in model simulated heads over-predicting measured heads at all locations.
- Sensitivity Run 4 – Recharge was decreased by 2x. This run resulted in model simulated heads under-predicting measured heads at all locations.

The overall direction of groundwater flow is similar for all cases; however, the magnitude of the model errors is considerably greater compared to the base case model (Table 42).

The data collected from monitoring wells, VWP, and other bores drilled in and near the Project demonstrate that the groundwater flow in this highly faulted and silicified aquifer section is highly restricted, and water levels are relatively deeper than in wells completed further from the mine. In some of the silicified sections, the aquifer is unable to produce any water. This numerical model, calibrated to the shallower and more consistent surrounding well water levels, is meant to show a maximum amount of dewatering possible. It is likely, where water is encountered in the deeper zones of the Project, that the lower flows (57.5 gpm) modeled to keep the water levels down after the first 70 days of pumping will be more than adequate for dewatering. Due to the compartmentalized nature of the aquifer surrounding the mine, it is possible larger flows of water may be initially encountered for short periods (days or weeks).

Table 42. Summary Of Sensitivity Analysis

Statistic	Base Model	Sensitivity Run 1	Sensitivity Run 2	Sensitivity Run 3	Sensitivity Run 4
		2x greater hydraulic conductivity	2x lower hydraulic conductivity	2x higher recharge	2x lower recharge
Residual Mean	10.98	170.35	-249.03	-234.12	173.41
Absolute Residual Mean	45.83	176.96	278.72	260.13	180.01
Residual Std. Deviation	53.93	130.82	271.55	251.15	133.64
Sum of Squares	72,696	1,107,174	3,258,175	2,829,320	1,150,329
RMS Error	55.04	214.78	368.45	343.35	218.93
Min. Residual	-78.98	-74.42	-686.52	-648.67	-74.42
Max. Residual	113.94	406.12	113.94	113.94	412.36
Number of Observations	24	24	24	24	24
Range in Observations	498	498	498	498	498
Scaled Residual Std. Deviation	0.11	0.26	0.55	0.50	0.27
Scaled Absolute Residual Mean	0.09	0.36	0.56	0.52	0.36
Scaled RMS Error	0.11	0.43	0.74	0.69	0.44
Scaled Residual Mean	0.02	0.34	-0.50	-0.47	0.35

The data collected from monitoring wells, VWP, and other bores drilled in and near the Project demonstrate that the groundwater flow in this highly faulted and silicified aquifer section is highly restricted, and water levels are relatively deeper than in wells completed further from the mine. In some of the silicified sections, the aquifer is unable to produce any water. This numerical model, calibrated to the shallower and more consistent surrounding well water levels, is meant to show a maximum amount of dewatering possible. It is likely, where water is encountered in the deeper zones of the Project, that the lower flows (57.5 gpm) modeled to keep the water levels down after the first 70 days of pumping will be more than adequate for dewatering. Due to the compartmentalized nature of the aquifer surrounding the mine, it is possible larger flows of water may be initially encountered for short periods (days or weeks).

A transient model was used to predict aquifer drawdown and associated impact to springs. However, there are other factors to consider when attempting to predict impacts to springs, including source water characteristics (i.e. geochemistry), geology, and elevation differences.

Due to the geochemical signature of Lowe Spring being different from PW-4, and because the location of Lowe Spring is near the contact between the different geological units (SPF 2019b), it is anticipated there may be less hydraulic connection between the production wells and the source of Lowe Spring; therefore, the modeled drawdown is probably conservative. Using similar reasoning, Poison Spring is more likely to be affected by the production well pumping because Poison Spring has a similar geochemical signature as PW-4; thus, the model might under predict impacts to Poison Spring.

The following points summarize the results and conclusions from this investigation:

1. The conceptual model for groundwater flow at Grassy Mountain provides the basis for the dewatering estimates. The current model suggests a single aquifer system as a function of scale, supported by the relatively uniform, shallow and deep potentiometric surface (at a high-level view) and correlation with groundwater elevation and depth. On a local scale, heterogeneity effects are apparent, attributed to local variations in hydraulic properties, facies changes, and/or the occurrence of faults/fault zones.

2. Estimated analytical steady-state bulk dewatering rates on the order of 20 gpm, with the potential to intercept up to 500 gpm on a short-duration basis (i.e., days to weeks), are anticipated based on the analytical approach.

    a. The low-end estimate reflects lower permeability in the range of $1x10^{-6}$ cm/s (or 0.003 ft/d) anticipated directly within the resource area. Due to the expression of individual faults or fault zones, the actual permeability may be more or less. SPF is not aware of direct testing of hydraulic conductivity or transmissivity based on aquifer pumping tests within the resource area to date to confirm this estimate. However, the results of pumping tests performed around the perimeter of the resource extent support an aggregate lower hydraulic conductivity within this magnitude due to limited yields and negative boundary conditions.
    b. The high-end estimate reflects higher hydraulic conductivity that may be more representative of basin conditions (i.e., unconsolidated and consolidated sedimentary deposits) and short-duration inflows into the resource area (i.e., faults and fractures serving as conduits for flow) that could potentially be intercepted during the mining activities. The anticipated hydraulic conductivity may be on the order of $1x10^{-4}$ cm/s (0.3 ft/d). This condition may arise from contributions from local zones of higher permeability that are effectively dewatered in early time. As the cone of depression or radius of influence extends from the theoretical pumping well(s) with time, the overall aquifer properties are expected to produce less water due to overall lower permeability effects.

3. The dewatering evaluation also examined potential groundwater inflow rates using transient analytical methods.

    a. The transient analytical (Theis) method was used to estimate the predicted dewatering rate of approximately 250 gpm to 600 gpm, assuming a single pumping well scenario, placed at the center of the Project. The theoretical drawdown effects at the perimeter of the Project were evaluated after one year of continuous pumping to produce 600 feet of drawdown (assuming an initial groundwater elevation of 3,700 feet for upgradient conditions and an assumed dewatering elevation of 3,100 feet). The higher flow rate range is consistent with anticipated short-duration inflow amounts over the span of days to weeks.

4. A three-dimensional numerical groundwater flow model was constructed and executed using MODFLOW to evaluate potential dewatering rates under steady- state and transient conditions.

    a. The model was constructed at a ten by ten-mile resolution, centered on the Project, with three layers. Regional and local groundwater flow conditions were simulated based on a distribution of hydraulic conductivity and storativity (informed by geologic mapping and the results of aquifer pumping tests), recharge from surface infiltration predominantly in higher elevation regions, and assignment of boundary conditions to reflect physical boundaries to the extent possible (including Owyhee Reservoir, Owyhee River, and select spring features).
    b. The steady state model dewatering was simulated by placing wells along the Project perimeter and assigning uniform pumping rates to achieve dewatering to the 3,100-foot elevation. Four wells were simulated at five gpm each for 20 gpm total pumping requirements under steady-state conditions, resulting in a pumping level elevation of approximately 2,950 feet to 3,100 feet.
    c. The transient model dewatering was simulated by placing four wells around the perimeter and one well in the center of the Project and pumping a total 480 gpm for 70 days and 57.5 gpm for the remaining lifetime of the mine (approximately ten years). The higher rate pumping for 70 days was able to lower water level elevations to less than 3,050 feet and the lower rate pumping initially allowed minor recovery then lowered the water levels to a range of elevations from 2,700 to 2,870 feet.
    d. The three-dimensional numerical model was created as a regional model for a baseline analysis of dewatering needs. This model was calibrated using the regional water levels. The deeper water levels located near the proposed mine and other highly silicified and compartmentalized areas are not represented in the model. The conceptual model report (SPF 2019c) discusses these deeper water levels and potential causes. Currently, there are no wells or piezometers completed in the highly silicified region encompassing the proposed mine that have a static water level higher than 3,200 feet amsl. Drillers have indicated flows of up to ten gpm in only three of the exploratory bores drilled in the proposed mine at depths shallower than 3,200 feet amsl. Only two of the exploratory bores in the proposed mine had a reported static water level shallower than 3,200 feet amsl. Due to its silicified and compartmentalized nature, the amount of water that flows through the proposed mine area is significantly limited. The three-dimensional numerical dewatering model does not account for this limitation and should be used as a worst case estimate for the maximum flow that would be required to dewater the proposed mine in its entirety.
    e. The planned mining method is D&F. This method used in the compartmentalized aquifer located at the Project will decrease the total volume of material requiring dewatering.

5. The transient model was also used to evaluate the drawdown effects of the dewatering wells and the mine operation production wells on the aquifer and nearby springs. Lowe Spring is approximately one mile away from the nearest proposed pumping well (Well 5) and had a predicted maximum drawdown of approximately 12 feet. Approximately 1.75 miles away, Poison Spring has a maximum predicted drawdown less 0.5 feet. The water sampled from Poison Spring has a similar geochemical characteristic as PW-4, while Lowe Spring shows a more volcanic geochemical signature. The geochemical signatures indicated Poison Spring may be affected by the groundwater production more than modeled and Lowe Spring may be affected less than modeled.

6. The dewatering and drawdown estimates reflect inherent uncertainty, both in the available datasets and necessary simplifying assumptions for representing a complex system. Therefore, these results are considered appropriate for baseline-level planning.

7. The accuracy of representing predominant groundwater flow paths and estimates of potential groundwater inflow depends on the sufficiency and accuracy of supporting data and assumptions. This process is inherently uncertain with respect to the conceptual model, translation of the conceptual to analytical and numerical models, and interpretation of results. Simplifying assumptions are necessary throughout this process. The level of accuracy is considered appropriate for a baseline estimate. Overall, the magnitude of dewatering estimates generated during this investigation on the order of 20 to 100 gpm for long-duration pumping, and up to 500 gpm for shorter-duration pumping (days to weeks) are within the range of previous investigations that used different methods.

2.9 Land Use

The Grassy Mountain Mine Project Land Use Baseline Report (Appendix B) was submitted to DOGAMI on January 26, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. Seventy-one percent of the land in Malheur County is federal land that is administered by the BLM (Oregon Partnership for Disaster Resilience [OPDR] 2014). The 2002 Southeastern Oregon Resource Management Plan and Record of Decision (SEORMP) indicates that the Land Use Study Area does not include any BLM-administered land that the BLM has identified for disposal. The SEORMP shows that the Land Use Study Area supports the Oregon-Idaho Graben, which is an area that the USGS identifies as most likely to contain large gold deposits. A BLM-identified transportation and utility corridor passes along the southern limit of the Land Use Study Area. There is one recreation area near the Land Use Study Area, a primitive campground at Twin Springs. Dispersed recreation is allowed throughout the Land Use Study Area. The SEORMP indicates that the mining and processing proposed as part of the Project would be an allowable use of BLM-administered land.

The Land Use Study Area is zoned Exclusive Range Use (ERU) and Exclusive Farm Use (EFU) in the Malheur County Code (MCC). The County's land use zone maps reflect these designations (C-A1: EFU, and C-A2: ERU). The Oregon Revised Statutes 215.283 and 215.296 define the allowable uses on ERU-designated land; allowable uses are reiterated in the MCC. In some cases, the allowable uses are conditional and must receive a conditional use authorization from the County within which the ERU land is located. Land in and near the Land Use Study Area is currently used for grazing and dispersed recreation and supports an existing road network that provides local access. Grazing is a farm use and is allowed by right in the Land Use Study Area. The state and local statutes do not address dispersed recreation (the MCC addresses developed recreation facilities such as parks and playgrounds). Most of the land is administered by the BLM, so dispersed recreation is managed in accordance with BLM policies.

The BLM has not yet identified any potential issues with the SEORMP or other specific requirements for implementing the portions of the Project that are on BLM-administered land and subject to BLM authorization. Mining and accessory infrastructure proposed as part of the Project is an allowed use of BLM-administered land in and near the Land Use Study Area if the Project can be developed in a manner that protects other sensitive resources, per the SEORMP energy and mineral resource objectives. A review of the resource information and SEORMP indicates that the Land Use Study Area does not support any areas of critical environmental concern, wild and scenic rivers, wilderness study areas, sage grouse lek sites, or riparian conservation areas. Information in the SEORMP indicates that portions of the Land Use Study Area are in or near areas that are open to mining but subject to operational timing limitations. Factors that would affect the operational timing limitations include proximity to occurrences of special status plants and mule deer winter range. Surveys of the Permit Area and a two-mile radius did not locate any threatened or endangered species.

OAR 632 Division 37 requires the Project proponent to receive an operating permit from DOGAMI to establish the mine and related processing facilities. A baseline study is one of several studies that the proponent must complete as part of its application for an operating permit. As it reviews the proposed Project, DOGAMI will identify potential issues, and the proponent would work with DOGAMI and other state agencies to address such issues, such as ensuring the proposed uses are compatible with surrounding land uses and develop and implement mitigation for potential conflicts, if necessary.

DOGAMI can only issue a permit if the proposed Project also receives local approval. In the case of this Project, the local approval involves upgrades to county-maintained roads. By working closely with the state and Malheur County, the proponent will develop an operating and reclamation plan that avoids or minimizes land use conflicts at the time of mine operation and in the years following closure.

The most substantial potential for conflict with local land use policies and regulation is related to how the proposed Project would affect ongoing grazing use that is a by-right use of ERU-zoned land upon which the Project is located. All potential Project conflicts with ERU use would be addressed through the Project's permitting processes.

As it considers the proposed Project, the County will apply guidance in the Comprehensive Plan (relate Project findings to County policy and ordinances) and evaluate whether the proposed Project would not interfere with current ranching practices, and that it complies with the County code. The County approved the Conditional Use Permit on May 23, 2019 and issued the Land Use Compatibility Statement to Calico on July 30, 2019.

2.10 Noise

The Grassy Mountain Mine Project Noise Baseline Report (Appendix B) was originally submitted to DOGAMI on October 5, 2018, then again on December 6, 2018, and February 13, 2019. The report was accepted by the TRT on March 1, 2019, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The following four ambient noise monitoring sites were chosen to represent the ambient noise environment in the Noise Study Area: Site A – an undeveloped location on BLM land approximately 170 feet west of Twin Springs Road and approximately three miles south of the intersection of Twin Springs Road and Cow Hollow Road; Site B – Lake Owyhee State Park, approximately 250 feet west of Fisherman Road (the access road into Indian Creek Campground) and approximately 600 feet south of the gate entrance into Indian Creek Campground; Site C – a site within the Mine and Process Area, approximately 375 feet southwest of the entrance gate and 150 feet west of an unnamed access road; and Site D – a residence located at 2025 Bishop Road, approximately 250 feet east of Russell Road. Table 43 summarizes the ambient noise measurement results.

Table 43. Ambient Noise Summary (dBA)

Metric	L_{eq}	L_{max}	L_{min}	L_1	L_{10}	L_{50}
Site A: Undeveloped location along Twin Springs Road						
Daytime Minimum	27.2	49.4	17.4	35.8	26.6	19.2
Daytime Average	35.9	58.3	19.0	45.7	39.1	30.3
Daytime Maximum	49.0	73.8	24.8	59.8	53.2	40.0
Nighttime Minimum	20.6	40.2	17.1	27.7	19.7	17.8
Nighttime Average	29.1	51.4	19.0	38.2	31.0	24.8
Nighttime Maximum	39.8	65.4	22.3	50.1	43.5	37.5
Site B: Lake Owyhee State Park						
Daytime Minimum	22.4	37.9	17.3	29.4	25.0	20.3
Daytime Average	28.1	49.7	20.2	37.9	28.5	24.0
Daytime Maximum	41.6	71.9	26.3	54.7	37.3	35.2
Nighttime Minimum	19.3	32.1	17.2	23.4	20.3	18.1
Nighttime Average	29.9	45.4	23.6	34.9	32.1	28.3
Nighttime Maximum	38.1	55.8	31.4	48.6	43.7	37.0
Site C: Grassy Mountain Mine and Process Area						
Daytime Minimum	32.5	55.5	17.1	44.2	28.8	20.7
Daytime Average	40.4	67.3	20.6	51.7	40.7	31.2
Daytime Maximum	56.7	94.4	31.9	64.7	56.0	46.8
Nighttime Minimum	19.3	40.8	16.9	23.8	20.2	17.9
Nighttime Average	26.6	50.7	18.4	34.2	27.4	22.5

Metric	L_{eq}	L_{max}	L_{min}	L_1	L_{10}	L_{50}
Nighttime Maximum	48.8	81.3	21.9	53.4	41.7	30.2
Site D: 2025 Bishop Road, Vale, Oregon						
Daytime Minimum	30.8	52.1	20.2	40.5	32.0	26.2
Daytime Average	37.8	60.0	24.5	47.1	39.8	33.2
Daytime Maximum	50.7	77.7	36.4	58.9	54.2	48.2
Nighttime Minimum	28.6	48.6	23.3	33.1	30.1	27.3
Nighttime Average	40.8	58.9	30.3	48.4	41.8	37.4
Nighttime Maximum	69.8	92.5	36.0	86.2	50.6	45.1

dBA = A-weighted decibel; L_{eq} = hourly average levels; L_{max} = hourly maximum levels; L_{min} = hourly minimum levels; L_1 = noise levels exceeded for one percent of each hour; L_{10} = noise levels exceeded for ten percent of each hour; L_{50} = noise levels exceeded for 50 percent of each hour
Daytime = 7:00 A.M. to 10:00 P.M.
Nighttime = 10:00 P.M. to 7:00 A.M.

At Site A, the undeveloped location along Twin Springs Road, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, occasional vehicular traffic, and bird activity (song and movement).

At Site B, Lake Owyhee State Park, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, vehicular traffic, boating activity on the lake, occupied campground activity, and bird activity (song and movement). At night, an added contributor was insect activity around the lake and although audible, was not excessive in loudness nor duration and should not have an impact on the proposed ambient noise limits.

At Site C, within the Permit Area, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, and bird activity (song and movement). Although not necessarily quantifiable by the weather data obtained at ground level, some fluctuations in the measurement data can be explained by upper atmospheric wind gusts/turbulence. There were no anthropogenic noise sources in the vicinity of Site C when the measurements were taken.

At Site D, the residential site along Russell Road, the primary noise contributors included atmospheric (wind) movement, vegetation movement caused by the wind, vehicular traffic along Russell Road and some along Bishop Road, and agricultural activity including irrigation pumping equipment and field implements. On two separate occasions, an irrigation pump was in operation, at 6:00 A.M. on the second day and at 6:00 A.M. on the third day, both instances for less than a one-hour measurement interval. The noise contributions from the irrigation pump can be seen in the L_{10} data as a three decibel (dB) increase on the second day and a five dB increase on the third day, and in the L_{50} data as a one dB increase on the second day and a three dB increase on the third day. At 4:00 P.M. and 5:00 P.M. on the third day, a tractor worked in a field to the southwest of the irrigation pump. These noise contributions can be seen in the L_{10} data as a seven to 12 dB increase, and in the L_{50} data as an eight to ten dB increase. Over the course of 72 single hour duration measurements at Site D, the irrigation pump only impacted two intervals, and the tractor activity also only impacted two intervals; therefore, noise from these two sources would only occur sporadically.

The results show that there is both diurnal variability and a reasonable amount of general variability from hour to hour within both the daytime and nighttime periods at all sites. L_{max} levels are typically higher during the daytime, indicating that the loudest noise sources are likely to be man-made sounds. Average daytime L_{eqs} are lowest at the Lake Owyhee State Park and highest in the proposed Mine and Process Area. Nighttime average L_{eqs} are lowest in the proposed Mine and Process Area and highest at the Bishop Road site. Average daytime and nighttime observed L_{50} levels at all sites range from approximately 22 dBA in the proposed Mine and Process Area to 37 dBA at the Bishop Road site.

Generally, noise levels in the Permit Area are low with L_{eq} levels at 57 dBA or below at all times, except for a nighttime spike at the residential site on Bishop Road, which occurred at 6:00 A.M. with the use of farming equipment near the road. The quietest site is at Lake Owyhee State Park, with the Mine and Process Area being the quietest during daytime hours, and the Bishop Road site being the loudest during nighttime hours. The calculated day-night noise levels (L_{dn}) at the residential site on Bishop Road was approximately 51 dBA for the first 48-hour period, with the calculated L_{dn} rising to 66 dBA on the third day due to the use of farming equipment.

A review of the lowest measured ambient noise levels indicates that only a few measured values approach the self-noise limits of the sound level meter (SLM). The SLM self-noise limit was measured at approximately 18 dBA. At three of the four monitoring locations (sites A, B, and C), the lowest nighttime L_{50} measured was between 17.8 dBA and 18.1 dBA. These values approach the self-noise limit of the SLM; therefore, actual ambient sound levels could have been quieter than the data indicate during those periods. However, at the two measurement locations that are near noise sensitive properties (Sites B and D), there were only three measured nighttime L_{50} values below 20 dBA (18.1, 19.0, and 19.2 dBA), all of which occurred at Site B. Only one of those hours approached the self-noise limit of the SLM, so the measurements are deemed to provide a valid representation of the existing ambient noise levels for the Project.

The representative ambient noise levels measured at the only two identified noise sensitive properties near the Noise Study Area are summarized in Table 44. The values in Table 33 were obtained using the statistical 5^{th} percentile in each data category. The statistical 5^{th} percentile was used rather than the L_{min} in each data category so that the representative levels would approach the lowest levels measured at each site without being biased by outlying quiet hours that occurred over the three-day measurement period. The proposed limits at the two sites (Table 45) are the representative ambient noise levels with the ten-dBA increase described in the ODEQ regulations.

Table 44. Representative Ambient Noise Levels Measured at Noise Sensitive Properties

Site	Daytime		Nighttime	
	L_{10}	L_{50}	L_{10}	L_{50}
Site B	25.6	22.4	21.3	19.1
Site D	34.0	26.7	30.2	28.1

Table 45. Proposed Ambient Noise Limits for the Project

Site	Daytime		Nighttime	
	L_{10}	L_{50}	L_{10}	L_{50}
Site B	35.6	32.4	31.3	29.1
Site D	44.0	36.7	40.2	38.1

2.11 <u>Oregon Natural Heritage Areas</u>

The Grassy Mountain Mine Project Oregon Natural Heritage Resources Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on August 15, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. There are no natural heritage resources in the Permit Area. The closest natural heritage resource to the Permit Area is the Succor Creek State Natural Area approximately 16 miles from the Permit Area. The next closest is the Crooked Creek State Natural Area approximately 61 miles from the Permit Area.

2.12 <u>Outstanding Natural Areas</u>

The Grassy Mountain Mine Project Outstanding Natural Areas Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on June 29, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The BLM list identifies only one Outstanding Natural Area (ONA) in Oregon: the Yaquina Head ONA, located along the coast in Newport, Oregon (BLM 2016). Additional internet searches also identified the Diamond Craters ONA (BLM 2018). The Diamond Craters ONA is located approximately 77 miles southwest of the Permit Area.

2.13 <u>Recreation</u>

The Grassy Mountain Mine Project Recreation Baseline Report (Appendix B) was submitted to DOGAMI on January 11, 2018. The report was accepted by the TRT on March 15, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Recreation Opportunity Spectrum (ROS) is a BLM-created conceptual framework for recreation managers to inventory, plan, and manage recreation resources on BLM land. The ROS provides a way to characterize either the capability of a resource to provide an experience, or the demand for an experience in terms of the activity opportunity and setting opportunity provided or demanded. There are two ROS classes in the Recreation Study Area: Rural and Semi-primitive Motorized. These classes are described in Table 46.

Table 46. Recreation Opportunity Spectrum Classifications in the Recreation Study Area

Classification	Description
Rural	This is a substantially modified environment. Resource modifications and utilization practices are to enhance specific recreation activities. Facilities are designed for use by a larger number of people. Motorized use and parking opportunities are available. The probability of user interaction is moderate to high, as is the convenience of sites and opportunities. These factors are generally more important than the physical setting. Wildland challenges and testing of outdoor skills are generally important. Activities may include interpretive services, swimming, bicycling, recreation cabin use, and skiing.
Semi-primitive Motorized	This is a predominately natural or natural-appearing environment of moderate to large size. User interaction is low, but there is evidence of other users. Minimum on-site controls and restrictions may be present. Use of motorized vehicles is permitted. There is a moderate probability of experiencing isolation, closeness to nature, and self-reliance in outdoor skills. Activities may include boating, motor biking, specialized landcraft use, mountain climbing, driving for pleasure, camping, and picnicking.

Resource-dependent recreation use, including driving for pleasure, camping, picnicking, hiking, hunting, scenery viewing, nature studies, rockhounding, and all-terrain vehicle (ATV) use are all popular activities occurring within the Recreation Study Area. Twin Springs Campground is the only designated recreation site in the vicinity of the Study Area, and it is commonly used for dispersed recreation activities such as hunting, rockhounding, and ATV use; however, the campground is located outside the Recreation Study Area boundaries.

2.14 Socioeconomics

The Grassy Mountain Mine Project Socioeconomics Baseline Report (Appendix B) was submitted to DOGAMI on February 21, 2018. The report was accepted by the TRT on July 20, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Socioeconomics Study Area is Malheur County, which includes the cities of Vale, Nyssa, Ontario, Adrian, Jordan Valley, and other unincorporated communities. Malheur County is Oregon's second largest county in the area but is largely undeveloped. The County is in the southeastern corner of the State of Oregon and is crossed by two major rivers, the Snake River and the Malheur River. Ninety-four percent of the County is undeveloped rangeland, most of which is federally administered by the BLM. Developed areas along the Snake and Malheur Rivers support agricultural production areas and agriculture-focused communities.

The County's population centers consist mostly of its incorporated cities (Ontario, Vale, Nyssa, Adrian, and Jordan Valley). Several unincorporated communities are also located within the

County. Malheur County's population has grown slowly and includes periods of net population gain and loss.

Malheur County has a slightly higher percentage of people 18 years of age and younger than the State as a whole, but its proportion of residents age 65 and older is about the same as the State. Females make up a smaller proportion of the population than the State as a whole. The County is not very racially diverse; 86 percent of residents are white. Median household incomes are substantially lower in Malheur County than in the State as a whole, and median values of owner-occupied homes are lower in Malheur County than the State. Approximately 38 percent of residents have a high school diploma and approximately 34 percent have completed some college. The rates of residents having a high school diploma are higher than the State as a whole, but the rates of residents having completed some college are lower than the State as a whole. The rate of college graduates is lower than the State as a whole (U.S. Census Bureau 2016e).

Most residents speak English at home. Approximately 24 percent of the County's residents primarily speak a foreign language, with Spanish the most prevalent. Approximately 32 percent of County residents identify themselves as being of Hispanic or Latino ethnicity (regardless of race). This rate is higher than the State, which reports a Hispanic or Latino proportion as approximately 12 percent of the total population.

The County has 11,629 housing units, with 88.5 percent occupied and 11.5 percent vacant. These rates are similar to those for the State as a whole. Of the occupied households in the County, 59.7 percent are owner-occupied, and 40.3 percent are renter occupied. Owner-occupied homes have a slightly higher average household size than renter-occupied units. Approximately 40 percent of all housing units are in Ontario (U.S. Census Bureau 2016f). Single family housing units are the most common type of housing in the County, comprising approximately 65 percent of the total. Multifamily housing units make up approximately 17 percent and mobile homes comprise approximately 18 percent of the total units in the County.

The median age of Malheur County real estate is 41 years, which is only four years older than the national median age of 37 (Sperling's Best Places 2017). Over half of the householders in the County and statewide have been in the same home since the 2000 through 2009 period. When compared to the state, Malheur County has a higher proportion of long-time householders in the same home (since 1980 or earlier) (U.S. Census Bureau 2016f). The median home sale price peaked in February 2009 at $174,100 (Zillow 2017). Most owner-occupied homes in the County are valued between $50,000 and $99,999, with the median home value being $127,000. These values are significantly lower than the same metrics for the state as a whole. The statewide median value is over $100,000 more at $237,300 (U.S. Census Bureau 2016g).

The median rent for Malheur County ($604) is lower than the state median ($907). Most renters (approximately 63 percent) in the County pay between $500 and $999 per month. Statewide, most renters (about 51 percent) also pay between $500 and $999 per month. When compared to statewide renters, a larger proportion of Malheur County renters pay less than $500 per month (approximately 32 percent for County renters compared to approximately nine percent of statewide renters) (U.S. Census Bureau 2016f).

For 2016, the U.S. Census Bureau estimated that the total civilian labor force (people aged 16 years and older and able to work) in Malheur County was approximately 11,936 people. Of these people, most of the unemployed individuals were age 16 to 19 years; approximately 28 percent of this population was estimated to be unemployed. People aged 20 to 24 years had the second highest unemployment rate, with approximately 18 percent of them being unemployed. For people living in poverty, the unemployment rate was approximately 31 percent in 2016. For disabled persons, approximately 21 percent were unemployed in 2016 (U.S. Census Bureau 2016h).

Malheur County October 2017 labor market information from the Oregon Employment Department (OED) shows that over-the-year employment increasing for manufacturing, professional/business services, retail trade, and mining/logging/construction services. The trends show reductions in private education/health services and local government (OED 2017a). In 2016, the average annual wage was $33,851, which is the lowest of the three southeastern Oregon counties (Grant, Harney, and Malheur) (OED 2017b).

The County does not provide water and sewer services. For unincorporated areas of the County, the Environmental Health Department issues on-site septic system permits, runs the Licensed Facility Program and Drinking Water Program, and oversees the County Solid Waste Program. The Cities of Ontario, Nyssa, and Vale provide specific services to their residents such as domestic water, wastewater, storm drain, and/or garbage collection services.
Fire protection in Malheur County is provided by the following districts, departments, and agencies: Ontario Fire & Rescue; Nyssa Fire Department; Vale Fire & Ambulance; Adrian Rural Fire Protection District; Jordan Valley Volunteer Fire Department; and BLM. The BLM has been integrated with the U.S. Forest Service since 1995 for fire and aviation management in the Pacific Northwest and is managed cooperatively between the two agencies and in close collaboration with the Pacific Northwest Wildfire Coordinating Group.

The Malheur County Sherriff's Office is the primary provider of law enforcement services to residents of Malheur County. The Ontario Police Department and Nyssa Police Department also provide law enforcement services to residents in those jurisdictions. The Oregon State Police (OSP) is a multi-disciplined organization that enforces traffic laws on state roadways, investigates and solves crime, conducts post-mortem examinations and forensic analysis, and provides background checks and law enforcement data. The OSP also regulates gaming, the handling of hazardous materials and fire codes, and educates the public on fire safety and enforce fish, wildlife, and natural resource laws (OSP 2016).

The Malheur Education Service District (ESD) provides a supporting infrastructure to the local school districts. The Malheur ESD supports ten local school districts containing 27 schools. These include eight high schools, three middle schools, nine elementary schools, and seven schools that service kindergarten through eighth grade (Malheur ESD 2017).

2.15 Surface Water

The revised Grassy Mountain Gold Project Surface Water Baseline Report (Appendix B) was submitted to DOGAMI on June 5, 2018, and again on August 14, 2018. The report was accepted by the TRT on January 14, 2019, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Surface Water Resources Study Area was established to develop an environmental baseline for assessing potential impacts from Project facilities, potential impacts of surface runoff from Project facilities, and to provide background data on the Owyhee River and Lake. The Surface Water Resources Study Area includes the Mine and Process Area and two separate and non-contiguous, areas on the Owyhee River/Lake. One location is on the Owyhee River, four miles downstream of Owyhee Dam, and the other location is upstream of the dam and Permit Area on the Owyhee River/Lake at Leslie Gulch.

No perennial surface water features are located within the immediate vicinity of the Surface Water Resources Study Area; therefore, the following five surface water sampling sites were selected and consisted of the closest perennial surface water bodies:

- Dry Creek Arm of Lake Owhyee;
- Owyhee River downstream of Owyhee Dam;
- Owyhee River/Lake upstream of Owyhee Dam at Leslie Gulch;
- Negro Rock Canyon Creek at the northern border of Study Area; and
- Twin Springs Creek upstream of Dry Creek.

Lake Owyhee and the Owyhee River are the predominant drainage features for the region, flowing south to north and ultimately discharging to the Snake River near the Oregon-Idaho border. Lake Owyhee, created in 1932 with construction of the Owyhee River Dam, is approximately six miles southeast of the Project. Tributary stream flow is typically ephemeral or intermittent (Orr, Orr, and Baldwin 1992; Baldwin 1959). Drainages in the Project Area do not flow directly into the Owyhee River or Lake Owyhee.

The main Surface Water Resources Study Area boundary includes a sampling site on Dry Creek Arm of Lake Owyhee, downstream from where Dry Creek and Twin Springs Creek enter the lake. The Surface Water Resources Study Area also includes the two separate and non-contiguous, areas on the Owyhee River/Lake: Owyhee River downstream of Owyhee Dam and Owyhee River upstream of Owyhee Dam at Leslie Gulch.

The Owyhee River/Lake sampling sites were selected to provide background surface water data in the vicinity of the Project. However, no impacts to Owyhee River/Lake are anticipated from the proposed Project because the Owyhee River drainage is in a different watershed than the Project site.

The Project is in the Sourdough Basin/Negro Rock Canyon watershed, which drains to the north. Grassy Mountain, located southeast of the Project, serves as the hydrologic divide between the

Sourdough Basin/Negro Rock Canyon watershed and the watersheds draining to the Owyhee River.

The five surface water sites located within the Surface Water Resources Study Area were visited bi-annually during the second and fourth quarters of 2013 and the second quarter of 2014. Water quality samples were collected from four of these five sites during the three sampling events. Samples were not collected at Twin Springs Creek upstream of Dry Creek because this site was dry during each visit.

Surface water conditions were considered steady state and only one set of field parameters (pH, electrical conductivity, specific conductance, dissolved oxygen) were collected. The sensors for the pH meter, conductivity meter, and dissolved oxygen meter were placed directly in the surface water for data collection. Readings were recorded once the measurements stabilized.

Water-quality samples collected from surface water were analyzed for the list of approved water quality analytes. Table 47 lists the approved analytes, as well as the laboratory testing method, the laboratory minimum detection limit (MDL), and the reporting limit (five times the MDL). For metals, samples for both total and dissolved metals were collected. For the other parameters, only total samples were collected.

Table 47. List of Water Quality Analytes

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Aluminum	EPA 200.7	0.03 mg/L	0.15 mg/L	total and dissolved
Arsenic	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Barium	EPA 200.7	0.003 mg/L	0.015 mg/L	total and dissolved
Cadmium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Calcium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Chromium	EPA 200.8	0.0005 mg/L	0.002 mg/L	total and dissolved
Copper	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Iron	EPA 200.7	0.02 mg/L	0.05 mg/L	total and dissolved
Lead	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Magnesium	EPA 200.7	0.2 mg/L	1 mg/L	total and dissolved
Manganese	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Mercury	1631E	0.2 ng/L	1.0 ng/L	total and dissolved
Nickel	EPA 200.8	0.0006 mg/L	0.003 mg/L	total and dissolved
Potassium	EPA 200.7	0.2 mg/L	1.0 mg/L	total and dissolved
Selenium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Silver	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Sodium	EPA 200.7	0.2 mg/L	1.0 mg/L	total and dissolved
Zinc	EPA 200.7	0.01 mg/L	0.05 mg/L	total and dissolved
Antimony	EPA 200.8	0.0004 mg/L	0.002 mg/L	total and dissolved
Beryllium	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved

Parameter	Laboratory Method of Analyses	Detection Limit	Reporting Limit	Sample Type
Bismuth	EPA 200.7	0.04 mg/L	0.2 mg/L	total and dissolved
Boron	EPA 200.8	0.01 mg/L	0.05 mg/L	total and dissolved
Cobalt	EPA 200.8	0.00005 mg/L	0.00025 mg/L	total and dissolved
Gallium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Lithium	EPA 200.7	0.008 mg/L	0.04 mg/L	total and dissolved
Molybdenum	EPA 200.8	0.0005 mg/L	0.0025 mg/L	total and dissolved
Scandium	EPA 200.7	0.1 mg/L	0.5 mg/L	total and dissolved
Strontium	EPA 200.7	0.005 mg/L	0.03 mg/L	total and dissolved
Thallium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Tin	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Titanium	EPA 200.7	0.005 mg/L	0.025 mg/L	total and dissolved
Vanadium	EPA 200.8	0.0002 mg/L	0.001 mg/L	total and dissolved
Uranium	EPA 200.8	0.0001 mg/L	0.0005 mg/L	total and dissolved
Nitrate+Nitrite (as N)	EPA 353.2	0.02 mg/L	0.1 mg/L	total
Ammonia Direct (as N)	EPA 350.1	0.05 mg/L	0.25 mg/L	total
Alkalinity	SM 2320B	2 mg/L	10 mg/L	total
Bicarbonate	SM 2320	2 mg/L	10 mg/L	total
Carbonate	SM 2320	2 mg/L	10 mg/L	total
Chloride	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Conductivity	SM 2510B	1 umhos/cm	5 umhos/cm	total
Cyanide, Total	EPA 335.4	0.003 mg/L	0.015 mg/L	total
Cyanide, WAD	SM 4500	0.003 mg/L	0.015 mg/L	total
Fluoride	EPA 300.0	0.05 mg/L	0.25 mg/L	total
Hardness	SM 2340B	0.8 mg/L	4.0 mg/L	total
pH	SM 4500-H B	0.1	0.5	total
Sulfate	EPA 300.0	0.5 mg/L	2.5 mg/L	total
Total Dissolved Solids	SM 2540C	10 mg/L	50 mg/L	total
Total Suspended Solids	SM 2540D	5 mg/L	25 mg/L	total
Total Phosphorus	EPA 365.1	0.01 mg/L	0.05 mg/L	total

mg/L = milligrams per liter; ng/L = nanograms per liter; umhos/cm = microhoms per centimeter

Out of the five surface water sites that were visited bi-annually that serve as background water quality monitoring locations, flow was only directly measured at one of these sites during the sampling period, Negro Rock Canyon Creek. At the three Lake Owyhee/River sites, flow could not be directly measured. Instead, flow was estimated from available USGS gauging sites, and lake elevation was obtained for the Dry Creek Arm site above Owyhee Dam from the Bureau of Reclamation. Flow and lake elevation data are summarized in Table 48. Flow data for the Owyhee River downstream of Owyhee Dam was obtained from USGS gauge 13183000, located 0.8 mile downstream of the dam (located between the dam and the sampling site).

Table 48. Flow and Elevation Data from Surface Water Sites

Quarter (Q)	Parameter	Negro Rock Canyon Creek	Dry Creek Arm of Lake Owyhee	Owyhee River Downstream of Owyhee Dam	Owyhee River Upstream of Owyhee Dam at Leslie Gulch
Q2 2013	Date/Time	6/26/13 12:00	6/27/13 14:20	6/26/13 17:00	6/27/13 9:00
Q2 2013	Flow (cfs)	0.04	N/A	152	119
Q2 2013	Elevation (ft)	N/A	2,622.22	N/A	2,622.22
Q4 2013	Date/Time	11/21/13 14:55	11/23/13 15:50	11/20/13 15:10	11/20/13 11:00
Q4 2013	Flow (cfs)	0.01 – 0.02	N/A	21	141
Q4 2013	Elevation (ft)	N/A	2,597.13	N/A	N/A
Q2 2014	Date/Time	6/24/14 10:55	6/23/14 15:20	6/19/14 15:45	6/19/14 12:30
Q2 2014	Flow (cfs)	0.01 – 0.02	N/A	165	105
Q2 2014	Elevation (ft)	N/A	2,602.69	N/A	N/A

ft = feet; cfs = cubic feet per second; N/A = not applicable

Flow data for the Owyhee River upstream of Owyhee Dam at Leslie Gulch was obtained from USGS gauge 13181000, identified as Owyhee River near Rome, Oregon. This gauge is approximately 50 river miles upstream of the sampling location but is the closest gauge upstream of the dam. Flow data from this gauge, therefore, is not a reliable representation of flow at the sampling site. However, flow at this gauging location does provide a reference point to associate with the sampling event and may be used to identify relationships between flow and water quality data as additional flow and water quality are collected. The Owyhee Dam at Leslie Gulch sample site is within the pool of Lake Owyhee at high lake levels. At lower lake levels, the Owyhee River flows past the site. During the Q2 2013 event, the sample site was within the backwater of Lake Owyhee. During the Q4 2013 and Q2 2014 events, the Owyhee River was flowing at Leslie Gulch.

Field water quality data collected during surface water sampling are presented in Table 49 and represent the complete field water quality dataset, as only one set of field parameters were measured.

Table 49. Field Water Quality

Site Name	Sampling Period	pH	EC	SC	Temp	DO	DO Saturation
		S.U.	µS/cm	µS/cm at 25 °C	C	mg/L	%
Dry Creek Arm of Lake Owyhee	Q2 2013	8.74	230	243	22	8.5	113
	Q4 2013	7.92	217	328	7.3	11.0	100
	Q2 2014	8.57	263	275	22.8	8.7	112

Site Name	Sampling Period	pH	EC	SC	Temp	DO	DO Saturation
		S.U.	µS/cm	µS/cm at 25 °C	C	mg/L	%
Negro Rock Canyon Creek	Q2 2013	6.86	395	482	15.4	4.2	49
	Q4 2013	7.23	ND	592	9.9	5.71	50
	Q2 2014	7.35	393	490	14.6	6.6	78
Owyhee River Downstream of Owyhee Dam	Q2 2013	8.67	187	239	13.3	10.7	116
	Q4 2013	8.84	187	292	6.1	11.8	105
	Q2 2014	8.81	230	289	14.3	10.4	116
Owyhee River Upstream of Owyhee Dam at Leslie Gulch	Q2 2013	8.08	330	349	22.1	8.0	99
	Q4 2013	8.43	239	357	7.7	10.2	95
	Q2 2014	8.59	306	351	18.2	8.00	99

µS/cm = microSiemens per centimeter; S.U. = significant unit

The pH of the Owyhee River and Lake Owyhee sampling sites consistently ranged between 8.0 and 9.0. The pH of Negro Rock Canyon Creek was lower, ranging from 6.86 to 7.35.

The specific conductance of the Owyhee River and Lake Owyhee sites ranged between 239 and 357 µS/cm at 25 °C. Negro Rock Canyon Creek had consistently higher values, ranging from 482 to 592 µS/cm at 25 °C.

The dissolved oxygen concentration at the Dry Creek Arm and Owyhee River upstream of Owyhee Dam at Leslie Gulch ranged between eight and 11 mg/L, with values above ten during the 4th Quarter of 2013 (November). The Owyhee River downstream of Owyhee Dam had higher dissolved oxygen concentrations, ranging from 10.4 to 11.8 mg/L, with the higher value measured during the 4th Quarter of 2013. Dissolved oxygen is higher when water temperature is lower. The dissolved oxygen concentrations measured at Negro Rock Canyon Creek were lower than the Owyhee River sites, with values ranging from 4.2 to 6.6 mg/L. The percent oxygen saturation was consistently at or above 100 percent at the Owyhee River sites but ranged from 49 to 78 percent at Negro Rock Canyon Creek.

Surface water analytical results were compared to ODEQ water quality standards as described in OAR 340-041. Water quality in the Owyhee Basin is managed to protect the designated beneficial uses including public and private domestic water supply, fish and aquatic life, and fishing.

For the aquatic life criteria, the standards are presented as Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC) which indicate the maximum allowable average one-hour and 96-hour average contaminant concentrations, respectively. Sampling results were compared to both the CMC and CCC values.

Human health criteria (HHC) are presented as “organism only” for areas in which fishing is the designated use and as “water + organism” for areas in which water supply and fishing are designated uses. In the Owyhee Basin, designated beneficial uses include water supply and fishing so the "water + organism" criteria apply.

The water quality results collected at each site for each parameter are included in Appendix E of the Surface Water Baseline Report (Appendix B). Table 50 displays the results that exceeded ODEQ's water quality standards.

Table 50. Water Quality Results

Sample Location	Arsenic, dissolved (mg/L) (CMC – 0.34, CCC – 0.15, HHC – 0.0021)			Arsenic, total (mg/L) (CCC – 0.34, CCC – 0.15, HHC – 0.0021)			Iron, total (mg/L) (CCC – 1.0)			Mercury, total (mg/L) (CMC – 2,400, CCC – 12.0)		
	Q2 2013	Q4 2013	Q2 2014	Q2 2013	Q4 2013	Q2 2014	Q2 2013	Q4 2013	Q2 2014	Q2 2013	Q4 2013	Q2 2014
Dry Creek Arm	0.0057	0.0072	0.0063	0.0057	0.0076	0.0064	--	1.16	1.45	--	--	--
Negro Rock Creek	0.0246	0.0231	0.0258	0.0243	0.0237	0.0268	--	--	--	--	--	--
Owyhee River DS	0.0059	0.0059	0.0063	0.0054	0.0059	0.0061	--	--	--	--	--	--
Leslie Gulch	0.0111	0.01	0.011	0.0114	0.0102	0.0108	1.15	--	1.22	23	13.2	19.9

Arsenic was the only water quality parameter where the HHC standard was exceeded at any of the surface water sampling sites. Arsenic was detected above the HHC limit of 0.0021 mg/L at all four of the surface water sampling sites during each of the three sampling events. Negro Rock Canyon Creek and Owyhee River upstream of the dam at Leslie Gulch consistently had the highest arsenic concentrations. At Negro Rock Canyon Creek, the total arsenic concentrations were consistent, ranging from 0.0237 to 0.0268 mg/L. At Leslie Gulch, the total arsenic concentrations were consistent but lower compared to Negro Rock Canyon Creek, ranging from 0.0102 to 0.0114 mg/L.

Total iron was detected above the aquatic life CCC standard of 1.0 mg/L on two occasions at both the Dry Creek Arm of Lake Owyhee and at the Owyhee River upstream of the Owyhee Dam at Leslie Gulch. At Dry Creek Arm, the first exceedance was 1.16 mg/L during the 4th Quarter of 2013 and the second exceedance was 1.45 mg/L during the 2nd Quarter of 2014. For the Leslie Gulch sampling location, the total iron concentration was 1.15 mg/L during the 2nd Quarter of 2013 and 1.22 mg/L during the 2nd Quarter of 2014.

Total mercury was detected above the aquatic life CCC standard of 12.0 mg/L at Leslie Gulch during all three of the surface water sampling events. Mercury was detected at 23 mg/L during the 2nd Quarter of 2013, 13.2 mg/L during the 4th Quarter of 2013, and 19.9 mg/L during the 2nd Quarter of 2014.

2.16 Terrestrial Vegetation

The Grassy Mountain Mine Project Terrestrial Vegetation Baseline Report (Appendix B) was originally submitted to DOGAMI on January 29, 2018, then again on October 2, 2018. The report was accepted by the TRT on October 23, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. Field surveys were conducted in a portion of the Terrestrial Vegetation Study Area by HDR in 2014 and 2015 (2014/2015 Survey Area). Additional field surveys were conducted in the remaining portion of the Terrestrial Vegetation Study Area by EM Strategies in 2017 (2017 Survey Area). Between the field surveys conducted in 2015 and 2017, there were six field-verified vegetation communities documented in the Terrestrial Vegetation Study Area: Agricultural; Bluebunch Wheatgrass/Cheatgrass/Annual; Burned Yellow Rabbitbrush/Bluebunch Wheatgrass; Crested Wheatgrass Seeding; Wyoming Big Sagebrush/Bluebunch Wheatgrass; and Wyoming Big Sagebrush/Crested Wheatgrass.

There were four transects established in the Wyoming Big Sagebrush/Crested Wheatgrass community during the 2014/2015 field surveys in the Terrestrial Vegetation Study Area, and three additional transects established during the 2017 field surveys, one each in the Bluebunch Wheatgrass/Cheatgrass/Annual community, the Crested Wheatgrass Seeding community, and the Wyoming Big Sagebrush/Crested Wheatgrass community. These transects were established to verify the mapped vegetation communities.

There were seven Daubenmire sampling locations established during the 2014/2015 field surveys in the Terrestrial Vegetation Study Area; six within the Wyoming Big Sagebrush/Bluebunch Wheatgrass community and one within the Crested Wheatgrass Seeding community. Seven additional Daubenmire sampling locations were established during the 2017 field surveys; two within the Bluebunch Wheatgrass/Cheatgrass/Annual community, one within the Crested Wheatgrass Seeding community, two within the Wyoming Big Sagebrush/Bluebunch Wheatgrass community, one within the Burned Yellow Rabbitbrush/Bluebunch Wheatgrass community, and one within the Wyoming Big Sagebrush/Crested Wheatgrass community. These sampling locations were established to determine the dominant plant species within each community.

The USFWS Information for Planning and Consultation species list reported that no federal threatened or endangered plant species are known to occur within the 2017 Survey Area. No federally threatened or endangered plant species were observed during the 2017 field surveys, or during the HDR 2014/2015 surveys.

A list of rare, threatened, and endangered plants was obtained from the Oregon Biodiversity Information Center in April 2017 for the 2017 Survey Area. Two plant species were reported to occur within two miles of the Terrestrial Vegetation Study Area: Cronquist’s stickweed (*Hackelia cronquistii*), a State Threatened species and a federal Species of Concern; and Mulford’s milk-vetch (*Astragalus mulfordiae*), a State Endangered species and a federal Species of Concern. No State-listed species were observed during the 2017 or 2014/2015 field surveys.

The Final Oregon/Washington State Director's Special Status Species List, July 13, 2015, which lists BLM sensitive plant species suspected or documented to occur with the Vale District was reviewed. No BLM sensitive plant species were observed during the 2017 or 2014/2015 surveys.

A list of noxious weeds for Malheur County, Oregon, was obtained from the Malheur County Weed Advisory Board. Malheur County has prioritized control and/or eradication of noxious weeds by A, B, and C classes, with Class A having the highest priority. Two noxious weed species were observed during the 2017 surveys: nodding thistle (*Carduus nutans*), a Class B species observed along the northern portion of the 2017 Terrestrial Vegetation Study Area in the Access Road Area; and cheatgrass (*Bromus tectorum*), the most dominant species observed throughout the Terrestrial Vegetation Study Area. The following species were observed during the 2014/2015 surveys: Austrian peaweed (*Sphaerophysa salusula*), a Class A species observed adjacent to the Access Road Area; Canada thistle (*Cirsium arvense*), a Class B species observed near the northern portion of the Mine and Process Area; and three class C species - cheatgrass, medusahead (*Taeniatherum caput-medusae*), and field bindweed (*Convoculus arvensis*). Class A species are subject to mandatory control/eradication where found. Class B species are required to be controlled within 50 feet of all property lines, easements, and rights-of-way. Class C species can be treated at the landowner's discretion.

2.17 Transportation

The Grassy Mountain Mine Project Transportation Baseline Report (Appendix B) was originally submitted to DOGAMI on January 18, 2018, then again on July 12, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The Main Access Road used for the Transportation Study Area includes portions of U.S. Highways 20 and 26 (U.S. 20 and U.S. 26, respectively), County-maintained Russell Road, and BLM-maintained Cow Hollow Road and Twin Springs Road.

An emergency access route has been identified as a portion of Oregon State Route 201, and County-owned Mitchell Butte Road and Owyhee Avenue. Owyhee Avenue is part of the main access to Owyhee Reservoir, which is a popular destination for recreationists. The emergency access route would share approximately four miles of Owyhee Avenue with this type of recreation-focused traffic.

ODT traffic count data from 2015 show that the average annual daily traffic (AADT) for U.S. 20 and U.S. 26 through Vale ranges between 2,501 and 5,000 vehicles. The volume decreases east and west of Vale and ranges between 1,001 to 2,500 AADT. An ODT traffic counter located west of the point where the main access route intersects U.S. 20 shows an AADT of approximately 1,900 for 2015 (ODT 2017).

In coordination with the Malheur County surveyor, traffic counts (PicoCount 2500, Version 2.25) were taken at two locations in the Transportation Study Area in fall 2014 and again in spring 2015 to record existing two-way road and trail usage on Russell Road and Twin Springs Road. The traffic counters do not reliably record lighter vehicles, like all-terrain vehicles and dirt bikes, so the data can only be said to reflect full-size vehicles. Table 51 summarizes the data collected.

Table 51. Traffic Count Data in the Transportation Study Area

Counter Number	Location	X Coordinate	Y Coordinate	Data Gathering Start Date	Data Gathering End Date	Total Recorded Vehicles
1	Russell Road (fall 2014)	475475	4862111	9/21/14	10/22/14	2,591
	Russell Road (spring 2015)			4/7/15	4/16/15	413
2	Twin Springs Road (fall 2014)	471910	4840599	9/21/14	10/22/14	564
	Twin Springs Road (spring 2015)			4/7/15	4/16/15	27

Note: coordinates are in NAD 83, UTM Zone 11 North, meters

2.18 Visual Resources

The Grassy Mountain Mine Project Visual Resources Baseline Report (Appendix B) was submitted to DOGAMI on December 22, 2017. The report was accepted by the TRT on February 28, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. The BLM's Visual Resources Management (VRM) system provides a method to identify visual resource values, establishes objectives for managing these values, and provides information to evaluate the visual effects of the proposed projects on public lands. The inventory of visual values combines evaluations of scenic quality, sensitivity levels, and distance zones to establish visual resource inventory classes, which are "informational in nature and provide the basis for considering visual values in the land use planning process. They do not establish management direction and should not be used as a basis for constraining or limiting surface disturbing activities" (BLM 1986).

VRM classes are typically assigned to public land units through the use of the visual resource inventory classes in the BLM's land use planning process. Two out of four VRM classes occur in the Visual Resources Study Area. Table 52 displays the two classes and the objectives of each class.

Table 52. BLM Visual Resources Management Classes in the Visual Resources Study Area

VRM Class	Description
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the character should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. Management activities may dominate the view and be the major focus of viewer attention. However, every attempt

VRM Class	Description
	should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Four key observation points (KOPs) were chosen to describe the existing visual elements within the Visual Resources Study Area in the context of form, line, color, and texture associated with the characteristic landscape, and to capture views that represent the existing landscape where Project activities are being proposed. Brief descriptions of the views at each KOP are provided in Table 53. Detailed descriptions of the form, line, color, and texture and photographs at each KOP are included in the Visual Resources Baseline Report (Appendix B).

Table 53. Key Observation Points

KOP	Location Description	VRM Class	View Description
1	End of Access Road facing south in Mine and Process Area	IV	Gently rolling hills with rock outcroppings in middleground and background. Sagebrush/bunchgrass vegetation has fine to medium texture. Linear elements include access road tire tracks.
2	Western portion of Mine and Process Area facing northeast	IV	Gently rolling hills. Sagebrush/bunchgrass vegetation creates a mottled, fine to medium texture across the landscape. Linear elements include access road tire tracks.
3	Intersection of Access Road Area and Twin Springs Road facing south toward Mine and Process Area	IV	Relatively flat valley bottom. Gently rolling hills are visible in the middleground and background near the Mine and Process Area. Vegetation is relatively homogeneous. The color and texture of the access road contrasts sharply with the adjacent, undisturbed landscape.
4	Along Twin Springs Road facing south toward Mine and Process Area	IV	Terrain slopes gently toward the south toward the Mine and Process Area. Slightly undulating landforms are visible in the middleground and background. Landscape is mottled with fine textured grass species. The color and texture of Twin Springs Road contrasts sharply with the adjacent, undisturbed landscape.

2.19 Wetlands

The Grassy Mountain Mine Project Draft Wetland Delineation Report (Appendix B) was submitted to the Oregon Department of State Lands (DSL) on March 1, 2018, and DSL concurrence was received May 3, 2018. On July 24, 2018, the TRT accepted the DSL concurrence as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. An additional letter from DOGAMI was received February 11, 2019, which repeated the acceptance by the TRT. Existing literature was reviewed to evaluate the physical features of the Wetland Study Area, including USGS maps, aerial imagery, National Wetland Inventory (NWI) maps, and the National Hydrography Dataset. The data review facilitated the identification of potential wetland areas and prioritization of field survey areas.

NWI mapping indicated the presence of two emergent wetlands and three ponds within or partially within the Wetland Study Area. The NWI describes the wetlands as PEM1Ch (palustrine, emergent, persistent, seasonally flooded, diked/impounded) and PEM1B (palustrine, emergent, persistent, saturated). The ponds are described as PUBH (palustrine, unconsolidated bottom, permanently flooded), PUSCx (palustrine, unconsolidated shore, excavated), and PUSCh (palustrine, unconsolidated shore, seasonally flooded, diked/impounded). The third pond, designated PUSCh, corresponds to Schweizer Reservoir on USGS maps. Two palustrine emergent wetlands, two springs, and one impounded area (Schweizer Reservoir) were identified during the 2015 and 2017 field investigations.

HDR surveyed a portion of the Wetland Study Area in 2012 (identified as Tax Lot 101), and an additional area in 2015. EM Strategies surveyed another portion in 2017. There were no surface waters observed during the 2012 surveys in Tax Lot 101. Between the 2015 and 2017 surveys, a total of two wetlands, two springs, one pond, one artificial waterway, and ten tributary drainages were observed in the Wetland Study Area. Three tributary drainages and one pond (Schweizer Reservoir) were observed within the area surveyed in 2015. Two wetlands, two springs, one artificial waterway (J-H Canal), and ten tributary drainages were observed within the area surveyed in 2017. The three tributary drainages surveyed in 2015 were contiguous with three of the ten drainages surveyed in 2017.

The Oregon DSL concurred with the findings on May 3, 2018. The purpose of the concurrence was to evaluate the features for the state Removal-Fill Law, which determined that the two wetlands and artificial waterway (J-H Canal) are subject to the permit requirements of the Removal-Fill Law. A separate determination by the Army Corps of Engineers may be conducted for purposes of complying with the Clean Water Act.

2.20 <u>Wild, Scenic or Recreational Rivers</u>

The Grassy Mountain Mine Project Wild, Scenic, or Recreational Rivers Baseline Report (Appendix B) was submitted to DOGAMI on May 30, 2018. The report was accepted by the TRT on July 19, 2018, as conforming to the Environmental Baseline Study Work Plans (EM Strategies 2017), which were accepted by the TRT on December 7, 2017. There are no designated wild, scenic, or recreational rivers in the Permit Area. The closest nationally designated wild, scenic, or recreational river is the Owyhee River, located approximately 31 miles to the south of the southernmost tip of the Permit Area. There are two portions of the Owyhee River included in the Oregon Scenic Waterway system: a portion of the main stem of the river, from Crooked Creek to Birch Creek, and a portion of the South Fork, from the Idaho border to the Three Forks area. These two segments total approximately 26 miles.

2.21 Wildlife Resources

The Grassy Mountain Mine Project Wildlife Resources Baseline Report (Appendix B) was originally submitted to DOGAMI on April 18, 2018, October 16, 2018, and January 30, 2019. Field surveys were conducted in a portion of the Wildlife Study Area by Northwest Wildlife Consultants, Inc. (NWC) between June 24, 2013, and May 30, 2014. Additional field surveys were conducted in the remaining portion of the Wildlife Study Area by EM Strategies between April 18, 2017, and February 6, 2018. Surveys were conducted in a 0.5-Mile Buffer Study Area or a Two-Mile Buffer Study Area, dependent on the species. In the 0.5-Mile Buffer Study Area, the following species were surveyed: pygmy rabbits and white-tailed jackrabbit (leoprids); bats; burrowing owl; landbirds; and general wildlife encounters were documented. In the Two-Mile Buffer Study Area, a greater sage-grouse habitat assessment and lek surveys, golden eagle nest surveys, nesting raptor surveys, and general observations of specials status species and non-listed species occurred.

Seventeen avian species were detected during large-plot avian surveys conducted by NWC at five plots between June 2013 and May 2014. Three of these species, horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), and common raven (*Corvus corax*), were found during all seasons and accounted for 137 of the 171 individuals detected. Golden eagles were detected during all seasons. Ferruginous hawks, a BLM Sensitive species, were detected during summer and spring (and found nesting during the 2014 raptor nest survey). The burrowing owl, also a BLM Sensitive species, was detected in the summer and fall of 2013 but was not found during any subsequent surveys. Other raptors detected outside of the large-plot surveys were northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and prairie falcon (*Falco mexicanus*). The prairie falcon was confirmed nesting within the Two-Mile Buffer Study Area; northern harrier was believed to be nesting within the Two-Mile Buffer Study Area in 2014, and long-eared owl was estimated to have bred successfully in 2013.

Forty-seven avian species were detected during small-plot avian surveys conducted by NWC at eight plots between June 2013 and May 2014. Of these, 25 were found only at plot 6, which was more than a mile from the Permit Area and contained habitats not found in the Permit Area. Together, the pond, marsh, and riparian trees at plot 6 constituted an oasis that attracted not only waterfowl, marsh birds, and riparian obligates (some of which nested there) but also migrants (including passerines) that used this taller, denser vegetation for cover and foraging during stopovers. Twenty-two species were detected at the other seven plots in habitat that is found within the Permit Area. Horned lark and western meadowlark were each found at six of the seven small plots, the only species found during all four survey seasons, and the most commonly detected species. Rock wren (*Salpinctes obsoletus*) was detected during spring, summer, and fall seasons (at the three plots containing a small amount of exposed rock). Six species were detected multiple times during spring and summer seasons; these were Brewer's sparrow (*Spizella breweri*), lark sparrow (*Chondestes grammacus*), loggerhead shrike (*Lanius ludovicianus*), Say's phoebe (*Sayornis saya*), sagebrush sparrow (*Artemisiospiza nevadensis*), and sage thrasher (*Oreoscoptes montanus*). All these birds are presumed to breed in or near the Permit Area, and active nests of horned lark, lark sparrow, and common nighthawk (*Chordeiles minor*) were found incidentally during other surveys. Mountain bluebirds (*Sialia currucoides*) were detected at two plots, but these detections occurred on a single fall survey day. Twelve other species were detected on a single occasion and at a single plot: ferruginous hawk (*Buteo regalis*), California quail (*Callipepla californica*), mourning dove (*Zenaida macroura*), common raven, barn swallow (*Hirundo rustica*), canyon wren (*Catherpes mexicanus*), black-throated sparrow (*Amphispiza bilineata*), white-crowned sparrow (*Zonotrichia leucophrys*), dark-eyed junco (*Junco hyemalis*), Brewer's blackbird (*Euphagus cyanocephalus*), and house finch (*Haemorhous mexicanus*).

Three raptor nests were active in 2013. One of these, a common raven nest, was active again in 2014. A burrowing owl (*Athene cunicularia hypugaea*) nest was identified by the presence of an adult owl and an abundance at the burrow entrance of pellets and excrement of this species. Only a single individual was ever seen at any one time, however, so whether a breeding attempt occurred remains uncertain. (Surveys did not begin in 2013 until after breeding would be expected to be complete.) The burrowing owl is a BLM Sensitive species. A successful breeding attempt by long-eared owls was documented by the presence at the pond of three young of this species and a stick nest in a tree with pellets and excrement in and beneath it. This nest was likely originally built by black-billed magpies (*Pica hudsonia*).

One active ferruginous hawk nest was observed within the Two-Mile Buffer Study Area during the April 27, 2014, aerial raptor nesting survey performed by NWC (NWC 2014). Within ten meters of the active ferruginous hawk nest, there was an inactive alternate nest. There were also two older inactive nests built by ferruginous hawks approximately two and three kilometers to the northeast and east-northeast of the active nest. These nests likely represented a separate ferruginous hawk breeding territory from the past. The ferruginous hawk is a BLM Sensitive species. Three active common raven nests were also located during the aerial survey. These nests could be used in future years by raptors, especially by great horned owl (*Bubo virginianus*) or prairie falcon, both of which will use stick nests constructed by other species. There were two other inactive stick nests (besides those of ferruginous hawk) identified during the aerial survey.

Raptor nest surveys were flown within the Two-Mile Buffer Study Area on April 21 and 28, 2017, in conjunction with the greater sage-grouse lek surveys. Potential nesting sites for raptors were surveyed from 100 feet to 350 feet from the aircraft. Nest site transect routes were flown along likely habitat on rock outcroppings, cliff faces, trees, and powerline structures. No occupied raptor nests were recorded during the aerial survey. A single red-tailed hawk was observed on two occasions during the surveys south of Grassy Mountain along the rimrock. Although there were many perch sites, no nests were found in the area. It is suspected the hawk may be resident of the Owyhee Canyon cliff faces immediately south of Grassy Mountain, as both times the hawk departed the area in the direction of the canyon to the south. A red-tailed hawk was also observed perched on a power transmission pole southeast of the Permit Area.

Seven raptor nests were recorded during the June 21 through 23, 2017, ground surveys. Two stick raptor nests were recorded on a southeast oriented rock outcrop in Sagebrush Gulch: a large raptor nest was approximately 25 feet from the ground on an approximately 35-foot high outcrop; and a small raptor nest is situated east of the larger nest at approximately the same height. No raptors were observed at or near the nests during visits on June 21 and 22, 2017. No evidence of occupancy such as recent whitewash and/or feathers was observed at the larger nest. However, one old pellet, possibly from a red-tailed hawk, as well as a few old bleached rabbit bones were found below the nest. The small raptor nest had abundant whitewash on the rock face below the nest and a few dark downy feathers were visible in sticks above the nest bowl. It is possible a common raven used the nest at one time; however, no raven pellets or feathers were found below the nest. A pair of red-tailed hawks was observed perched and flying near the golden eagle nest OR GE 1327. The birds were observed in courtship behavior during the May 27, 2017, survey. Numerous perch sites were found on several rocks and sagebrush on the ridge line approximately 750 feet southeast of the nest location with abundant whitewash, molted feathers, and prey remains of rabbits. No further breeding activity at this nest was observed during the June and July 2017 surveys. A female Cooper's hawk (*Accipiter cooperii*) was recorded on June 23, 2017, in the cottonwood trees that surround the pond below Sagebrush Spring. At least three small stick nests were observed in the trees. The hawk gave an alarm call but remained in the cover of the trees while the biologist surveyed the site for sage-grouse broods from approximately 100 meters away. No Cooper's hawks were observed during site visits on July 4 and 5, 2017, and it is unlikely any of the nests were used by Cooper's hawks. On June 22, 2017, an inactive large raptor nest was recorded in a cottonwood tree at No Name Springs. Two adult red-tailed hawks were observed soaring approximately 0.25 mile south of the nest tree. No raptors were observed perched in or near the tree during a one-hour observation period. No sign (e.g., whitewash, scat, feathers, prey remains, pellets) was found below or near the nest. On June 23, 2017, an inactive prairie falcon nest was recorded on a rock outcrop at the south end of Double Mountain. No falcons were observed during a 1.5-hour monitoring session. Molted feathers, old eggshells, and pellets were present beneath the nest ledge. No downy feathers, recent prey remains, or scat, which could suggest use in 2017, were found. Two pairs of rock doves (*Columbia livia*) were nesting in a horizontal ledge in the outcrop. A hive of bees occupied a pothole in the outcrop. Two closed-leghold trap sets were also located along the base of the outcrop.

No burrowing owls (*Athene cunicularia hypugaea*) or burrowing owl nests were found during the three broadcast surveys conducted in 2017. No evidence of burrowing owl presence within the 0.5-Mile Buffer Study Area, such as pellets, feathers, tracks, and scat, were found during surveys conducted for other wildlife species. Potentially suitable breeding habitat is present along the access road in locations dominated by grass and low shrubs. Numerous burrows dug by ground squirrels (*Urocitellus* spp.), badgers (*Taxidea taxus*), and coyotes (*Canis latrans*), which could provide potential nest sites, are found throughout the 0.5-Mile Buffer Study Area.

Observations of raptors and raptor nests were recorded January 25 and February 6, 2018, while flying aerial winter greater sage-grouse (*Centrocercus urophasianus*) surveys in the Two-Mile Buffer Study Area. A red-tailed hawk was observed perched at a large raptor nest in a cottonwood tree along the Malheur River. A second red-tailed hawk was observed perched at a large raptor nest in a cottonwood tree next to a farmhouse. A pair of ferruginous hawks was recorded at a platform nest in the foothills south of the J H Canal. One bird was perched on the platform and the other bird flushed from the ground near the platform. A ferruginous hawk nest was recorded upslope of Cow Hollow on a low relief rock outcrop approximately ten feet above the ground. A pair of prairie falcons was recorded at the nest identified in 2017 on a rock outcrop at the south end of Double Mountain.

The golden eagle (*Aquila chrysaetos*) nests located and monitored by NWC in the 2014 aerial survey are outside of the Two-Mile Buffer Study Area, and therefore, are not discussed in the baseline wildlife report. An aerial survey was conducted of the Two-Mile Buffer Study Area on April 21 and 28, 2017, in conjunction with the greater sage-grouse lek survey. No occupied golden eagle nests were observed. Golden eagle nest OR GE 1327, which is within the Two-Mile Buffer Study Area, was observed from the ground for a four-hour period on May 27, 2017. A pair of red-tailed hawks was engaged in courtship behavior near the nest, however no golden eagles were observed.

Observations of golden eagles were recorded during the aerial survey for winter use by greater sage-grouse in the Two-Mile Buffer Study Area. Golden eagle nest OR GE 1327 was observed from the air on both January 24 and February 6, 2018; no golden eagles were observed near the nest nor were recent greens present in the nest. Two golden eagle nests were recorded on a pinnacle rock outcrop approximately 0.75-mile upslope of Sagebrush Gulch. An adult golden eagle flushed from the rock outcrop. One nest is approximately 30 feet above the ground while the other nest is approximately 40 feet above the ground on a 60-foot rock outcrop. Both nests are located on ledges. One eagle was observed perched on the outcrop on January 24, 2018, while a pair of eagles was observed at the outcrop during the February 6, 2018, survey. The eagles were variously seen flying together or perched on the outcrop with nests. In addition, observations of four adults and one immature golden eagle were recorded during both the January 24 and February 6, 2018, flights at locations that were not associated with nest sites.

Greater sage-grouse brood-rearing surveys were conducted on June 25, 2013, and July 25, 2013. No sign of use of the Two-Mile Buffer Study Area by greater sage-grouse was detected. No birds were encountered, nor were any feathers, tracks, or scat found. No greater sage-grouse or their sign were encountered during any other field surveys. Scat of this species can persist for many months and even years; therefore, the lack of such sign is indicative of little or no use of the Two-Mile Buffer Study Area by this species in recent years. Winter use surveys were conducted on December 20, 2013, and January 14 and 15, 2014; the latter were done under ideal conditions, clear days with a covering of snow on the ground. No sign of use of the survey area by greater sage-grouse was detected. No birds were encountered, nor were any feathers, tracks, or scat found. No known greater sage-grouse leks are known to exist within the Two-Mile Buffer Study Area (Milburn 2014). No sign of this species was found during any surveys prior to the April 2014 lekking season; therefore, there were no areas of potential concentration to be checked for leks. Listening for drumming males during the hour before and after sunset (on April 10 and April 28, 2014) yielded no detections of greater sage-grouse or their leks.

No sage-grouse hens and chicks or evidence of sage-grouse presence (e.g., scat, tracks, feathers) were found in any of the surveyed spring locations during the June and July 2017 surveys. No greater sage-grouse were detected during the two aerial winter-use surveys in January and February 2018. No leks were found during ten hours of aerial transect surveys in April 2017.

No potentially suitable pygmy rabbit (*Brachylagus idahoensis*) habitat was identified within the 0.5-Mile Buffer Study Area. The most nearly suitable areas were surveyed on November 26, 2013, and May 30, 2014. No pygmy rabbits or their sign (scat or burrows) were detected. No pygmy rabbits or their sign were detected during any of the other surveys conducted within the Two-Mile Buffer Study Area. No potentially suitable white-tailed jackrabbit (*Lepus townsendii*) habitat was identified within the 0.5-Mile Buffer Study Area. The most nearly suitable areas were surveyed on November 26, 2013, and May 30, 2014. No white-tailed jackrabbits were encountered, and all jackrabbit pellets found were in habitat more characteristic of the widespread congeneric black-tailed jackrabbit. No white-tailed jackrabbits were detected during any of the surveys conducted within Two-Mile Buffer Study Area.

No pygmy rabbits or their sign (e.g., burrows, scat, tracks) were found in the 0.5-Mile Buffer Study Area along the access road during the May and July 2017 surveys. Potentially suitable habitat is present in the extensive patch of sagebrush that extends from DM Spring south approximately 2.5 miles. Within this area, surveys focused on patches of sagebrush that were uneven in height and density and in drainages. The sagebrush habitat in the other mapped patches lacks the shrub density and canopy cover characteristic of occupied pygmy rabbit habitat as described by Ulmschneider et al. (2004). Small scats produced by juvenile cottontail (*Sylvilagus nuttallii*) rabbits in summer can be similar in size to those of pygmy rabbits. To confirm species attribution of these scats, three samples were collected and submitted for species identification via DNA analysis to the University of Idaho Laboratory for Ecological, Evolutionary and Conservation Genetics. The scats were from mountain cottontails, not pygmy rabbits. During the 2017 surveys, no white-tailed jackrabbits were observed in any of the survey areas. The large lagomorph scats found were typical of black-tailed jackrabbit (*Lepus americanus*) not the larger scats produced by white-tailed jackrabbits. This species can also be readily observed during aerial surveys, but none were detected during the low-elevation 2018 winter aerial surveys conducted for sage-grouse. Potential habitat is present in the sagebrush steppe habitat in the southern portion of the 0.5-Mile Buffer Study Area along the access road.

No caves or mine adits were found during the 2013-2014 field surveys, and no areas with potential to concentrate bat roosting or maternal colonies were identified within the Permit Area. Bat detectors were operational from before sunset to after sunrise at each of the five locations during a total of 21 nights between June 24 and October 25, 2013, and between April 8 and May 30, 2014. Ten species of bats were detected over the course of the study. Small-footed myotis (*Myotis ciliolabrum*) appears to be present near the Permit Area from at least April through September. Canyon bat (*Parastrellus merican*) and California myotis (*Myotis californicus*) are also likely present in the Permit Area through a majority of the survey season, with the latter having a slightly more protracted period of presence. Silver-haired bat (*Lasiomycteris noctivagans*) appears to move through the area during spring and late summer migration with some regularity. The other species detected are uncommon or rare, with the possible exception of pallid bat (*Antrozous pallidus*), for which there were detections at three locations and on several nights in July and August 2013.

Three bat species were detected during the 2017 acoustic surveys: California myotis; small-footed myotis; and silver-haired bat. Three of the six survey locations did not have any recordings. All equipment was working. Fewer species were detected in 2017 as compared to 2014 likely due to only five survey nights. In addition, the 0.5-Mile Buffer Study Area along the access road provides little structural diversity that can provide day-roosting habitat for bats. No adits, shafts, or caves were found. Potential day-roosting habitat consists of a few rock outcrops and the deciduous trees at DM Spring. The three sites with recordings had water that probably attracted bats for foraging and drinking.

Wildlife species and habitats occurring within and adjacent to the 0.5-Mile Buffer Study Area are consistent with desert areas of the Great Basin and consist of desert-rangeland type habitat where sagebrush and grasses are the dominant species. Mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) are present in the 0.5-Mile Buffer Study Area year-round, but in low densities. ODFW-designated mule deer winter range is bisected by approximately five miles of the north end of the Permit Area. There is no other big game winter range that intersects the Permit Area (ODFW 2015). During the NWC surveys in 2014, the largest herds of mule deer and pronghorn antelope were observed at the northern end of the Permit Area along the access road where they presumably feed in the alfalfa fields. During the 2017 EMS surveys, mule deer and pronghorn antelope were observed primarily in the vicinity of springs. Elk (*Cervus canadensis*) scat was noted in a few locations near springs and one bull elk was observed near an unnamed spring east of Sagebrush Gulch. During the 2018 aerial winter sage-grouse surveys, groups of mule deer were recorded throughout the Two-Mile Buffer Study Area while a herd of 30 pronghorn antelope was observed in Cow Hollow. No elk were observed.

Use of the 0.5-Mile Buffer Study Area is low by water-dependent species, such as the migratory waterfowl and shorebirds that travel within the Pacific Flyway. Lake Owyhee, located six miles to the southeast of the site, attracts several species of migrating waterfowl, shorebirds, and passerines. Many of these birds cross the 0.5-Mile Buffer Study Area in transit. Sagebrush-dependent species, like sage sparrow, occur in the 0.5-Mile Buffer Study Area, but in low numbers due to the high degree of disturbance to the existing habitat and the dominance of cheatgrass. Raptor use is common.

During the NWC surveys, the Pacific chorus frog (*Pseudacris regilla*) was detected numerous times at the single pond within the Permit Area and at DM Spring. The sagebrush lizard (*Sceloporus graciosus*) and western fence lizard (*Sceloporus occidentalis*) were generally associated with small rock outcrops, like those at Small Avian Plots 1 through 3. The long-nosed leopard lizard (*Gambelia wislizenii*), Great Basin collared lizard (*Crotaphytus bicinctores*), western whiptail (*Cnemidophorus tigris*), desert horned lizard (*Phrynosoma platyrhinos*), and pygmy short-horned lizard (*Phrynosoma douglasi*) were encountered primarily in sagebrush shrub steppe and in sandy soil types.

Ground squirrels, especially Merriam's (*Urocitellus canus*), were extremely abundant in the 0.5-Mile Buffer Study Area. They provide an important source of prey for the raptor species that breed in the area. Both badger and coyote were present; these species prey on the abundant ground squirrels, create their own burrows and expand those of their prey, and provide potential burrows for burrowing owls and other wildlife. A bobcat (*Lynx rufus*) was encountered on one occasion during the NWC survey, and tracks were found during winter surveys. Porcupines (*Erethizon dorsatum*) were observed in several locations within the 0.5-Mile Buffer Study Area.

3 OPERATING PLANS

3.1 Proposed Operations

Calico proposes to construct, operate, reclaim, and close an underground mining and precious metal milling operation known as the Grassy Mountain Mine (Project).

In general, the proposed mining and precious metal processing operations will consist of an underground mine and ore processing facilities, including a conventional mill and tailings storage facility (TSF), and a waste rock storage area, as well as other support facilities. The Project will include the following major components (Figure 6):

- One underground mine;
- One waste rock storage area;
- One carbon-in-leach (CIL) processing plant;
- One borrow pit area;
- One TSF;
- Run-of-mine (ROM) ore stockpile;
- One reclaim pond;
- A water supply well field and pipeline, associated water delivery pipelines, and power;
- A power substation and distribution system;
- One ventilation shaft;
- Access and haul roads;
- Ancillary facilities that include the following: haul, secondary, and exploration roads; truck workshop; warehouse; stormwater diversions; sediment control basins; reagent and fuel storage; storage and laydown yards; explosive magazines; fresh water storage; monitoring wells; meteorological station, an administration/security building; borrow area; growth media stockpiles; and solid and hazardous waste management facilities to manage wastes; and
- Reclamation and closure, including the use of the reclaim pond as an Evaporation Cell (E-Cell) during the TSF closure.

Calico proposes to mine approximately three million tons (mtons) of mill-grade ore and 0.2 mtons of waste rock (total of 3.2 mtons). The material (both ore and waste) will be extracted from the underground mine using conventional underground mining techniques of drilling, blasting, mucking, loading, and hauling. Calico will use hydraulic loaders to load the ore and waste into the haul trucks. The haul trucks will transport the waste rock to the waste rock disposal areas near the TSF and transport the ore to the ROM stockpile adjacent to the crushing and milling facilities. The ore will be leached in a CIL processing plant to recover the precious metals into a “pregnant” leach solution. The pregnant solution will then be processed for metal recovery and further off-site refining. Exploration activities, expected to disturb up to ten acres, will occur within the Project Area.

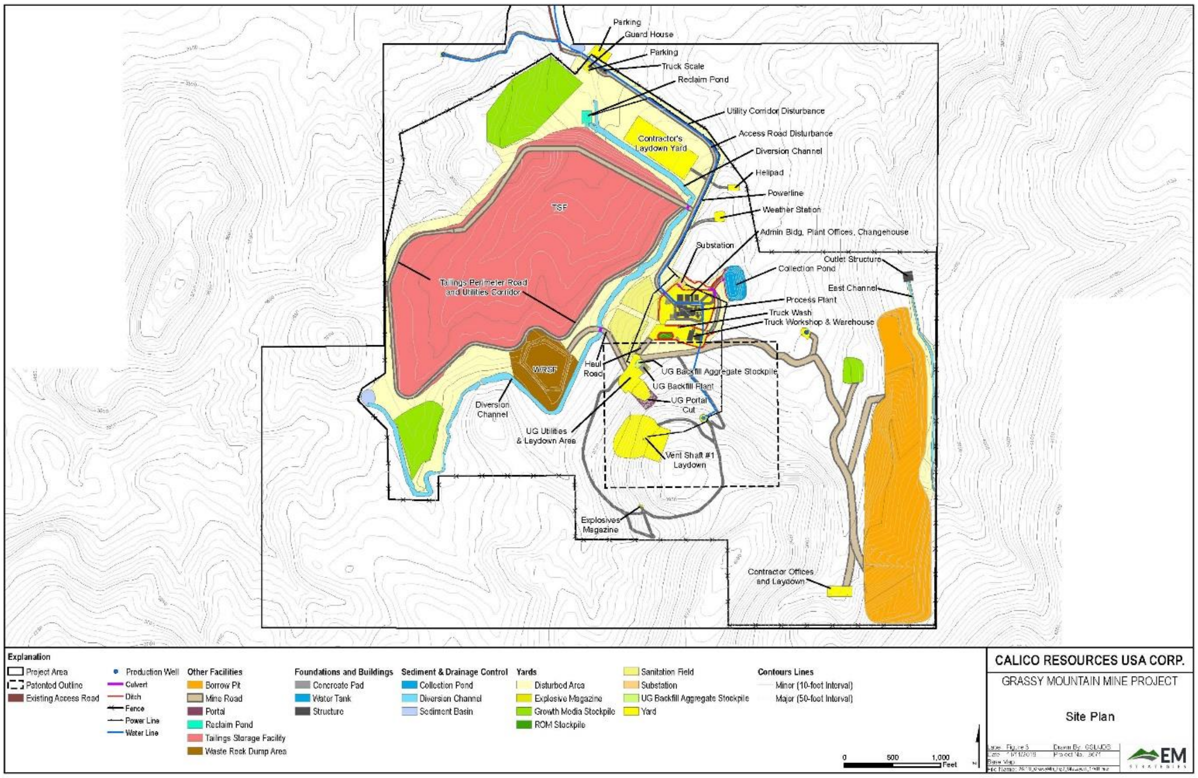


Figure 6. Grassy Mountain Site Arrangement

3.1.1 Estimated Disturbance Acreage

The Project would result in approximately 320 acres of proposed surface disturbance for the planned underground mine, process plant, waste rock storage, tailings storage, ore stockpile, water-well sites and distribution system, electrical power substation and distribution system, ancillary facilities, reclamation, and closure. Table 54 describes the proposed surface disturbance, by disturbance component, for the Project.

Table 54. Proposed Surface Disturbance for the Grassy Mountain Mine

Component	Public Acres	Private Acres	Total Acres
Portal Area	0.0	0.5	0.5
Waste Rock Storage Area	8.4	0.0	8.4
Tailings Storage Facility (TSF)	99.2	0.0	99.2
Process/Administration Area[1]	6.5	0.7	7.2
Laydown/Yard Areas	65.5	8.2	73.7
Roads	21.6	3.3	24.9
Water Tank	0.0	0.1	0.1
Water Wells and Water Pipeline[2]	6.5	0.6	7.1
Fence[3]	15.5	0.0	15.5

Component	Public Acres	Private Acres	Total Acres
Borrow Area[4]	42.9	0.0	42.9
Diversion Ditches and Sediment Basins	11.9	0.0	11.9
Growth Media Stockpiles	18.2	0.0	18.2
Exploration[5]	5.0	5.0	10.0
Total	**301.2**	**18.4**	**319.6**

[1]This includes the mill, refining plant, administrative building, parking lot, security building, mining contractor yard, reagent storage, assay laboratory, and substation.
[2]Includes the water supply pipeline at 16,164 feet with a 15-foot construction disturbance width and well locations each at 0.25 acre.
[3]Includes the perimeter fence at 22,358 feet with a 30-foot construction disturbance width.
[4]The aggregate quarry application (Appendix V of the Consolidated Permit Application) has an acreage value of 50 acres, which includes diversion structures, yards, and a growth media stockpile. These features, excluding the Borrow Area, are accounted in other categories in this table.
[5]The actual location of the exploration activities within the Project Area is currently unknown and is assumed to be equally on public and private lands.

3.1.2 Operational Timeframes

The proposed Project will be active for approximately 14 years, which includes two years of pre-production and nine years of mining and processing. Three years of closure and reclamation are estimated with several years beyond anticipated for groundwater monitoring. This schedule may be modified based on the rate of mining and future commodities prices. Table 55 and Figure 7, respectively, show detailed schedules.

Table 55. Development Schedule

Development Type	Units	Pre-Prod -2	Pre-Prod -1	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Total
Main Decline	K Feet	1.3	4.4	1.5	-	-	-	-	-	-	-	-	7.3
Vent Drift	K Feet	0.1	1.1	1.5	-	-	-	-	-	-	-	-	2.6
Level Access	K Feet	-	-	0.5	0.4	0.2	0.4	0.4	0.4	0.5	0.5	-	3.2
Level Development Waste	K Feet	-	-	2.1	1.5	1.0	1.4	2.1	3.0	2.1	0.3	-	13.4
Level Development Ore	K Feet	-	0.1	11.9	0.3	-	-	-	-	-	-	-	12.2
Vent Shaft	K Feet	-	1.0	0.5	-	-	-	-	-	-	-	-	1.5
Total Development	K Feet	1.4	6.6	18.0	2.2	1.1	1.7	2.4	3.3	2.7	0.8	-	40.2

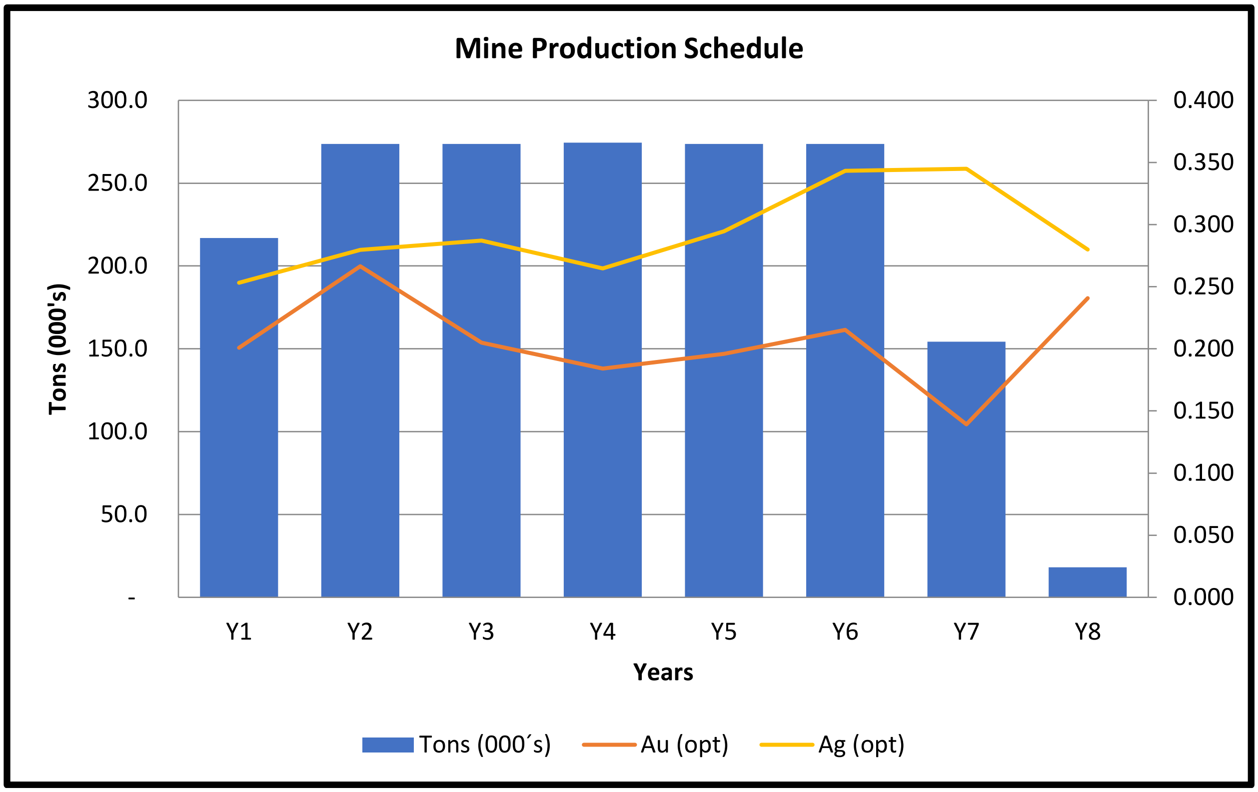


Figure 7. Mine Production Schedule

3.1.3 Work Force

Personnel requirements for the LOM are shown in Figure 8, which includes the mine, process facility, administration, security, and Health, Safety, and Environmental Compliance (HSEC). The administrative personnel shift system is planned to be five days on and two days off, at ten hours per day. Production-related mining personnel (operators, fitters, electricians, and assistants) will work a shift system of four days on and three days off in two teams. Each team will work 12 hours per day so the mine can operate 24 hours per day, four days per week. Processing will work 24 hours per day, seven days a week. Some personnel may work additional overtime through weekends for care-and-maintenance requirements, as needed. The operating calendar is based on 360 operating days per year.

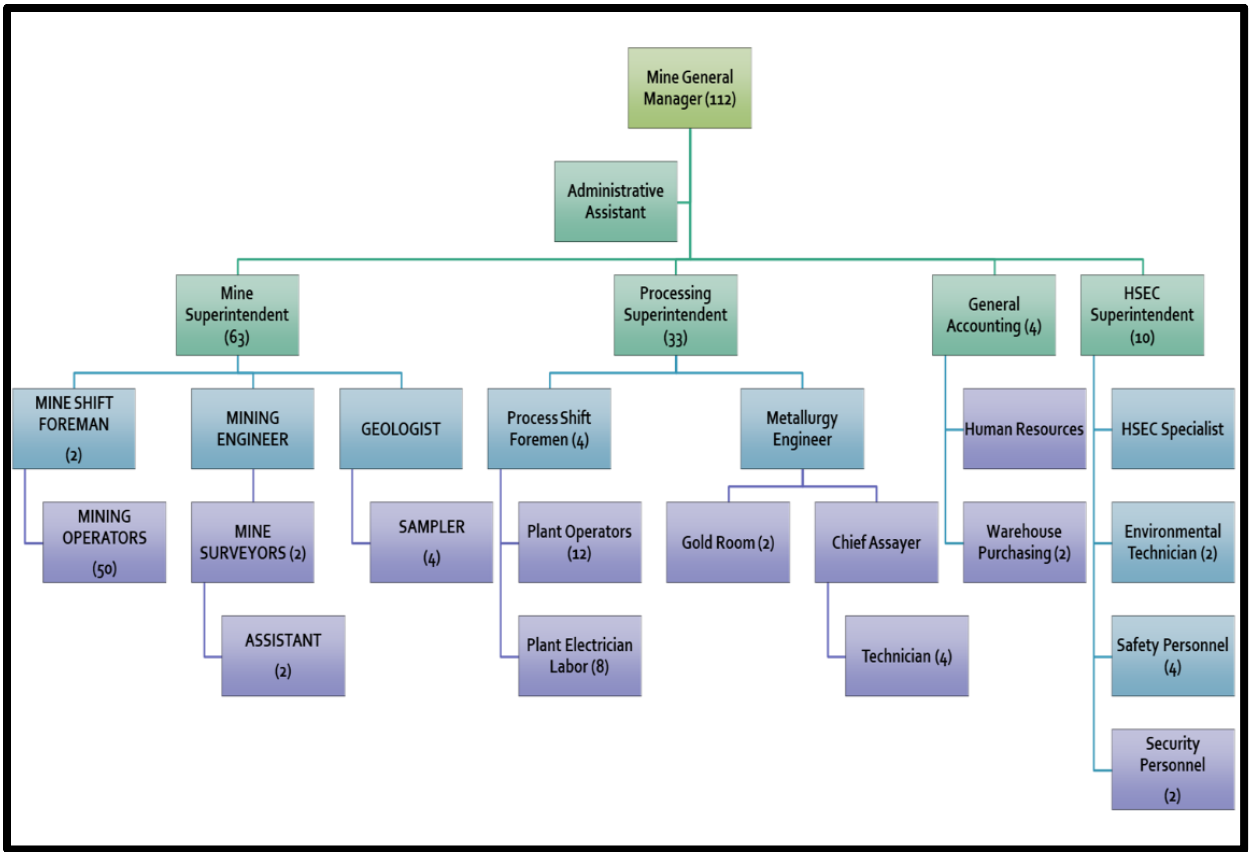


Figure 8. Mine Organization Chart

3.1.4 Local Hire Policy

Calico plans to implement a proactive community involvement and consultation process including: 1) local-hire preference; 2) local contracting and purchasing where practicable; and 3) mine-worker job training to provide an experienced workforce.

Mining and milling jobs are expected to be sourced to local communities where possible, with limited relocation to supply the expertise reinforcing the local experience level. Calico also has plans to further partnerships with local community colleges and vocational schools whereby "mining expertise" can be developed through "partnership curriculums." These partnerships are likely to include Treasure Valley Community College in Ontario, Eastern Oregon University in LaGrande, and the College of Western Idaho in Boise. The Project will employ approximately 100 people.

The Project will create many jobs within Malheur County. This would enable economic development during the one-year construction period and the estimated ten-year mine life. Currently, Malheur County is the poorest County in Oregon with an unemployment rate of 10.7 percent and a recent job growth rate of -2.10 percent. The economy of the County would increase with the new high-paying jobs provided by Calico. Workers will commute daily to the

Project from surrounding towns. Calico will also provide a daily bus shuttle service from Vale designed to limit the number of personal vehicles traveling to the work site.

3.2 Project Access Road

To provide for employee and public safety, Calico plans to control access at both the mine area and the processing plant, as well as the Permit Area in general. This would be accomplished by fencing, gating, and upgrading the existing public access from the existing Twin Springs Road.

The main access road to Grassy Mountain will utilize an existing BLM road to the site and a County right-of-way (ROW) across private land. This road is approximately 17 miles long and will need to be upgraded to include some straightening and widening in portions and have a gravel roadbed. The location and land status of the road is shown in Figure 2 in Section 1.6 and Figure 9 below.

The Road Design Report (Appendix AC) includes improvements, realignments where necessary, culvert size and location, and cross sections along the alignment. A drainage analysis was also performed to assess drainage patterns and to determine the adequacy of culverts and propose upgrades where necessary. Access road specifications are included in Section 3.2.1. This Project access road will be maintained by Calico during the mine operations and roadbed water, as needed, and grading as necessary to maintain the designed condition of the roadbed.

3.2.1 Road Design

HDR, an engineering firm in Boise, Idaho completed the design for the road alignment and provided general road profiles (Appendix AC). The road design conforms to BLM Gold Book standards and the American Association of State Highway and Transportation Official's (AASHTO) manual Geometric Design of Very Low-Volume Local Roads (average daily trips [ADT]<=400). The area type is rural, the total roadway width is 24 feet (includes travel lanes and shoulders) and the speed limit will be 35 mph. All design details are included in the Road Design Report in Appendix AC.

Lidar survey data was processed to create an existing ground model, which was then evaluated, and field reviewed to assure width, slope, ditches and culvert locations/sizes were adequate. Wherever the design model deviated from the existing roadbed, changes were proposed in design (Appendix AC).

An aggregate source located on private property has been identified, although other public sources may also be available.

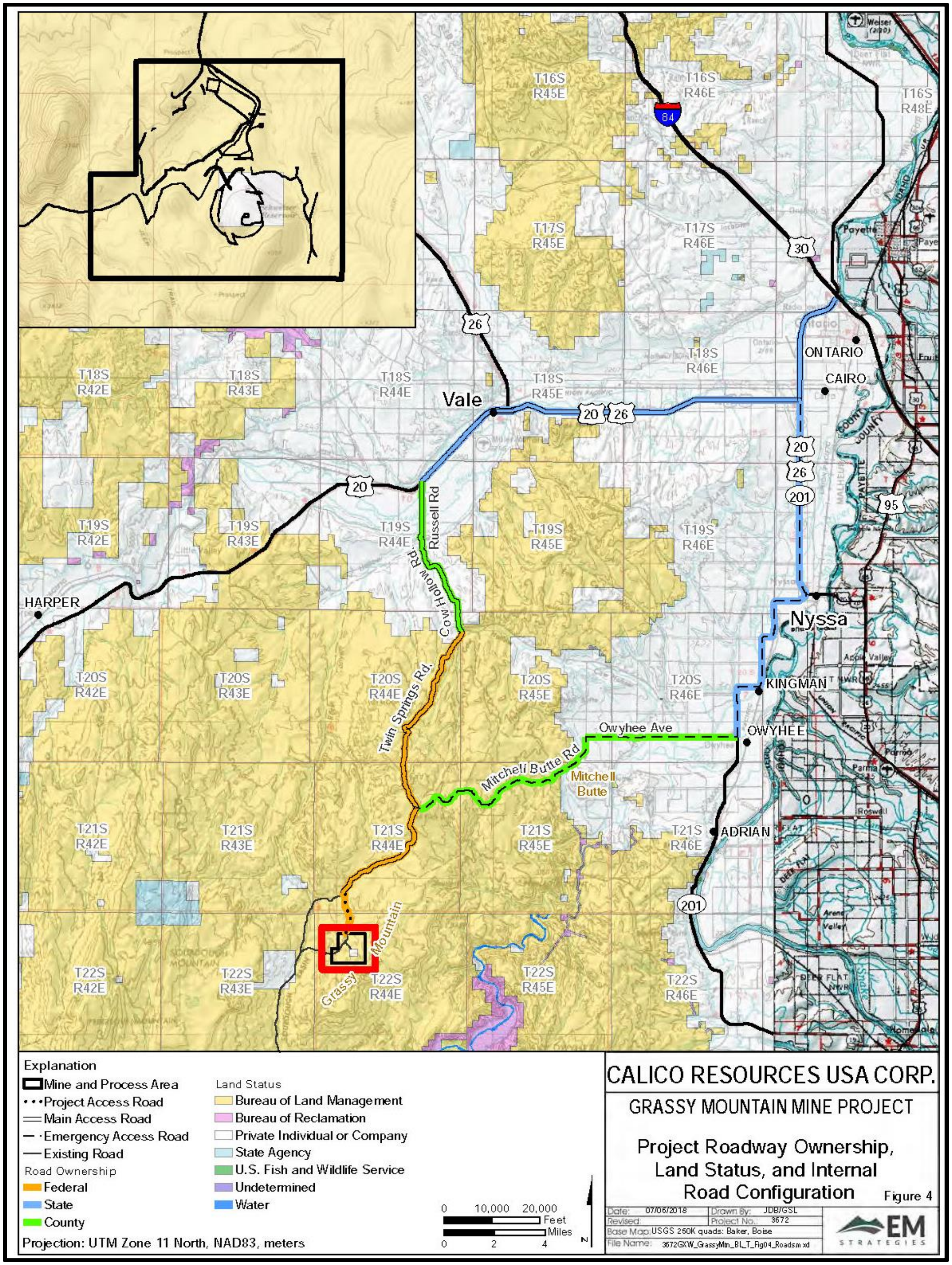


Figure 9. Grassy Road Land Status

Table 56. Selected Access Road Specifications

Item	Criteria
Design Speed	35 mph
Travelway	20 ft
Shoulder Width	2 ft each side
Ditches	2:1 Cut Slope
ADT	<100
Design Vehicle	WB-67
Design Load	HS-20
Maximum Curve Radius	460 ft
Maximum Grade	8% (except pitch grades not exceeding 300 ft in length and 10% in grade
Stopping Sight Distance	170 ft

3.2.2 Operation and Maintenance

It is expected that seasonal road maintenance will be sufficient to provide access to the site for all personnel and any deliveries related to the mine site. Mining and exploration activities can be conducted year-round.

This Project access road will be maintained by Calico during the mine operations and water will be used on the roadbed, as needed for dust suppression. The road will be graded, as necessary, to maintain the designed condition of the roadbed.

3.3 Mining Operation

Extraction of the Grassy Mountain estimated mineral reserves is planned via a proposed underground mine that will be accessed via one decline and a system of internal ramps as shown in Figure 10. One shaft is planned for exhaust ventilation and secondary egress. The planned mining method is D&F using diesel-powered mining equipment. CRF and uncemented RF will be used for backfill of the production drifts and level access to prevent any subsidence.

The mine design is based on a production rate of 1,300 to 1,400 tons per day over four days per week, with two shifts per day. This is intended to provide sufficient material to feed the mill at a rate of 750 tons per day on a seven day per week basis. The underground production schedule is discussed in Section 3.3.11.

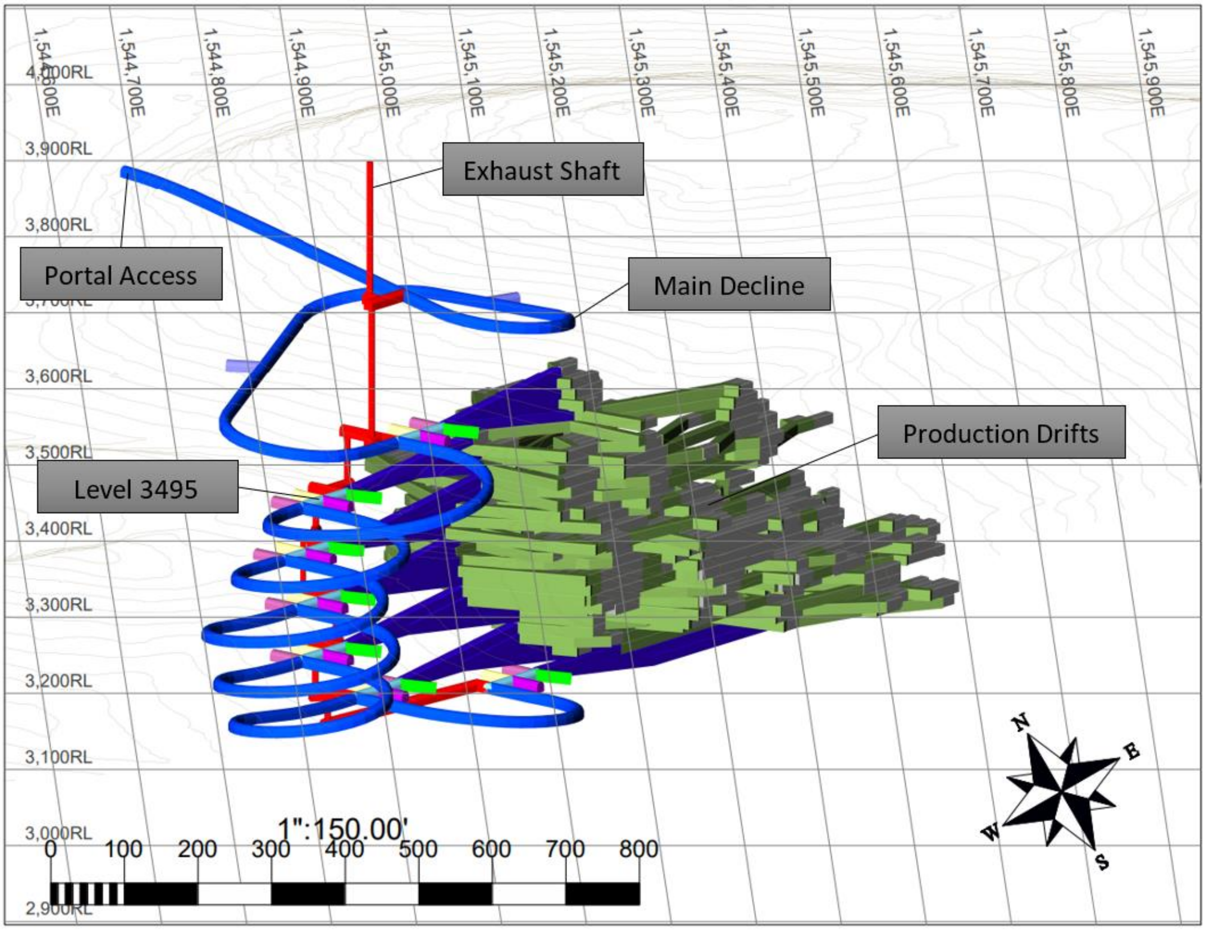


Figure 10. Isometric View of Grassy Mountain Mine

Nominal development sizes of 15 feet wide by 15 feet high are planned for the main decline. All production drifts will be 15 feet high and will have three different width sizes that include 15 feet, 20 feet, and 30 feet wide. Production drifts will vary in width depending on ground conditions and ground support. These production drift sizes will allow the miners and associated mining equipment access and flexibility to maximize production from the mine, as well as minimize waste haulage from the development headings.

According to the analysis conducted by Ausenco, the majority of the ground conditions within the Grassy Mountain deposit are classified as being of fair to poor rock quality, and the rock mass rating (RMR) is typically less than 49. Ground support was designed to maintain a safe operation for these ground conditions.

The mining cycle involves drilling, blasting, and mucking for the development and production drifts. This will be followed by reinforcement and ground support for safe operation, and finally backfill of the production drifts.

Mining Equipment to be used for the Grassy Mountain underground mine is specified in Section 3.3.3.

3.3.1 Geotechnical Considerations

Miss Allison M. Pyrch, PE, GE Associate Geotechnical Engineer at Hart Crowser Inc, and an Oregon-Certified Engineer, has conducted a high-level overview of the preliminary geotechnical data analysis and underground support recommendations. Miss Pyrch confirms the adequacy of the prefeasibility / preliminary level of design development methodologies and ground support recommendations based on the current information. Additional engineering analyses, supported by a continuing program of geological / geotechnical and hydrogeological exploration, is expected to continue through future design stages and facility operation. As stated by Ms. Pyrch, "*Further, final support and design parameters must be evaluated and re-assessed continuously during mine operation to ensure that the designed and implemented ground support is matched to the encountered ground conditions to ensure stability and more importantly a safe working condition for all personnel entering the mine.*"

3.3.1.1 Geotechnical Characterization

The details of the mining design require the application of empirical methods and geotechnical criteria to classify the rock mass. These details allow for evaluation of the geotechnical variations throughout the deposit, thus defining different geotechnical zones within the deposit. This facilitates the design of all underground excavations.
It is necessary to classify the quality of the rock mass on the basis of its geotechnical attributes in order to obtain uniform zones or units, as follows:

- Identify the parameters that influence the behavior of the rock mass
- To divide the information of the rock mass in groups or classes of similar behavior.
- Provide characteristics and quantitative data for each rock class

There are many different classification systems of rock, the Q (Barton et al. 1974) and the RMR (Bieniawski 1976, 1989) systems are widely used for the construction of tunnels and civil works.

The rock quality designation (RQD) is defined as the percentage of whole pieces greater than or equal to 100 millimeters (mm) in length, Figure 11 shows the procedure for measurement and calculation of RQD and Table 57 shows the rock mass quality based on RQD.

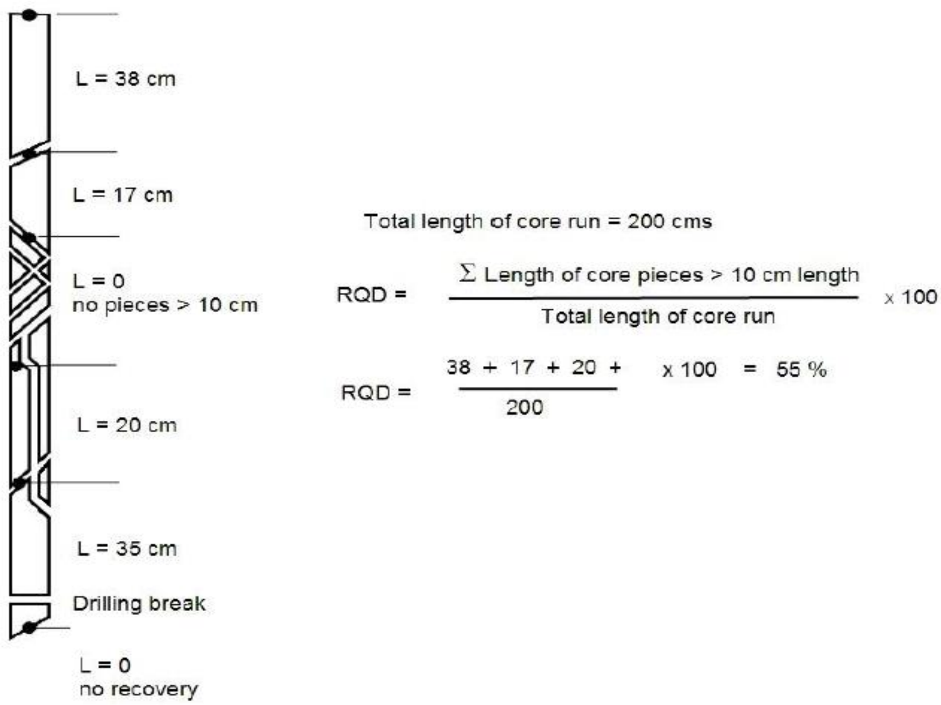


Figure 11. Procedure for Measurement and Calculation of RQD (after Deere 1989)

Table 57. Rock Mass Quality According to RQD

Rock Quality Designation (RQD)	Rock Mass Quality
<25	Very Poor
25 - 50%	Poor
50 - 75<%	Regular
75 – 90%	Good
90 – 100%	Very Good

Source: Practical Rock Engineering 2006.

The RMR was proposed by Z.T. Wieniawski in 1976 and is used to evaluate the rock mass according to its quality, hardness, orientation, spacing, groundwater conditions and orientation of discontinuities.

The application of the RMR system aims to identify the most significant parameters influencing the behavior of a rock mass, divide a particular rock mass formation into a number of rock mass classes of varying quality, provide a basis for understanding engineering design and to derive quantitative factors for engineering design.

The RMR classification includes information on the strength of the intact rock material, the spacing, number and surface properties of the structural discontinuities as well as allowances for the influence of subsurface groundwater, in situ stresses and the orientation and inclination of dominant discontinuities.

The following six (6) parameters are used to classify a rock mass using the RMR system:

- Uniaxial compressive strength of rock material
- RQD
- Spacing of discontinuities
- Condition of discontinuities
- Groundwater conditions
- Orientation of discontinuities

In applying this classification system, the rock mass is divided into a number of structural regions and each region is classified separately. The boundaries of the structural regions usually coincide with a major structural feature such as a fault or with a change in rock type. In some cases, significant changes in discontinuity spacing or characteristics, within the same rock type, may necessitate the division of the rock mass into a number of small structural regions.

The RMR system is presented in Table 58, giving the ratings for each of the six parameters listed above. These ratings are summed to give a value of RMR. The following example illustrates the use of these tables to arrive at an RMR value.

Table 58. Rock Mass Classes Determined from Total Ratings

Rock Mass Classes Determined From Total Ratings					
Rating	100 < 81	80 < 61	60 < 41	40 < 21	< 21
Class Number	I	II	III	IV	V
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock

Source: Practical Rock Engineering.

3.3.1.1.1 Golder Geotechnical Appraisal

A geotechnical appraisal of the proposed underground mine area was carried out by Golder Associates Inc. (Golder) during 2016-2017 (Golder 2018). Geotechnical data are available from three different drilling campaigns that were completed prior to the 2016-2017 drill campaign. Calico, Newmont, and Atlas carried out RQD measurements. Additional geotechnical data from the Newmont and Calico drilling were reviewed, but not used directly in Golder´s 2016-2017 evaluation, due to uncertain reliability and consistency in the data. Table 59 shows the drill holes used in the Golder appraisal.

Table 59. Geotechnical Drill Hole Investigation

Company	Year	Number of Geotechnical Drill Holes	Information Considered	Other Geotechnical Information
Calico	2011	2	RQD	None
Newmont	1992	13	RQD, core photographs in splits	Recovery, fracture, frequency, joint condition rating (JCR), hardness, rock strength, underground rock mass ratings (URMR)
Atlas	1986-1992	6	RQD	Recovery, weathering, breakage, hardness, bedding, joints
Paramount	2016-2017	27	RMR	RQD, fractures, International Society for Rock Mechanics (ISRM) strength rating, weathering index, JCR

The 2016-2017 drilling campaign included 27 core holes of HQ3-diameter (2 3/8-inch diameter) drilled using a triple-tube core barrel to maximize core recovery. Two holes were logged in detail for geotechnical characterization by Golder personnel at the drill rig. The other 2016-2017 holes were logged by Calico personnel according to Golder's instructions and procedures. Drill Holes Collar Locations (2016-2017) (Figure 12) shows the locations of the two Paramount geotechnical hole collars within an approximate 0.075 oz Au/ton cut-off boundary.

Golder utilized the Paramount and Golder geotechnical log data to characterize the orebody and surrounding rock mass based on a calculation of RMR from the logged data. Figure 13 (The Golder Rock Mass Rating, all 2016-2017 Core) is the RMR histogram for all core that was geotechnically logged from the 2016-2017 drill campaign. The historical data was not evaluated with the 2016-2017 campaign because the historical logging of RQD data is not comparable with the RMR logging during the 2016-2017 campaign.

The Golder review of the 2016-2017 drill core indicated the presence of a significant number of zones of broken rock fragments within what Golder termed "a matrix of soil" and referred to as "Soil Matrix Breccia." These zones are more correctly referred to as "clay matrix breccia" as described in detail in the "Preliminary Feasibility Study and Technical Report for The Grassy Mountain Gold and Silver Project" (MDA 2018). The clay matrix breccia is readily observed in core in split tubes immediately after drilling, but it is also clearly identifiable after the core has been boxed and somewhat disturbed.

The geological and geotechnical data did not identify any trends or patterns that would allow the delineation of rock quality domains for mine design, with the exception of very poor-quality rock encountered in and around the interpreted subvertical structures. However, very poor-quality rock is not limited to the vicinity of the structures, it is also frequently observed between

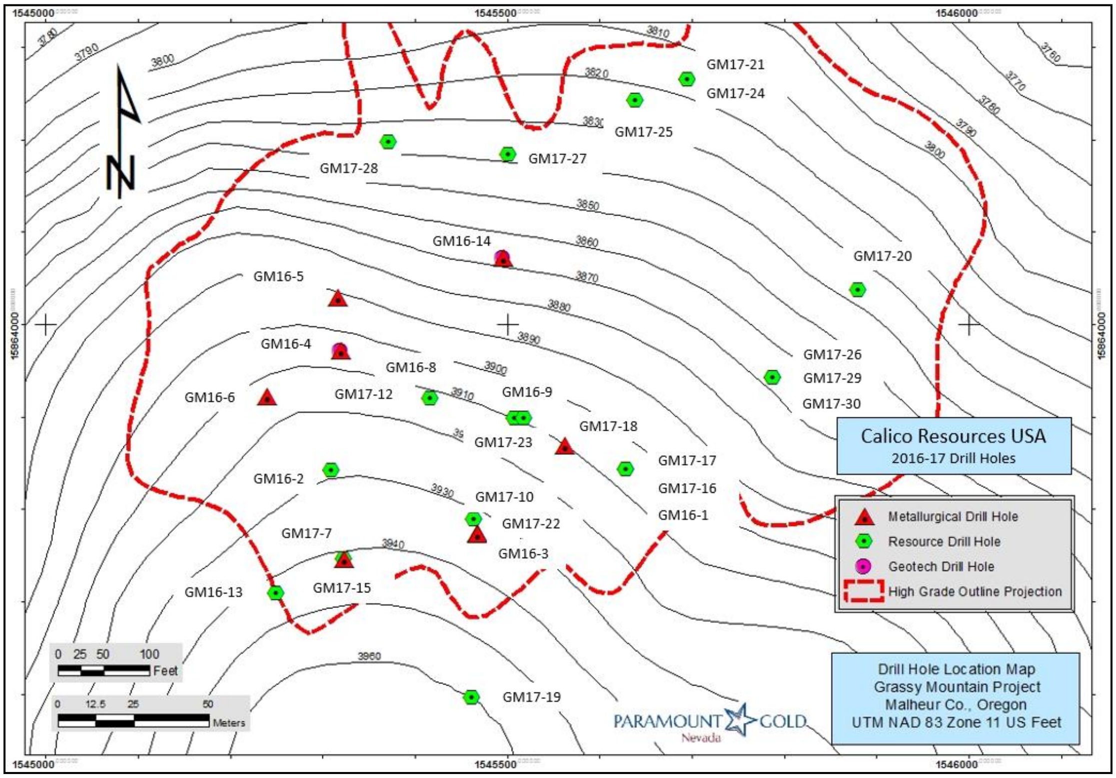
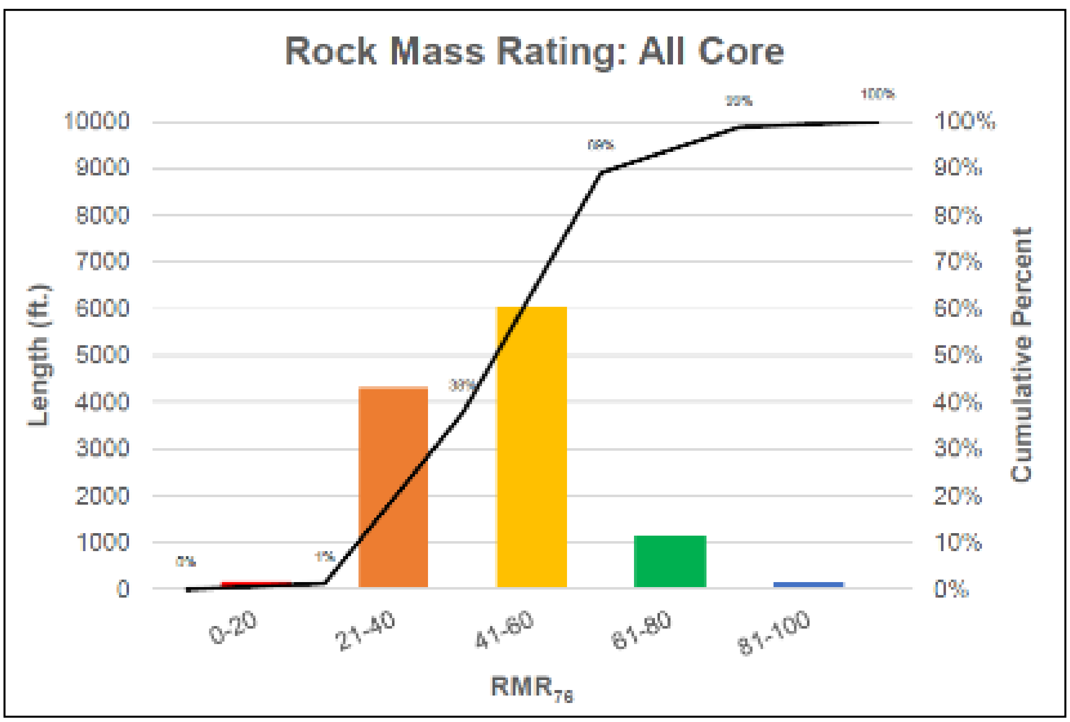


Figure 12. **Drill Holes Collar Locations (2016 - 2017)**



Source: Golder 2018

Figure 13. Golder Rock Mass Rating, All 2016-2017 Core

structures. Therefore, this degree of variability will require a selective mining method that can quickly respond to changing ground conditions.

Golder concluded that, in the absence of spatial patterns in rock quality, three categories of rock quality should be used for PFS-level design and cost estimating purposes. Table 60 (The Rock Quality Categories, modified after Golder 2017) shows the three rock quality categories applied to the design of the Grassy Mountain underground mine workings.

Table 60. Rock Quality Categories, Modified from Golder 2017

Rock Quality Category	Description	Approximate Expected Percent of Excavations(a)
Type I	Moderately fractured rock	20%
Type II	Poor quality, highly fractured rock	40%
Type III	Clay matrix breccia and other very poor-quality rock (clay, broken rock and rubble in core boxes)	40% (15% clay matrix breccia, 25% other poor-quality rock)

Note: based on percent encountered within 2016-2017 drill holes.

3.3.1.1.2 Ausenco 2017 Geotechnical Work

In 2017, Ausenco's geotechnical group, conducted a review of all the available geotechnical information provided by Paramount, including core logs, core photographs, and the work completed by Golder that is summarized above. Ausenco's objectives were to select a mining method and develop support recommendations for underground openings.

Ausenco's geotechnical group reviewed all core photographs from the 2016 - 2017 core drilling campaign and estimated additional geotechnical parameters that were incorporated into the geotechnical review.

In order to characterize the rock mass ore body a statistical analysis was performed on the geotechnical data derived from the core logging by Paramount and Golder staff. This analysis was performed on each hole as well as the 27 drill holes in aggregate. The RMR results are shown in Figure 14 (RMR Histogram from 27 Drill Holes).

Based on the RMR statistics and Ausenco's interpretation and correlation of the RMR data with the geological database, the Grassy Mountain deposit was assigned to three classes of rocks according to geotechnical quality:

- Class 1: Rocks of Poor geotechnical quality according to RMR; approximately 40 percent of the deposit.

- Class 2: Rocks of Regular geotechnical quality according to RMR; approximately 50 percent of the deposit.
- Class 3: Rocks of Good geotechnical quality according to RMR; approximately ten percent of the deposit.

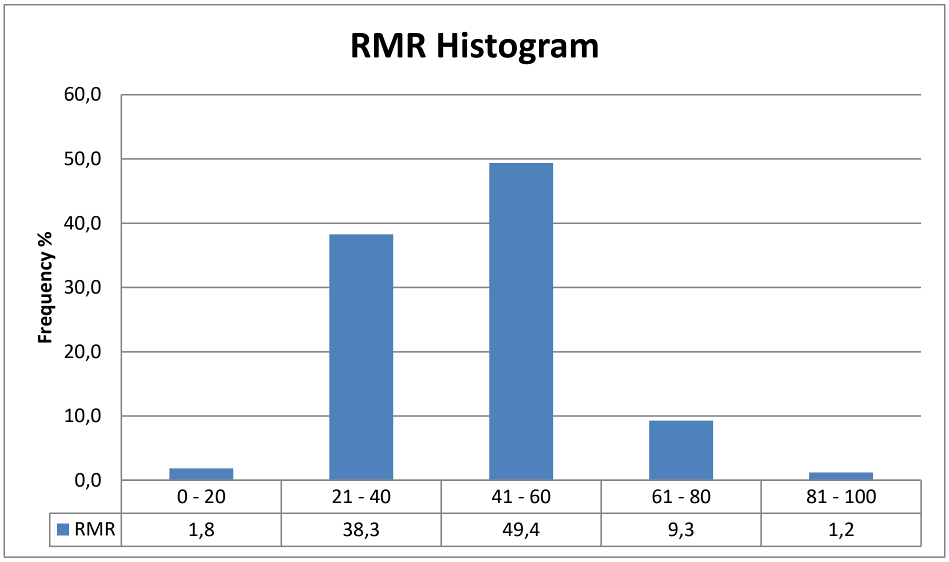


Figure 14. RMR Histogram from 27 Drill Holes

The Ausenco Rock Quality Categories (Table 61) shows the cumulative frequency values based on the RMR Histogram from 27 Drill Holes (Figure 14) with the classes of rocks assigned by Ausenco.

Table 61. Ausenco Rock Quality Categories

Rock Quality (RMR)		Frequency (%)	Rock Class	Deposit (%)
0 - 20	Very Poor	1.8	-	-
20 - 40	Poor	38.3	Class 1	40
40 - 60	Fair	49.4	Class 2	50
60 - 80	Good	9.3	Class 3	10
80 - 100	Very Good	1.2	-	-

The Very Poor and Very Good rock qualities, according to the RMR classification, are not representative of the deposit due to the low frequencies measured, so they were omitted from the three classes of rock assigned. However, they do exist and should be considered when mining, in particular the very poor quality, as if encounter it may require additional support revision. Examples of the three classes are shown in Figure 15.

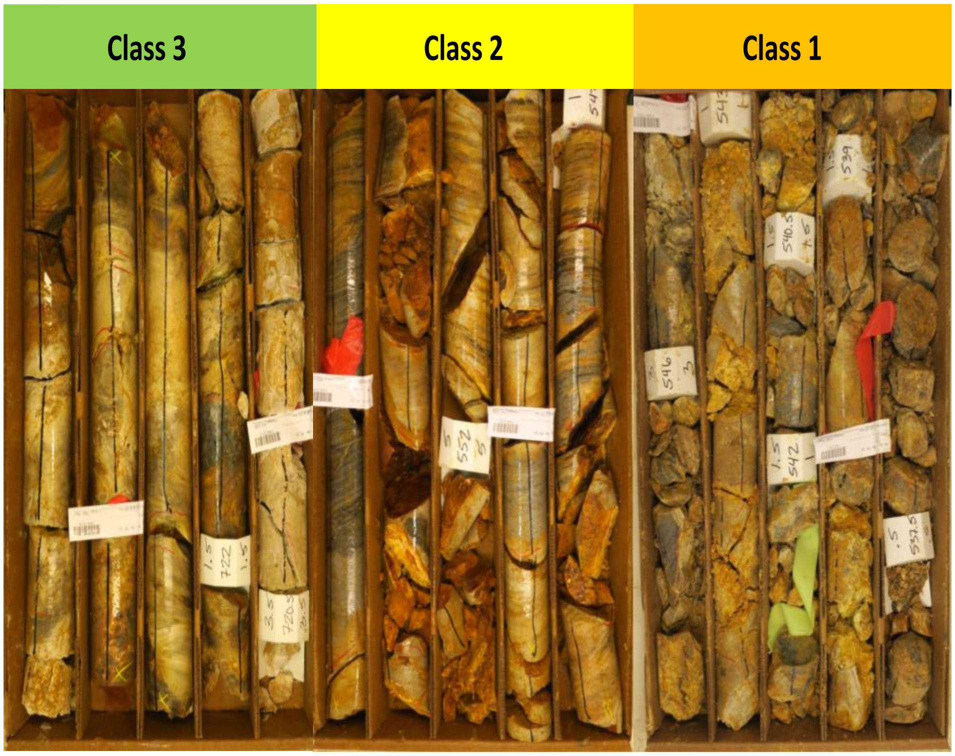


Figure 15. Examples of Three Geotechnical Rock Classes

3.3.1.2 Intact Rock Strength

Physical testing of suitable rock core specimens allows the determination of the mechanical properties of intact rock required for mine design using rock mass classification or numerical analysis methods. The intact rock strength is commonly measured in uniaxial compression, point load, indirect tensile, and triaxial compression tests (Brady and Brown 2004). Usually, a limited (but representative) number of cylindrical specimens of each rock type should be tested for uniaxial compressive strength (UCS) in a suitable laboratory equipped with a stiff testing machine. A larger number of point load tests can be carried out during the core logging process for orebody delineation. A comprehensive set of suggested testing methods has been published by the International Society for Rock Mechanics (ISRM) (Brown 1981; Ulusay and Hudson 2007).

The 2016–2017 drill campaign where Golder´s characterized the rock mass using the RMR system also selected core samples for laboratory testing from six boreholes.
Point load tests (PLT) were carried out by Paramount geologists in the core shed, after geotechnical logging, according to the ASTM Standard D 5731-07: Determination of the Point Load Strength Index of Rocks, and Application to Rock Strength Classifications. PLTs were

performed at approximately ten-foot intervals down hole on the six (6) boreholes, see Table 62 below.

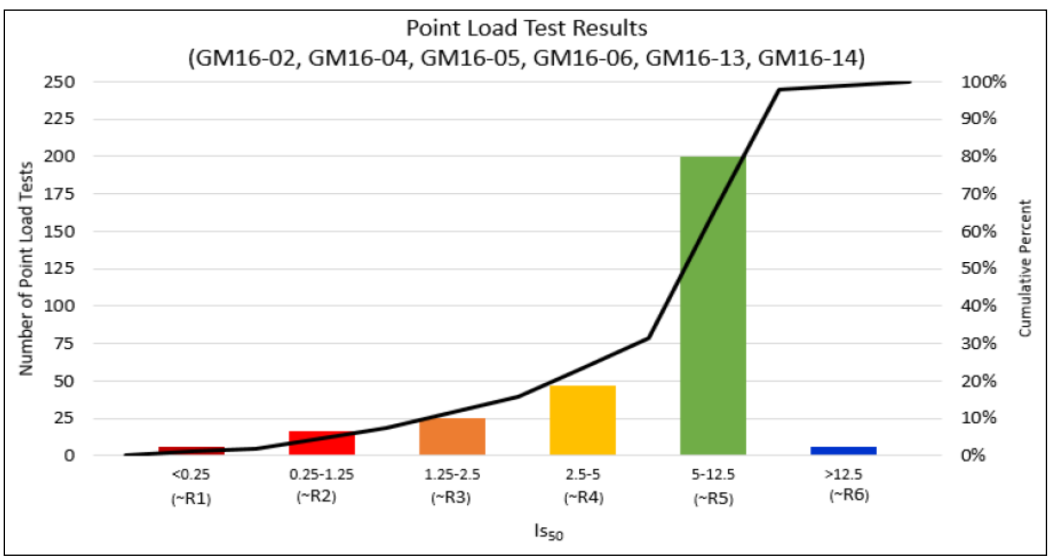
Table 62. Summary of Point Load Testing, Modified from Golder 2017

Hole ID	Number of Point Load Tests
GM16-02	33
GM16-03	41
GM16-04	76
GM16-05	28
GM16-13	46
GM16-14	76

A histogram of Is50 (Is50 is the point load strength with the size of samples corrected; according with ASTM standard D 5731-01 named before) calculated from the point load test results, and the approximate equivalent ISRM field strength is presented in Figure 16. The ISRM field strength grouping are based on the following correlation between UCS and Is50, assumed based on typical correlation value.

$$UCS = 20\ x\ Is50$$

An all point load test was performed at the Vale core shed and are presented together.



Source: Golder, 2018.

Figure 16. Histogram of Point Load Test Results

Rock core samples were collected by Golder personnel from holes GM16-04 and GM16-14 for UCS testing after the core was logged and photographed. Samples were shipped to Golder´s laboratory in Burnaby, British Columbia for UCS testing. UCS tests were only performed on samples from GM16-04 and GM16-14 (Golder, 2018), see Table 63 below.

Table 63. UCS Results Summary, Modified from Golder

N°	Borehole #	Sample #	Depth (ft)	Stress SigmaU (Mpa)	Rock Type	Failure Mode	
						Type	(deg)
1	GM16-04	1	8,0 - 8,8	50,7	Sandstone / Arkose	6	-
2	GM16-04	2	79,5 - 80	64,7	Sandstone / Arkose	1	-
3	GM16-04	3	151,7 - 152,5	119	Sandstone / Arkose	2	-
4	GM16-04	4	212,8 - 213,4	109,2	Siltstone	2	-
5	GM16-04	6	296,2 - 297,0	96,6	Siltstone	2	-
6	GM16-04	7	370,6 - 371,3	139,4	Siltstone	7*	-
7	GM16-04	8	410,0 - 410,8	138	Sandstone / Arkose	2/6	-
8	GM16-04	9	441,0 - 442,0	152,8	Sandstone / Arkose	7*	-
9	GM16-04	11a	563,1 - 564,3	24,4	Sandstone / Arkose	6/7*	-
10	GM16-04	11b	563,1 - 564,3	124,7	Breccia	6*	-
11	GM16-04	12	597,1 - 597,9	40,9	Sandstone / Arkose	6*	-
12	GM16-04	13	652,7 - 653,8	113	Sandstone / Arkose	7*	-
13	GM16-04	16	742,0 - 742,6	2,8	Sandstone / Arkose	1	-
14	GM16-14	1	30,3 - 31,0	16,5	Sandstone / Arkose	5	19
15	GM16-14	3	115,9 - 116,7	123,4	Siltstone	5	25
16	GM16-14	4	167,0 - 167,8	81,5	Siltstone	6	-
17	GM16-14	5	245,5 - 246,1	99,3	Siltstone	6*	-
18	GM16-14	6	306,0 - 306,5	92,7	Siltstone	6*	-
19	GM16-14	7	375,2 - 375,9	118,9	Siltstone	6*	-
20	GM16-14	9	482,8 - 483,4	90,1	Sandstone / Arkose	6	-
21	GM16-14	10	560,6 - 561,3	78,2	Siltstone	6*	-
22	GM16-14	11	597,9 - 598,5	133,8	Sandstone / Arkose	5*	28
23	GM16-14	12	630,7 - 631,3	44,6	Sandstone / Arkose	5	27

Note: Codes for failure mode as follows:
1.- diagonal shear plane(s); 2.- vertical fracture(s); 3.- vertical splitting; 4.- shear along discontinuity; 5.- conical; 6.- spalling; 7.- other.

The following observations have been made with respect to the UCS results:

- Field strength estimates for the intervals that were sampled UCS results for eight out of 23 samples. Where different, the laboratory UCS was generally higher than the field estimate. This is commonly the case for relatively strong rock since it can be difficult to distinguish between an R4 and R5 rock in the field.
- Spalling was the most common mode of failure, with several tests showing signs of high energy spalling prior to failure.

3.3.1.3 Field Estimates of Rock Strength

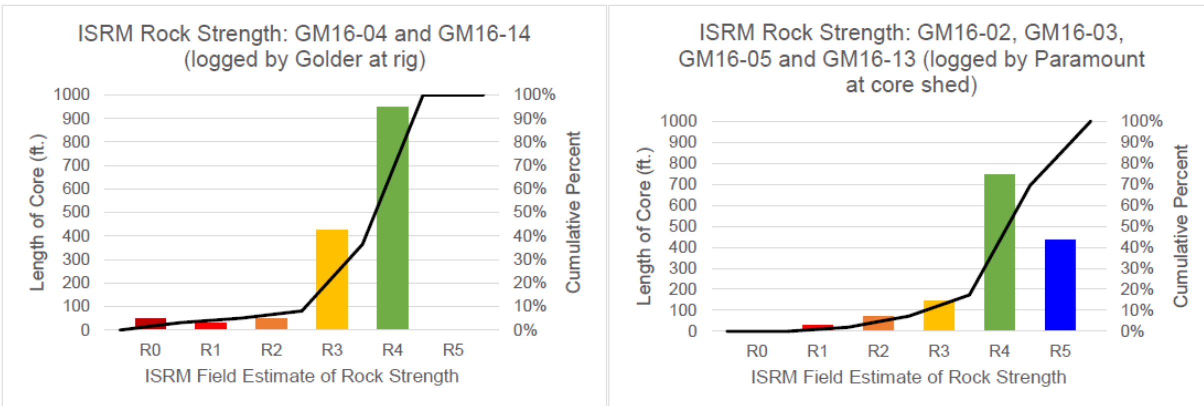
Field estimates of intact rock strength were carried out by Golder and Paramount personnel during core logging. No field strength estimates were assigned to zones of "lost core" or no recovery. The field estimates of intact rock strength are based in the ISRM method (ISRM 1981) summarized in Table 64.

Table 64. Field Estimate of Strength

Grade*	Term	Uniaxial Comp. Strength (MPa)	Point Load Index (MPa)	Field estimate of strength	Examples
R6	Extremely Strong	> 250	>10	Specimen can only be chipped with a geological hammer	Fresh basalt, chert, diabase, gneiss, granite, quartzite
R5	Very strong	100 - 250	4 - 10	Specimen requires many blows of a geological hammer to fracture it	Amphibolite, sandstone, basalt, gabbro, gneiss, granodiorite, limestone, marble, rhyolite, tuff
R4	Strong	50 - 100	2 - 4	Specimen requires more than one blow of a geological hammer to fracture it	Limestone, marble, phyllite, sandstone, schist, shale
R3	Medium strong	25 - 50	1 - 2	Cannot be scraped or peeled with a pocketknife, specimen can be fractured with a single blow from a geological hammer	Claystone, coal, concrete, schist, shale, siltstone
R2	Weak	5 - 25	**	Can be peeled with a pocketknife with difficulty, shallow indentation made by firm blow with point of a geological hammer	Chalk, rocksalt, potash
R1	Very weak	1 - 5	**	Crumbles under firm blows with point of a geological hammer, can be peeled by a pocketknife	Highly weathered or altered rock
R0	Extremely weak	0.25 - 1	**	Indented by thumbnail	Stiff fault gouge

*Grade according to Brown. **Point load test on rocks with a uniaxial compressive strength below 25 MPa are likely to yield ambiguous results. Source: ISRM suggested methods, 1981.

Histograms of the ISRM field estimates of intact rock strength are presented in Figure 17 below. The data for GM16-04 and GM16-14 (detailed logging by Golder personnel at the rig) are plotted separately from the four oles logged by Paramount personnel at the core shed for comparison.



Source: Golder 2018.

Figure 17. Rock Strength – Detailed Core Logging

The distribution of strength from point load test is broadly similar to the field estimated strengths. The absolute magnitude of the UCS based on the Is50 is uncertain since no site-specific correlation exists.

3.3.1.4 Structural Analysis

The purpose of the structural model is to describe the orientation and spatial distribution of the structural defects that are likely to influence the stability of the mine. A structural model for mine design is typically developed at two levels, major structure and structural fabric. This differentiation relates largely to continuity of the features and the resultant impact with respect to the mine design elements. Major faults are likely to be continuous, both along strike and down dip, although they may be relatively widely spaced. Hence, they could be expected to influence the design at the mine scale. On the other hand, the structural fabric typically has limited continuity but close spacing, and therefore becomes a major consideration in stope design scale and development.

3.3.1.4.1 Major Structure and 3D Model

The gold-silver deposit is situated within a zone of complex extensional block faulting and rotation (Figure 18). Faults at Grassy Mountain are dominated by N30°W to N10°E striking normal faults developed during Basin and Range extension and are inferred to have post-mineral displacement. On the east side of the deposit, these faults are inferred to have down-to-the east movement based on interpreted offsets of a prominent white sinter bed in drill holes, as well as drilled intersections of fault gouge. A set of orthogonal, N70°E-striking high-angle faults of minor displacement are inferred to link the graben faults. One of these, the Grassy fault, has vertical offset of only ten to 40 feet or less, but it coincides with the axis of the high-grade core of the deposit.

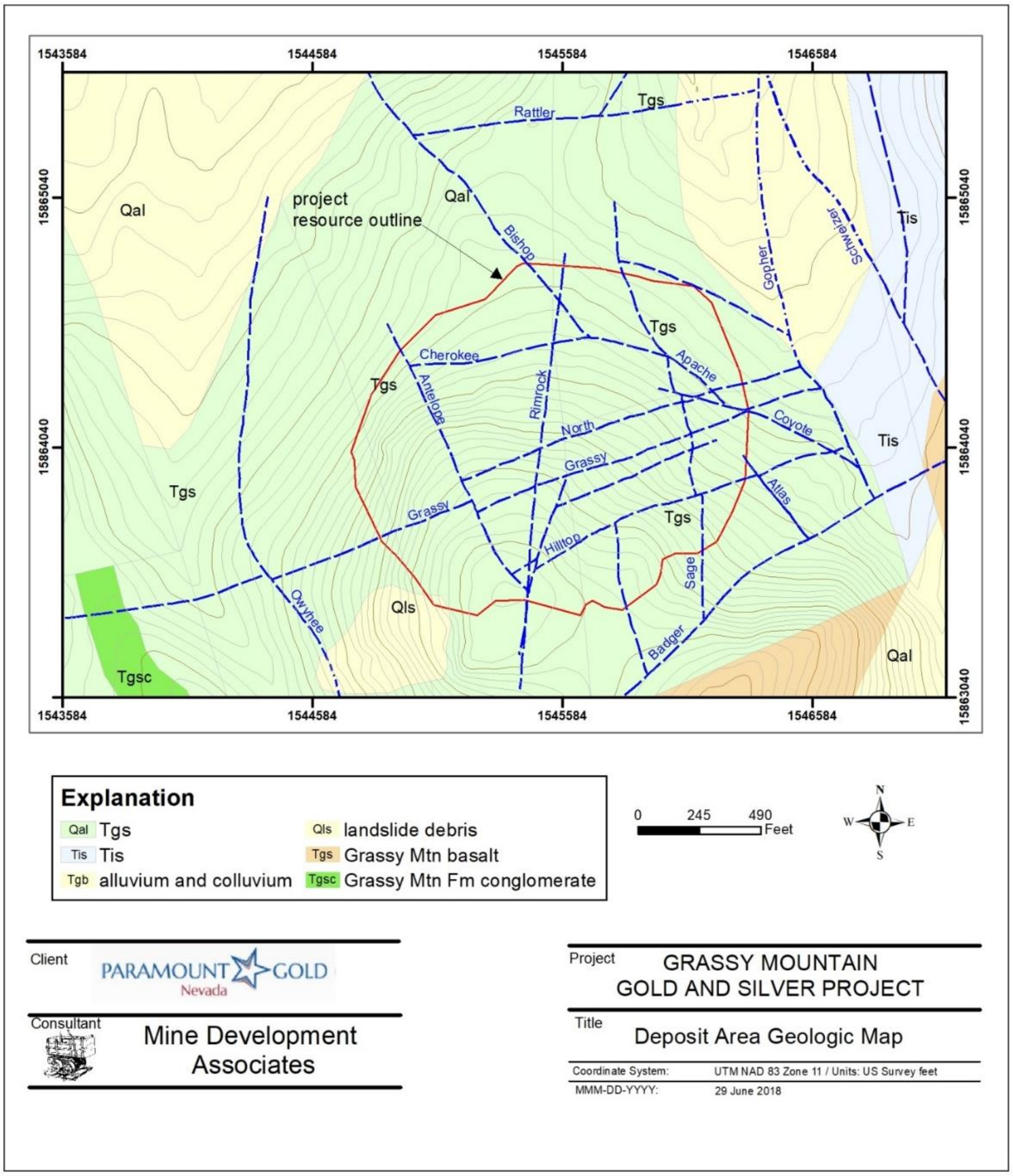


Figure 18. Major Faults in the Deposit Area

3.3.1.4.2 Structural Fabric

The geotechnical holes drilled in the 2016–2017 campaign were drilled with “Triple Tube” techniques to increase core integrity and preservation for best geotechnical logging and measurements. Observations of the core suggest that there is little systematic structure, except for the very steep features often sub-parallel to core axis that are likely oriented similarly to the interpreted northwest-southeast striking structural set that is associated with mineralization. The remaining structure is typically very small scale, irregular, and generally related to micro-defects within the rock mass.

3.3.1.5 Summary of Geotechnical Analysis and Evaluation for Underground Mining

Ausenco believes the available geotechnical data are adequate for designing the mine openings associated with the estimation of the Grassy Mountain mineral reserves at current stage. Risks associated with the current level of geotechnical analysis are discussed in the PFS (MDA 2018).

While the rock quality is variable, and the deposit is mineable based on the chosen mining method, care will need to be taken during the execution of the mining plan. The selected mining method and underground support recommendations are specified in the PFS (MDA 2018).

3.3.2 Underground Mining Method

Initial surface access to the estimated reserves, which lie at depths between 500 and 700 feet below the surface, will be via a portal and decline. This portal is further described in Section 3.3.8 Mine Access. The decline will be developed from the portal proceeding on an approximately 12 to 14 percent slope down to the lowest mineralized zones. D&F techniques, also known as cut-and-fill, will be used to mine the orebody.

A total of 32 levels, each of 15 feet in height, are in the current mine plan.

The decline will provide the connection to all services. The design intent is to have the decline located as close as possible to the mineralization in order to reduce transportation costs, but sufficiently removed from mining activities to ensure that the decline is geotechnically stable for the planned life of mine. A summary of the mine design dimensions is shown in Table 65.

Table 65. Underground Mine Design Dimensions

Activty Type	Width (ft)	Height (ft)	Diameter (ft)	Length (ft)	Maximum Gradient (%)
Decline	15	15		varies	12 to 14
Level Access	15	15		varies	0 to 14
Ventilation Access	15	15		varies	0
Sump	15	15		50	-12
Stockpile	15	15		50	0
Power Station	15	15		50	0
Loading Bay	15	15		50	0
Production Drifts	15, 20, & 30	15		varies	0
Decline Turning Radius				100	
Ventilation Raise			9		Vertical

Excavated waste rock from the decline construction will be stored on the surface in the WRD area (Section 3.3.4). Other excavations for ventilation would also connect the underground with the surface.

A surface explosive magazine for storage of blasting materials will be constructed according to the Mine Safety and Health Administration (MSHA) and U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives (BATFE) regulations. Blasting agents will include ammonium nitrate and fuel oil (ANFO) and emulsions. An explosives truck will be loaded with blasting agents at the surface explosives magazine. Caps and boosters will be hauled in separate dry boxes.

The D&F mining method was selected using the methodology proposed by Nicholas (1981), taking into account the geometry and the geotechnical conditions of the Grassy Mountain gold deposit. The D&F method is highly flexible and can achieve high recovery rates in deposits with complex and flat-dipping geometries, as is the case at Grassy Mountain. The D&F design proposed for levels 3315, 3300, and 3285 is shown in Figures 19, 20, 21 and 22. Each level plan shows the proposed mine operational layout.

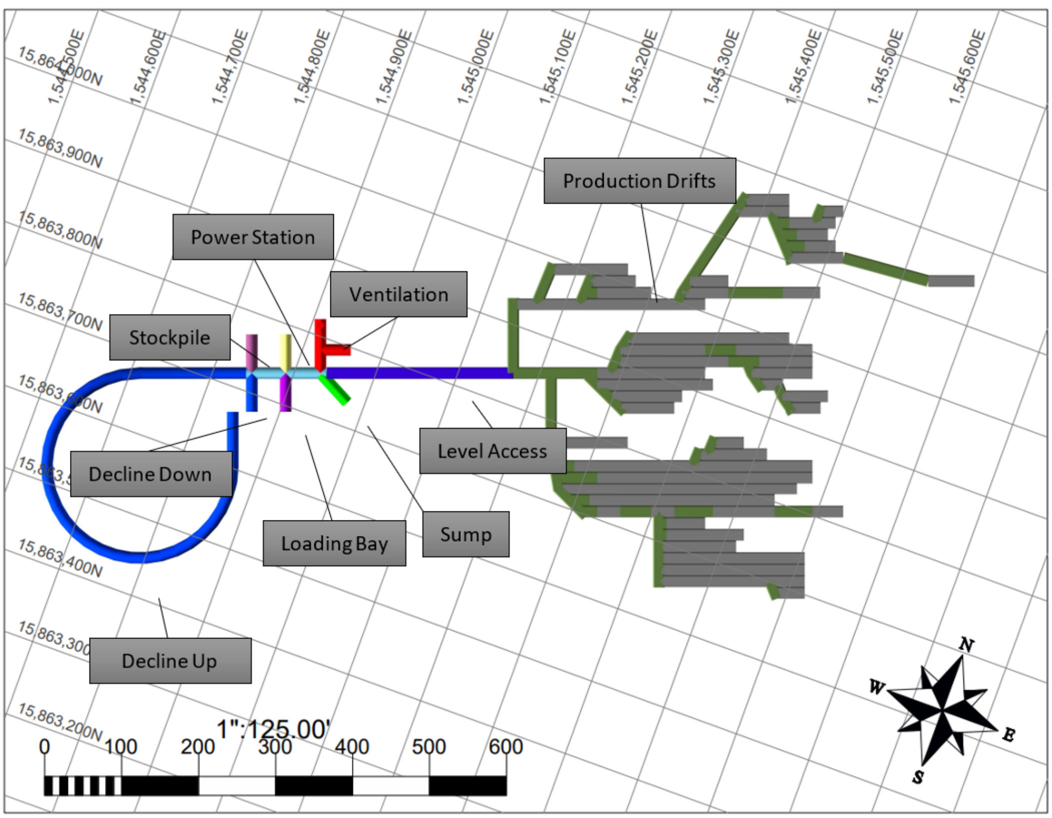


Figure 19. Proposed Drift and Fill Design for the 3315 Level

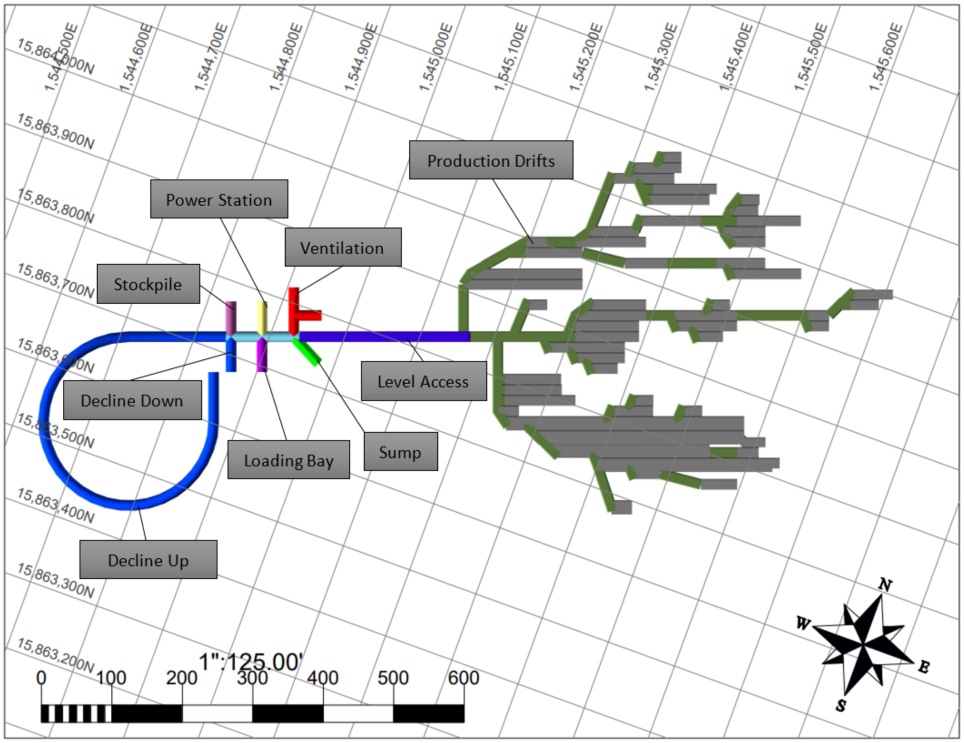


Figure 20. Proposed Drift and Fill Design for the 3300 Level

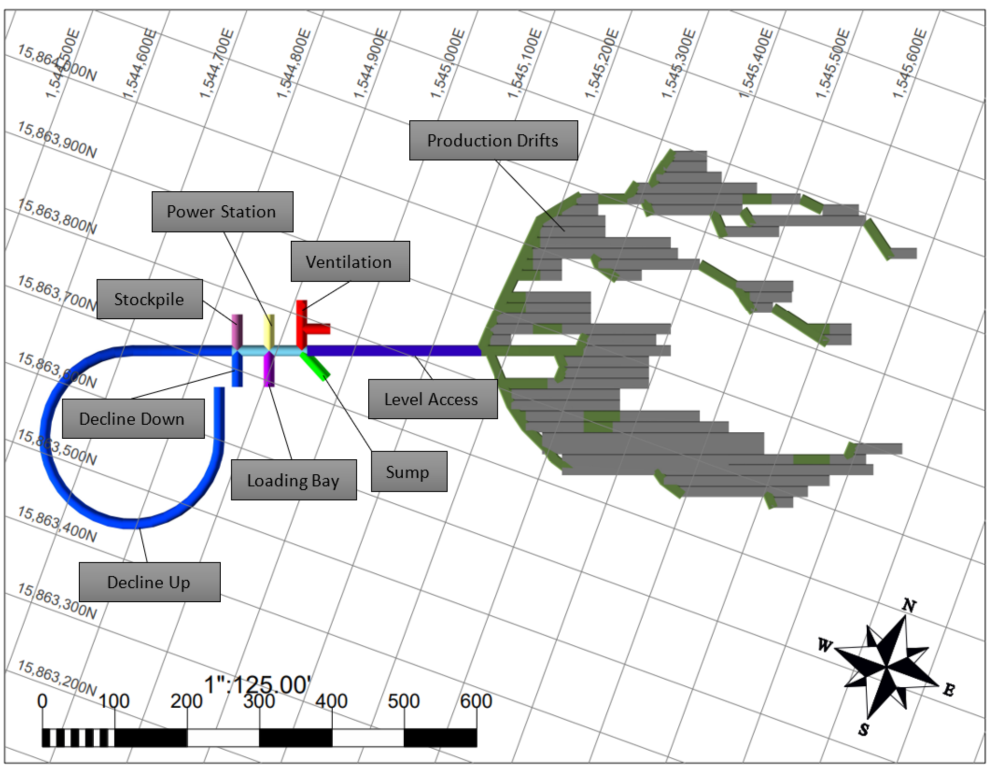


Figure 21. Proposed Drift and Fill Design for the 3285 Level

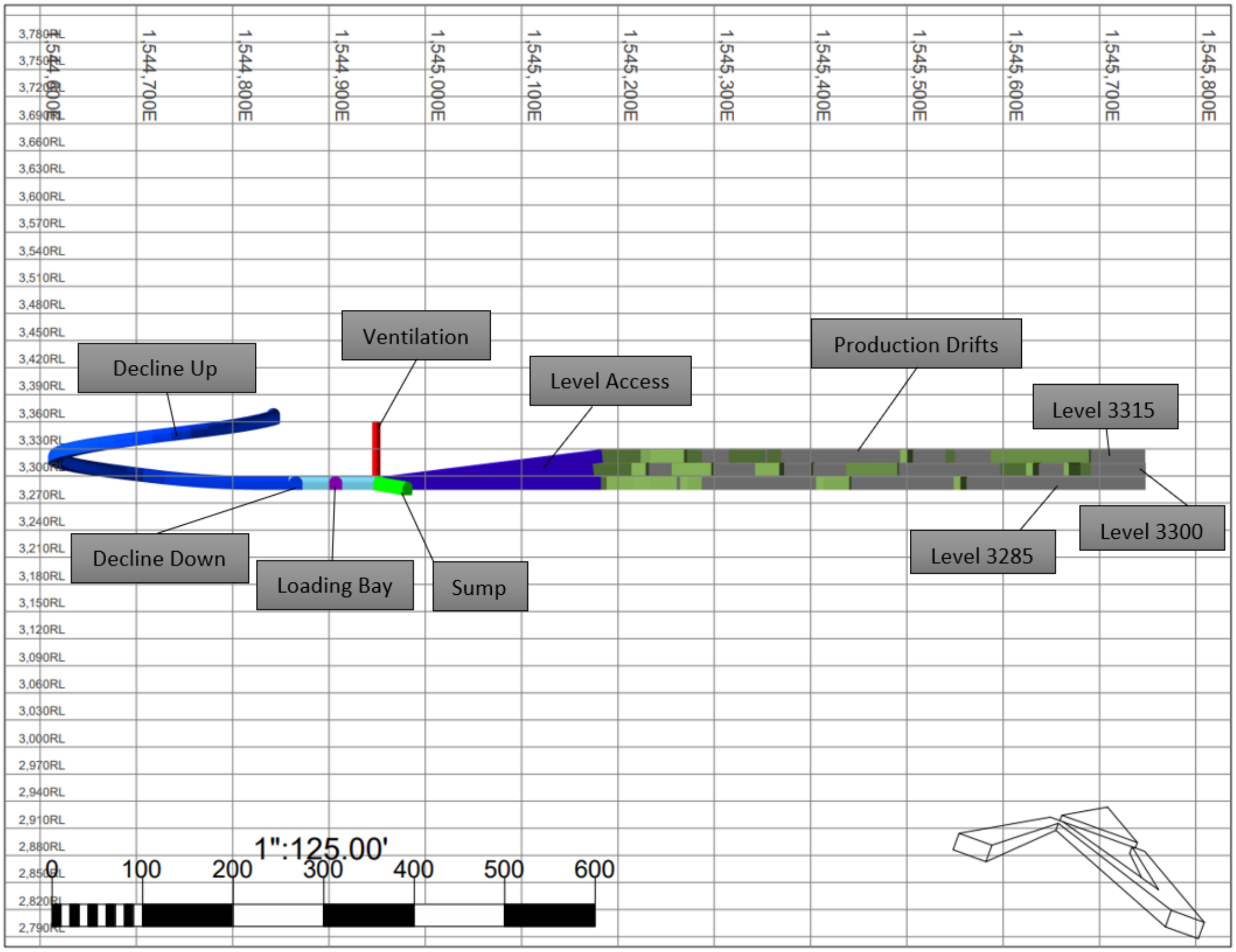


Figure 22. Section View of Drift and Fill Designs for the Levels 3315, 3300, and 3285

Each development level will have a sump, power station, ventilation raise, a stockpile, a truck loading bay, and access to the decline. Each development level will have access to three to five production levels depending on the geometry of the mineralized reserves. Each production level will have a few main hauling routes developed in ore, as much as possible, to minimize waste extraction. From these routes, interconnected drifts will be used to mine the ore.

The production will utilize a combination of top-down and bottom-up mining directions depending on mineralization geometry and economic factors. The areas using a bottom-up direction will be sequenced in the following order:

Bottom-Up Sequence

1. Mine primary production drifts;
2. Fill primary production drifts using CRF;
3. Mine secondary production drifts;
4. Fill secondary production drifts using RF; and
5. Procced to next level up.

The areas using a top-down direction will be sequenced in the following order:

Top-Down Sequence

1. Mine a production drift;
2. Fill the production drift with CRF;
3. Repeat steps 1 & 2 until the level is filled with CRF; and
4. Procced to the next level down.

All production and development levels will be backfilled with CRF or RF after production is complete (see Section 3.3.5.). Backfill material will be mine waste which had been previously stored on the surface and basalt from the Borrow Pit proposed on the far east side of the Permit Area. The material to be used for CRF will have sufficient cement added to neutralize any acid generation potential. If waste is not suitable, it will be permanently stored in the waste rock storage facility, which is to be a fully lined facility adjacent to the TSF. The mining operation will generate less than 200,000 tons of mine waste and therefore the majority of the backfill material will be composed of basalt that will be mined from the project Borrow Pit. The basalt has been tested and does not have acid generating potential (Appendix B).

The maximum D&F dimensions (Table 65 and Figure 23) were defined to ensure underground stability, based on the geotechnical conditions. These dimensions were estimated using the methodology proposed by Mathews (1981), which considers the hydraulic ratio of the drift and the geology and geotechnical conditions of the deposit.

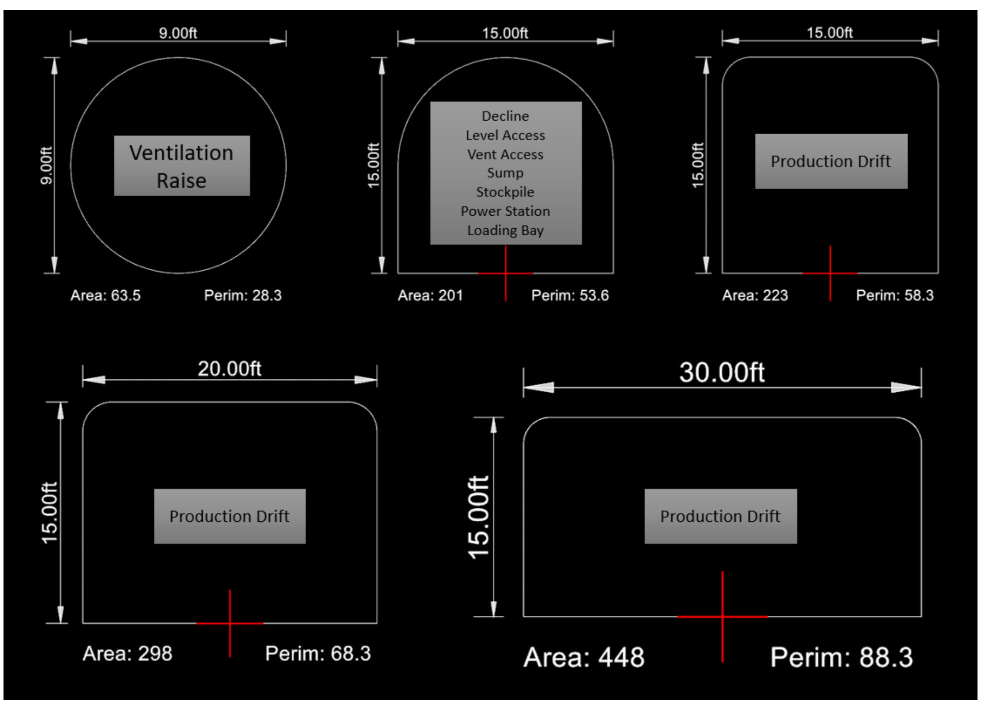


Figure 23. Underground Drift Profile Sections

3.3.2.1 Surface Stability Assessment

Surface stability is critical to ensure safe underground extraction. The dimensions and stability of the area between surface and the mine are a function of several parameters. The most important parameters are the width of the orebody, the stress regime, the blasting practices, the rock mass strength, the extraction sequence (top-down or bottom-up), and whether backfill will be introduced into the system.

The ground conditions in the Grassy Mountain deposit are estimated to be without problematic stress conditions. The mining method selected, the support designed, and the backfill together will ensure the mine to be stable, allowing safe underground extraction without surface subsidence. The operating mine plan has incorporated a geotechnical instrumentation plan for the entire mine with topographic instrumentation on surface to monitor stability.

3.3.2.2 Drilling and Bolting

Production and development drilling will be done using electric-hydraulic development-drill jumbos. Twin-boom jumbos are planned for large-dimension development rounds. Bolting machines will provide for ground support installation.

3.3.2.3 Blasting

Local contractors will perform blasting services. Emulsion will be used for most production blasting and development rounds. Boosters, primers, detonators, detonation cord, and other ancillary blasting supplies will also be required. Bulk explosives will be stored in a secure powder magazine on surface in accordance with current applicable explosives regulations.

Blasting will occur at designated times using a centralized blasting system. Where ventilation allows, on-shift-blasting of isolated high-priority development headings is anticipated.

Once the jumbo drill has completed the drilling cycle, the emulsion blasting agent will be loaded into the holes with the respective NONEL® blasting cap and booster. The timing of the round with the NONEL® caps is extremely important as it is critical to pulling the maximum amount of distance per round.

For decline development with a 15-foot by 15-foot profile, an estimated 591 pounds (268 kg) of emulsion is required for each round. The powder factor will be 3.90 lbs/ton (1.95 kilogram per ton [kg/t]) assuming 164 tons of material movement per round. For level access development, an estimated 507 pounds (230 kg) of emulsion will be required for each round. A powder factor of 3.86 lbs/ton (1.93 kg/t) is estimated for level-access development assuming 129 tons of material will be moved per round.

3.3.2.4 Ground Support

Ground support will be installed with specifications based on the geotechnical analysis discussed in the Prefeasibility Study report (Mine Development Associates, 2018). The support analysis was carried out using empirical techniques based on recommendations from Barton et al. (1974) and Barton (2002). The empirical design used the support abacus approach, which relates the rock mass quality (Q) to an equivalent dimension (De). The Q value was obtained from a range of values that define each rock class, derived from Gonzalez de Vallejo (2004) as follows:

$$RMR = 9 * Ln\,(Q) + 44$$

These values use the RMR and Q values summarized in Table 66 that are based on the three rock classes shown in Figure 24.

Table 66. Interpreted Relationship between RMR and Q

Rock Class	$RMR_{B'89}$		Q Barton '74	
	Min	Max	Min	Max
Class 1	21	40	0.08	0.64
Class 2	41	60	0.72	5.92
Class 3	61	80	6.61	54.60

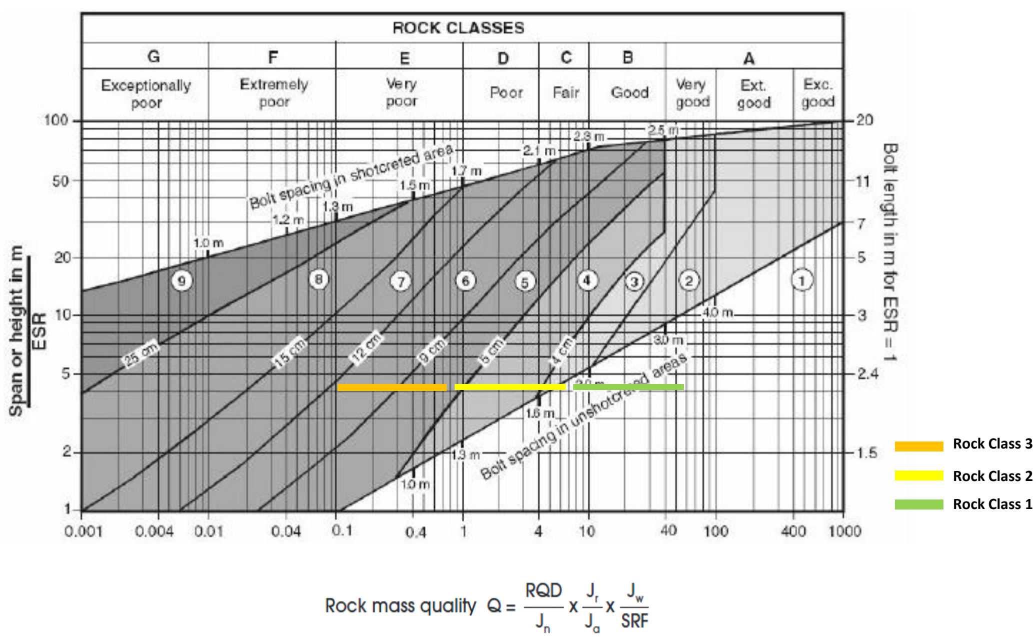


Figure 24. Rock Mass Quality and Rock Support

The De value is obtained by dividing the size of the excavation by the excavation support ratio (ESR), which is relative to the intended use of the excavation and the required factors of safety (FOS), and based on the following empirical relationship:

$$De = \frac{Excavation\ Span, diameter\ or\ height\ (ft)}{Excavation\ Support\ Ratio\ ESR}$$

An ESR equal to 1.0 was selected as a conservative parameter for the De calculation.

Dimensions for the decline, level access, and drifts were calculated using the following equation:

$$De = \frac{15\ (ft)}{1.0} = 15$$

- Decline: 15 by 15 feet;
- Level Access: 15 by 15 feet; and
- Drifts: 20 by 13 feet.

The decline ramp 15-foot by 15-foot dimension was used as maximum excavation span, which is considered for permanent infrastructure. The other infrastructure is considered to be temporary. The recommended support is shown in Table 67.

Table 67. Support Recommended (based on Barton 2002)

Rock Class	Q	Value	Support Pattern (ft)			Shotcrete (ft)
Class 1	0.08	Min	4.3	x	4.3	0.2 – 0.3
	0.64	Max	5.2	x	5.2	
Class 2	0.72	Min	5.6	x	5.6	0.16 – 0.2
	5.92	Max	6.9	x	6.9	
Class 3	6,61	Min	5.9	x	5.9	Occasional
	54,60	Max	10.8	x	10.8	

The support pattern and shotcrete thickness for the decline ramp should be assigned according to the rock class indicated in Table 34.The geotechnical stability analysis also indicates that the support pattern and shotcrete thickness for the level access and drifts will be associated to rock class 2 and rock class 1, respectively.

The length of the bolts (Lb) as proposed by Barton (1980) was estimated using the following empirical relationship:

$$Lb = 2 + 0.15 * \frac{D}{ESR}$$

Where the D is the maximum span dimension for each access and ESR is equal to 1.0.

Table 68 shows the rock bolt length calculated for the decline ramp, level access, and drift sections.

Table 68. Estimated Rock Bolt Lengths

Infrastructure	Section (ft)	Bolts Length (ft)
Decline Ramp	15 x 15	8.8
Level Access	15 x 15	8.8
Drift	20 x 13	8.5

The installation of the advance support as a function of the distance to the excavation front has been evaluated using the empirical relationship as follows:

$$Max\ Span\ Unsupported = 2 * ESR * Q\hat{}0.4$$

Table 69 shows the maximum distance to the excavation front by rock class.

Table 69. Maximum Unsupported Span

Rock Class	Q	Range	Maximum Span (Unsupported) (ft)
Class 1	0.08	Min	2.3
	0.64	Max	5.6
Class 2	0.72	Min	5.9
	5.92	Max	13.5
Class 3s	6.61	Min	14.0
	54.60	Max	32.5

An example of ground support design for the main decline in Grassy Mountain is shown in a cross section view in Figure 25.

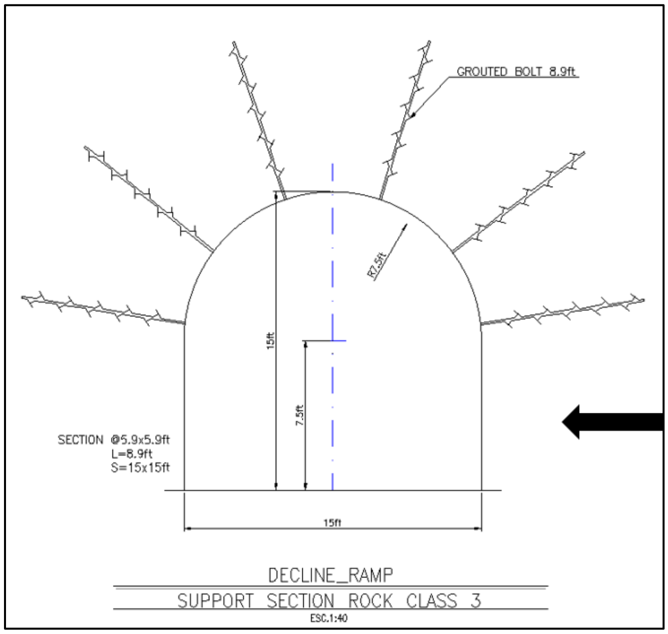


Figure 25. Cross Section of Support for Decline (Rock Class 3)

3.3.2.5 <u>Mucking</u>

Load-haul-dump vehicles (LHDs) with a nominal 5.2 cubic yard (yd^3) bucket capacity will be used for decline development and excavation of level accesses, drifts, and footwall drives. Backfill placement will also be done using the 5.2 yd^3 LHDs.

The LHDs will be used to load the underground mining trucks using the same main access for each level. Material will then be hauled by the trucks up the decline to the surface and dumped at the ore stockpile or waste dump as appropriate. A front-end loader will feed the ore from the stockpile into the primary crusher. On every development level 15 feet by 50 feet truck loading bay will be excavated off the decline back to make sufficient room for loading operations.

3.3.2.6 <u>Haulage</u>

The planned haulage will use conventional low-profile underground-mining trucks of 20 ton equipped with ejector beds. For all mining levels, trucks loaded underground will transport the ore and waste directly to surface. Once unloaded on the surface, the truck capacities will be used to transport backfill materials on their return trips into the mine.

Ore that is hauled to surface as part of mine scheduling will be placed in the crusher stockpile. Waste rock hauled to surface will be deposited at a WRD facility that will be located about 1,640 feet from the mine portal. The waste will be fully utilized over the mine life as CRF material, reducing the total amount of basalt borrow material required over the mine life.

3.3.3 Mining Equipment

Mine operations at Grassy Mountain will utilize mobile mining equipment suitable for underground mines as specified in Table 70. The estimate of the fleet size was based on equipment running-time requirements to achieve the mine production plan.

Table 70. Mine Equipment Requirements

Underground Mining Equipment	Quantity
Drilling Development Jumbo (Sandvik DD210)	2
Bolter (Sandvik DS311)	1
LHD 5.2 yd3 (CAT R1600)	4
Front-end Loader (JCB 456ZX)	1
Truck with Ejector Bed (CAT AD22)	3
Emulsion Loader (CAT 440)	1
Telehandler (JCB 540-170)	2
Bulldozer (Cat D6T)	1
Motor Grader (Paus PG5HA)	1
Service Truck (Chevrolet Colorado)	1
Diamond Drilling (Hydracore Gopher)	1

During the first year of usage, the utilization is restricted to the range between 50 percent and 60 percent for all the equipment due to the limited production faces. The productivities of development drill and long hole drill are 222 feet per hour (ft/hr) and 114 tons per hour (ton/hr), respectively. The truck productivity varies from 15 to 153 tons/hr depending the haul distance. The shortest haul distance is only 1,640 ft and the longest is more than 12,000 ft.

The maximum permanent underground mine equipment required for the LOM are summarized in Table 71.

Table 71. Mine Equipment Requirements

Underground Mining Equipment	Quantity
Drilling Development Jumbo (Jumbo DD21-40)	2
Bolter (Sandvik DS311)	1
LHD 5.2 yd^3 (LH410)	4
Front-end Loader (JCB 456ZX)	1
Low Profile Truck (AD30)	3

Underground Mining Equipment	Quantity
Emulsion Loader	1
Telehandler (JCB 540-170)	2
Bulldozer (Cat D6T)	1
Motor Grader (Paus PG5HA)	1
Fuel Truck	1
Service Truck	1
Diamond Drilling (Hydracore Gopher)	1

During very limited peak times, the maximum requirement of low-profile trucks will be five, however, only three trucks are considered as permanent fleet and additional trucks will be provided by a local contractor sporadically.

3.3.4 Waste Rock Storage

A single waste rock storage area will be constructed over the life of the Project to temporarily store the approximately 0.2 million tons of material. A haul road will connect the portal with the waste rock storage area. The design of the WRD facility is included in Appendix C.

The WRD is designed to employ the same containment system design and underdrain collection piping system as the TSF described in Section 3.3.13 below. The design criteria presented below are based on OAR, requirements of the Project as defined by Calico, and Golder's experience designing and constructing lined WRDs in similar environments. The following OAR Divisions have been used to develop minimum acceptable design levels:

- DOGAMI, Chemical Process Mine Regulations, OAR 632, Division 37
- ODFW, Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420
- ODEQ, Chemical Mining, OAR Chapter 340, Division 43

The WRD design criteria in Table 72 presents the minimum design criteria proposed for the Project WRD and the corresponding OAR Regulation or Guideline.

Table 72. WRD Design Criteria Table

Parameter	Value	Reference or Regulation
Capacity	200,000 tons	Ausenco/MDA
WRD Containment System (top to bottom)	Continuous 80-mil high-density polyethylene liner (HDPE) geomembrane, geosynthetic clay liner (GCL), prepared subgrade	Golder
WRD Underflow Collection System	Perforated and solid CPE and HDPE gravity draining piping network	OAR 690-020-0038
WRD Leak Detection System	Perforated 2-inch diameter Schedule 80 PolyVinyl Chloride (PVC) pipe network and monitoring ports	OAR 340-043-0000
WRD Underflow Collection System	Perforated and solid CPE and HDPE gravity piping network in 18-inch-thick drainage layer 6-inch-thick filter layer Gravity flow to reclaim pond	Golder and OAR 340-043-0050
WRD Design Earthquake, Operational	475-year return period	Golder
Peak Ground Acceleration, PGA	0.08g	Golder
Horizontal PGA Factor, k, for pseudo-static stability analyses	½ of the PGA	Haynes-Griffin, Franklin (1984) and Seed (1982)
Static Stability, Factor of Safety	1.5 (minimum)	Golder
Seismic Stability (pseudo-static), Factor of Safety	1.1 (minimum)	Golder

Water Management: An underdrain collection system will also be installed above the geomembrane liner for the WRD. The system will capture and convey any storm water that contacts the stockpiled material above the geomembrane liner. Similar to the TSF described in Section 3.3.13, the collection system will consist of a series of perforated corrugated polyethylene (CPE) and HDPE pipes installed within the drainage layer above the geomembrane liner.

Prior to exiting the WRD, the perforated HDPE collection pipe will transition to solid-wall HDPE dual containment WRD underdrain pipe. The WRD underdrain delivery pipe consist of a six-inch diameter DR17 HDPE carrier pipe and an outer ten-inch diameter DR17 HDPE containment pipe. The WRD containment system design is presented on the Design Drawings in Appendix C.

The underdrain outlet pipe will travel overland to the Stage 1 TSF impoundment where the outer ten-inch diameter HDPE containment pipe will terminate above the geomembrane lining system.

The six-inch diameter DR17 HDPE solid wall carrier pipe will continue to the TSF reclaim pond described in Section 3.3.13. Prior to discharging into the reclaim pond, the WRD underdrain outlet pipe will enter an open channel monitoring flume for sampling and flow rate measurement.

WRD Stability: The WRD is designed to remain in place during operation only. Due to the temporary nature of the WRD, geotechnical stability of the WRD was performed for static and pseudo-static conditions using an operational basis earthquake (OBE) with a return period of 475 years. The site-specific hazard assessment for the Project is presented in Appendix C. The following table presents the geotechnical stability analysis results for the WRD.

Table 73. Summary of Critical WRD Stability Analysis Results

Analysis Method	Static FOS (Target design minimum is 1.5)		Pseudo-static FOS (k = 0.04 g) (Target design minimum is 1.1)	
Effective Stress	Failure through Foundation	Waste Rock Slide over the Liner	Failure through Foundation	Waste Rock Slide over the Liner
	1.8	1.6	1.6	1.4

Detailed discussions on analyses and construction-level design of the WRD containment system are presented in Appendix C.

3.3.5 Backfill

The backfill method has been selected according to the geological and geotechnical conditions of the deposit, as well as the selected D&F mining method. The main objectives of the backfill are to provide stability to the drifts and to control dilution associated with the ore extraction. CRF and RF will be used in the primary and secondary drifts, respectively. To the extent possible, the waste rock from underground operations will be used for CRF and rock from the borrow pit will be used for RF.

3.3.5.1 Cemented Rock Fill

A plant to produce the CRF will be built as part of the Project infrastructure. The backfill plant will be located near the underground mine portal and will produce the CRF. No test work has been done for CRF at this time, so a standard mix with seven percent cement will be used pending further study. The CRF from the backfill plant will be transported down the decline using the haul trucks. Haul trucks will place the CRF in the production drifts using ejector beds. LHDs will have push plate attachments to jam the CRF as tight as possible to the back.

Control of the CRF slump properties will be an important factor to its successful use. The CRF will need to be thin enough for trucks to handle in the transporting and dumping of the material, but stiff enough to allow the LHDs to pack the material into position. The slump properties will be adjusted based on locations and experience. It is assumed that the curing time for the CRF will be approximately 28 days. Following curing, the adjacent secondary drift can be filled with RF using LHDs. A utility crew will be required to move connections so that backfill is delivered to the appropriate stope. This will allow backfilling to proceed on a 24-hour basis.

CRF will be used to backfill primary drifts allowing for reasonable recovery of secondary drifts. The CRF will have the following properties:

- Cement: 7.0%;
- Water / Cement (ratio): 0.70 to 0.85;
- Waste Rock: 85% – 90% (rock with good geotechnical rating); and
- Nominal Size: -6 inches.

It is assumed that the cement will properly encapsulate any potentially acid-generating material. Thus, the mine waste will be used as available. This will reduce the mine waste storage to zero over the LOM. When mine waste is not available, rock from the borrow pit on the east side of the Project will be utilized for CRF.

3.3.5.2 Rock Fill

The RF will be used in the secondary drifts according to the design and mine plan. It will act as an unconfined filling adjacent to the primary drifts which will have been previously filled with CRF. Basalt material from the borrow pit on the east side of the Project will be used. This basaltic rock is not acid generating (Appendix B).

RF material will be hauled at the ROM size. The transport and disposal of RF into the drifts will use mine trucks that will place the material at unloading points inside the mine, where it will subsequently be loaded and transported to the drifts using LHDs. The LHDs will push the material into place as tight as possible using the push plate attachment.

3.3.6 Mine Drainage

Any mine drainage will be collected and used in the drilling and mining process or pumped to the surface for use in the milling process or will be hauled to the Collection Pond near the Processing Facilities. This water quality will be tested regularly to ensure that the quality meets the intended use. If significant volumes are encountered, the mine drainage will be collected in a water truck and hauled to the processing plant for use/reuse or infiltrated. Dewatering operations are described in Section 3.3.9.1 in this document.

3.3.7 Ventilation

The ventilation network was designed to comply with U.S. ventilation standards for underground mines [Code of Federal Regulations (CFR)/Title 30. Underground metal and non-metal mines. Washington, DC: U.S. Government Printing Office, Office of the Federal Register]. Regulatory concentrations for gases are specified by the 1973 American Conference of Industrial Hygienists

(ACGIH) threshold limit values (TLVs) [71 Fed. Reg. 3 28924 (2006)]. For diesel particulate matter (DPM), a permissible exposure limit (PEL) of 160 µg/m3 total carbon is specified in the U.S. diesel rule for metal/non-metal mines [71 Fed. Reg. 28924 (2006)].

MSHA sets an airflow requirement for the dilution of gas emissions, and an additional airflow requirement for dilution of DPM. These values are published with the list of approved engines on MSHA's internet website. Airflow of 200,000 cubic foot per minute (ft^3/min) was selected as a minimum reference for the ventilation design in order to meet the MSHA ventilation standards.

Required airflows were determined at multiple stages during the mine life, using equipment numbers and utilization rates, specific engine types and exhaust output, and the number of personnel expected to be working underground. The designed ventilation system includes the following parameters:

- Required air flow of 200,000 ft^3/min;
- Two 70HP Fans in parallel with 3.4 in w.g.;
- Air density of 0.072 pound per cubic feet (lb/ft^3); and
- Only four production levels operating at a single time.

The planned ventilation will use an exhaust system and will require two exhaust fans in parallel on the surface. An exhaust vent raise of nine feet in diameter will connect all the levels in the mine to the surface exhaust fans. Figure 26 shows the main components of the proposed ventilation network with air-flow directions. The ventilation is limited to only four production levels operating at a single time.

The development of the ventilation raises will utilize a raise bore machine. A raise bore machine is an electro-hydraulic mechanical method of excavating vertical or near-vertical raises from one level to another level. A pilot hole of nine to 14-inches in diameter is drilled from the upper level to the lower level. Then the reamer is attached and reams from the lower level to the upper level, with smooth circular walls. This will create a raise with a diameter of nine feet.

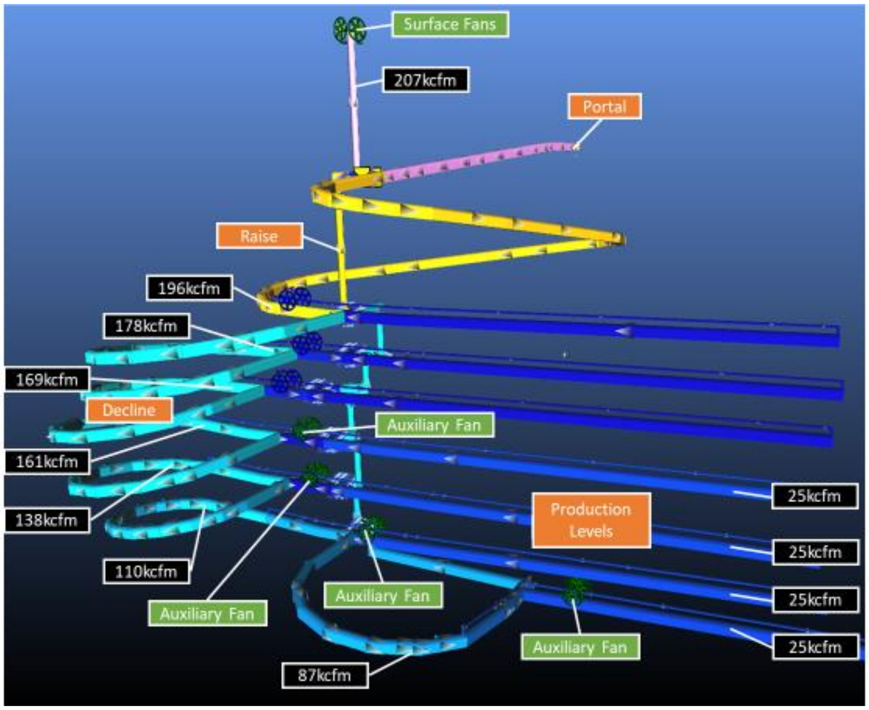


Figure 26. Ventilation Network

3.3.8 Mine Access

The main access portal will be located close to the process plant infrastructure. Figure 27 shows the location and configuration of the portal. Figure 28 shows the cross sectional view of the planned design for the portal.

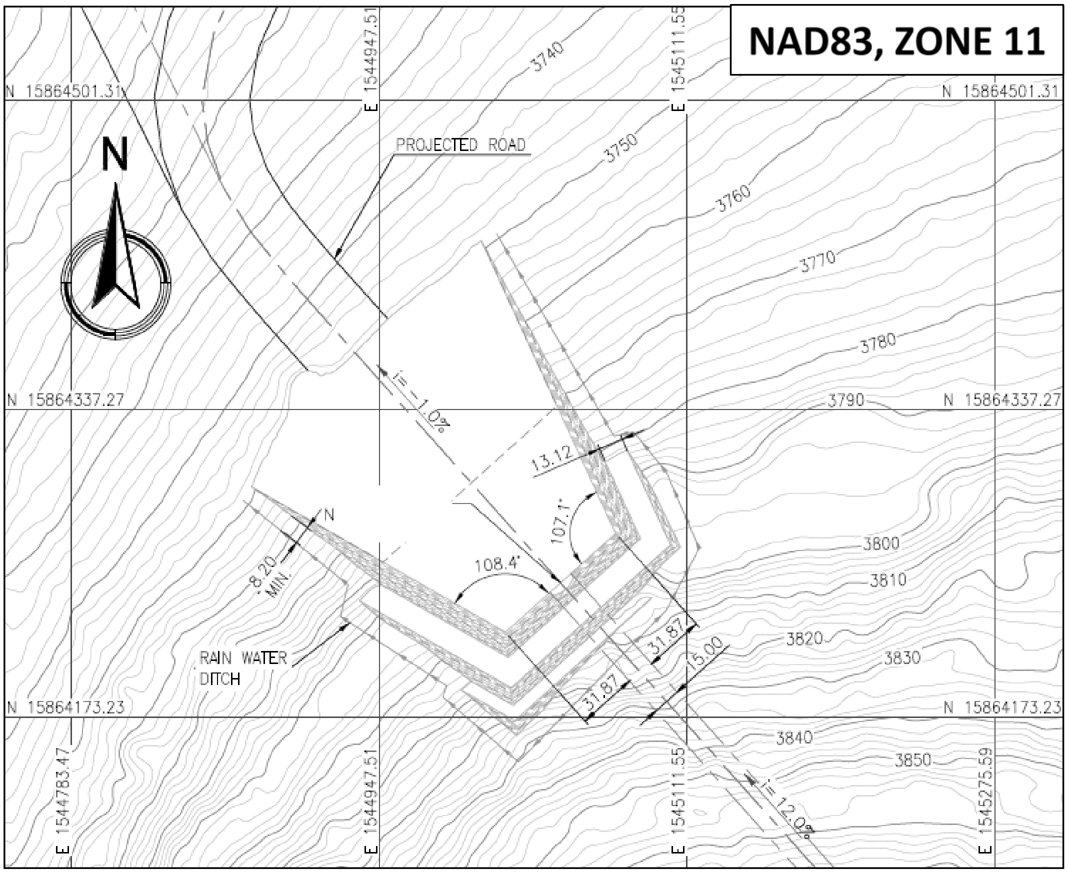


Figure 27. Location of Main Portal Access

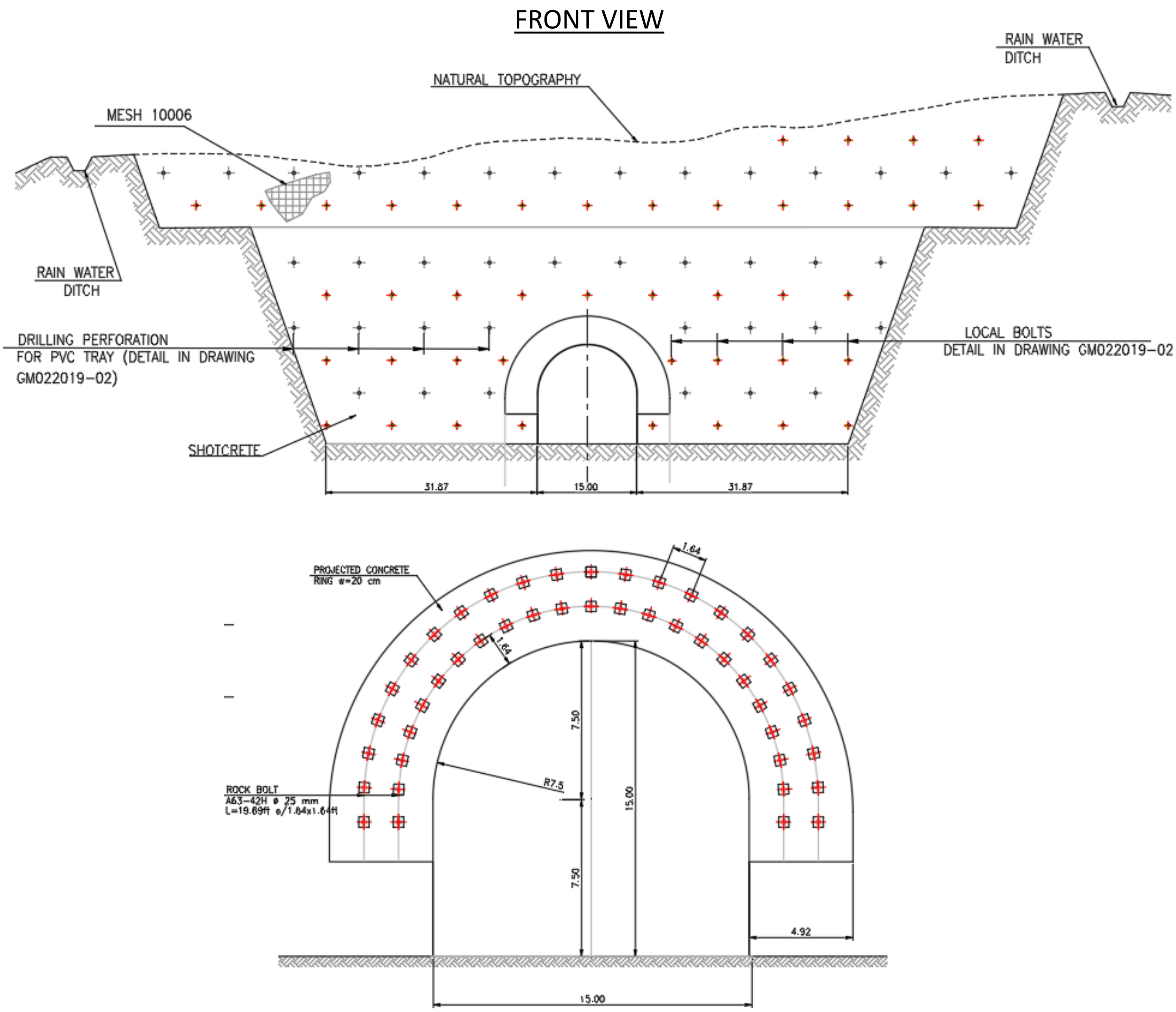


Figure 28. Main Portal Design

3.3.9 Hydrogeology Analysis

This section is from the Groundwater Baseline Data Report (Appendix B) by SPF of Boise, Idaho. This summary is the Conceptual Model from Vol. II of the Groundwater Baseline Data Report.

The aquifer system in the vicinity of the Project occurs within the Grassy Mountain Formation, generally consisting of arkosic sandstone, siltstone, and conglomerate. The unit includes interbedded fine-grained sediments. The Grassy Mountain Formation is the host unit for the Project. The unit is underlain by the Kern Basin Tuff, a fine-grained lithic tuff.

Groundwater is typically found within the Grassy Mountain Formation in unconsolidated or weakly consolidated sandstone and conglomerate units and interbedded sediments. The water-bearing zones appear to be somewhat compartmentalized due to faults, sedimentary facies changes, and silicification in and around the Project. Cross- sections developed from available subsurface lithology demonstrate the variability in water-bearing strata throughout the Project area. However, a relatively consistent and uniform piezometric surface throughout the area indicates some degree of hydraulic connectivity between the various water-bearing zones.

Water levels in the area are typically stable, with some seasonal variations evident in shallow wells or wells otherwise subject to more direct recharge. There is some evidence of a general decline in the shallow aquifer zone in several wells in the vicinity of the Project, possibly due to inadequately sealed boreholes at or near the Project allowing shallow aquifer zones to drain to deeper zones. The observed decline is on the scale of a few feet over several years.

The Grassy Mountain Formation in and near the Project is silicified and strongly indurated. Geophysical data indicates that the zone of silicification increases with depth. Based on available information, a saturated zone occurs within the Project at an elevation ranging from 3,300 to 3,100 feet, which is above the expected maximum depth of the proposed mine (approximately 3,050 feet). However, this zone does not appear to be consistent throughout the Project. While portions of the Project are understood to be saturated, hydraulic conductivity and resultant groundwater flow appear to be severely restricted by silicification and/or faulting. Testing of GMW17-32 completed in silicified sediments near the Project suggests a very low hydraulic conductivity on the order of 10^{-6} to 10^{-7} cm/s. A long recovery period after testing this well also is an indication of very low hydraulic conductivity.

Near the Project there are isolated pockets of less-silicified material with higher conductivity, and faults in these areas may act as conduits for groundwater flow. There is not an obvious relationship between groundwater occurrence and depth within the Project, suggesting a complex heterogeneous system heavily influenced by silicification and faulting. Given the location of the Project relative to the groundwater divide, the available groundwater recharge to the area appears to be limited as well.

The silicified nature and faulting of the sediments in and around the Project has a strong effect on hydraulic conductivity but may also result in a strong downward vertical gradient within the aquifer system. Groundwater elevation is strongly correlated with well depth in this area. This vertical gradient is theorized to result in the deeper potentiometric surface observed in deeper wells. The horizontal gradient in this area is also relatively high, consistent with flow impeded by low hydraulic conductivity, with silicification apparently being a major factor.

In the general area of the Project, faults appear to act as barriers to groundwater flow on the south and east sides but the true impact of faulting on groundwater flow is hard to differentiate from the effects of deposit silicification. The silicification and faulting seems to decrease the hydraulic conductivity of the arkosic sandstone but potentially increase the hydraulic conductivity of the underlying tuff. It is possible with the combination of the silicification, steeply dipping interbedded clay, siltstone, and sinter, and the faulting near the Project allows some groundwater from the Project to flow into (or through) the tuff.

The Kern Basin Tuff, like the Grassy Mountain Formation, surfaces at higher elevations on the southern and eastern sides of Grassy Mountain and dip towards the north and northwest directions towards Negro Rock Canyon.

Groundwater flow in the Project area is generally from the southeast to the northwest, from higher elevations along the base of Grassy Mountain to lower elevations along Negro Rock Canyon. This flow direction is evident in both the shallow and deep potentiometric surfaces, a result that also supports a single aquifer system.

Downgradient of the Project, the strata are less silicified, and the horizontal and vertical gradients are not as pronounced. It is still likely that horizontal and vertical connectivity between aquifer zones is affected by low permeability, discontinuous, interbedded layers of clay and siltstone. Hydraulic conductivity is higher downgradient of the Project, but lithologic variations and faulting affect groundwater flow and occurrence. Hydraulic conductivity values downgradient of the Project derived from test pumping are on the order of 10^{-3} cm/s to 10^{-5} cm/s, representative of sandstone and conglomerate aquifers. Consistent piezometric head in wells completed at different elevations would suggest a single aquifer system.

The geochemistry of the groundwater appears to be strongly influenced by lithology. The main regional aquifer displays a Na/K-HCO3 geochemical identity, associated with volcanic tuff and sedimentary deposits. Groundwater originating from volcanics shows a Ca-HCO3 signature. Water chemistry changes are evident in the immediate vicinity of the Project.

The Grassy Mountain fault zone extending north of the Project acts like a barrier to groundwater flow based on testing of nearby wells; the most productive wells in the area are presumably located on the east side of the Grassy Mountain fault zone.

Discharge of the regional aquifer is assumed to be local springs and ultimately the Malheur River. The low total aggregate spring discharge in the hydrologic basin suggests a low groundwater recharge.

While limited in spatial extent and hydraulic connectivity, the water-bearing zones within the Grassy Mountain Formation are proposed to constitute a single, heterogeneous and locally complex aquifer system. This conclusion is supported by lithology, piezometric surface, and geochemical signature. The aquifer system is defined by low hydraulic conductivity and high hydraulic gradient in and near the Project and higher hydraulic conductivity and lower hydraulic gradient away from the Project. Groundwater conditions appear to be mostly influenced by silicification and/or faulting near the Project and sedimentary facies changes and faulting downgradient of the Project.

3.3.9.1 Dewatering

The following discussion on dewatering is from Vol. III of the Groundwater Baseline Data Report (Appendix B).

The Inflows under steady-state conditions were projected using analytical equations by Marinelli and Niccoli (2000); inflows under transient conditions were evaluated using the Theis equation.

- For the steady-state analysis, potential groundwater inflow into the proposed mine workings were estimated from: (1) shallow aquifer zones present at the same elevation as mine workings; and (2) a deeper zone within the aquifer beneath the mine workings. The rate obtained from the steady-state approach reflects equilibrium, long-duration dewatering conditions and does not necessarily reflect dewatering estimates under a short-duration. Initially, higher pumping rates are anticipated due to higher groundwater inflow during the early stages of dewatering. Dewatering requirements are expected to lessen over time as dewatering takes place in the surrounding aquifer until steady-state conditions are ultimately reached.
- The transient analysis involved performing Theis drawdown calculations (Theis 1935) to evaluate potential short-duration pumping requirements. This method calculates drawdown effects with distance from the pumping location over time. The assumed pumping center is in the middle of the resource area, and theoretical drawdown is calculated at a distance that coincides with the edge of the resource area (i.e., approximately 0.1 mile from the center of the Project).

The analytical methods used to project dewatering requirements and possible impacts from pumping (see Section 4) are simplified solutions for analyzing a complex problem. A numerical model was constructed to further evaluate potential dewatering requirements and groundwater-production impact. A numerical model is also a simplified representation of a complex system but allows more simulation flexibility (such as including a sloping aquifer and multiple pumping wells). This section describes model construction, parameter values, calibration results, sensitivity analysis, and the results from an additional dewatering scenario. The USGS code MODFLOW 2000 (Harbaugh, A.W. et al. 2000) was used for performing numerical groundwater flow modeling and dewatering projections.

The following points summarize the results and conclusions from the steady-state, Theis and numerical modeling on dewatering and drawdown effects:

1. The conceptual model for groundwater flow at Grassy Mountain provides the basis for the dewatering estimates. The current model suggests a single aquifer system as a function of scale, supported by the relatively uniform, shallow and deep potentiometric surface (at a high-level view) and correlation with groundwater elevation and depth. On a local scale, heterogeneity effects are apparent, attributed to local variations in hydraulic properties, facies changes, and/or the occurrence of faults/fault zones.
2. Estimated analytical steady-state bulk dewatering rates on the order of 20 gpm, with the potential to intercept up to 500 gpm on a short-duration basis (i.e., days to weeks), are anticipated based on the analytical approach.
    a. The low-end estimate reflects lower permeability in the range of 1x10-6 cm/s (or 0.003 ft/d) anticipated directly within the resource area. Due to the expression of individual faults or fault zones, the actual permeability may be more or less. SPF is not aware of direct testing of hydraulic conductivity or transmissivity based on

aquifer pumping tests within the resource area to date to confirm this estimate. However, the results of pumping tests performed around the perimeter of the resource extent support an aggregate lower hydraulic conductivity within this magnitude due to limited yields and negative boundary conditions.

   b. The high-end estimate reflects higher hydraulic conductivity that may be more representative of basin conditions (i.e., unconsolidated and consolidated sedimentary deposits) and short-duration inflows into the resource area (i.e., faults and fractures serving as conduits for flow) that could potentially be intercepted during the mining activities. The anticipated hydraulic conductivity may be on the order of 1x10-4 cm/s (0.3 ft/d). This condition may arise from contributions from local zones of higher permeability that are effectively dewatered in early time. As the cone of depression or radius of influence extends from the theoretical pumping well(s) with time, the overall aquifer properties are expected to produce less water due to overall lower permeability effects.

3. The dewatering evaluation also examined potential groundwater inflow rates using transient analytical methods.
   a. The transient analytical (Theis) method was used to estimate the predicted dewatering rate of approximately 250 gpm to 600 gpm, assuming a single pumping well scenario, placed at the center of the Project. The theoretical drawdown effects at the perimeter of the Project were evaluated after one year of continuous pumping to produce 600 feet of drawdown (assuming an initial groundwater elevation of 3,700 feet for upgradient conditions and an assumed dewatering elevation of 3,100 feet). The higher flow rate range is consistent with anticipated short-duration inflow amounts over the span of days to weeks.

4. A three-dimensional numerical groundwater flow model was constructed and executed using MODFLOW to evaluate potential dewatering rates under steady-state and transient conditions.
   a. The model was constructed at a ten by ten-mile resolution, centered on the Project, with three layers. Regional and local groundwater flow conditions were simulated based on a distribution of hydraulic conductivity and storativity (informed by geologic mapping and the results of aquifer pumping tests), recharge from surface infiltration predominantly in higher elevation regions, and assignment of boundary conditions to reflect physical boundaries to the extent possible (including Owyhee Reservoir, Owyhee River, and select spring features).
   b. The steady state model dewatering was simulated by placing wells along the Project perimeter and assigning uniform pumping rates to achieve dewatering to the 3,100-foot elevation. Four wells were simulated at 5 gpm each for 20 gpm total pumping requirements under steady-state conditions, resulting in a pumping level elevation of approximately 2,950 feet to 3,100 feet.
   c. The transient model dewatering was simulated by placing four wells around the perimeter and one well in the center of the Project and pumping a total 480 gpm for 70 days and 57.5 gpm for the remaining lifetime of the mine (approximately

ten years). The higher rate pumping for 70 days was able to lower water level elevations to less than 3,050 feet and the lower rate pumping initially allowed minor recovery then lowered the water levels to a range of elevations from 2,700 to 2,870 feet.

d. The three-dimensional numerical model was created as a regional model for a baseline analysis of dewatering needs. This model was calibrated using the regional water levels. The deeper water levels located near the proposed mine and other highly silicified and compartmentalized areas are not represented in the model. The conceptual model report (SPF 2019c) discusses these deeper water levels and potential causes. Currently, there are no wells or piezometers completed in the highly silicified region encompassing the proposed mine that have a static water level higher than 3,200 feet amsl. Drillers have indicated flows of up to ten gpm in only three of the exploratory bores drilled in the proposed mine at depths shallower than 3,200 feet amsl. Only two of the exploratory bores in the proposed mine had a reported static water level shallower than 3,200 feet amsl. Due to its silicified and compartmentalized nature, the amount of water that flows through the proposed mine area is significantly limited. The three-dimensional numerical dewatering model does not account for this limitation and should be used as a worst case estimate for the maximum flow that would be required to dewater the proposed mine in its entirety.

e. The planned mining method is drift-and-fill. This method used in the compartmentalized aquifer located at the Project will decrease the total volume of material requiring dewatering.

5. The transient model was also used to evaluate the drawdown effects of the dewatering wells and the mine operation production wells on the aquifer and nearby springs. Lowe Spring is approximately 1 mile away from the nearest proposed pumping well (Well 5) and had a predicted maximum drawdown of approximately 12 feet. Approximately 1.75 miles away, Poison Spring has a maximum predicted drawdown less 0.5 feet. The water sampled from Poison Spring has a similar geochemical characteristic as PW-4, while Lowe Spring shows a more volcanic geochemical signature. The geochemical signatures indicated Poison Spring may be affected by the groundwater production more than modeled and Lowe Spring may be affected less than modeled.
6. The dewatering and drawdown estimates reflect inherent uncertainty, both in the available datasets and necessary simplifying assumptions for representing a complex system. Therefore, these results are considered appropriate for baseline-level planning.

7. The accuracy of representing predominant groundwater flow paths and estimates of potential groundwater inflow depends on the sufficiency and accuracy of supporting data and assumptions. This process is inherently uncertain with respect to the conceptual model, translation of the conceptual to analytical and numerical models, and interpretation of results. Simplifying assumptions are necessary throughout this process. The level of accuracy is considered appropriate for a baseline estimate. Overall, the magnitude of dewatering estimates generated during this investigation on the order of

20 to 100 gpm for long-duration pumping, and up to 500 gpm for shorter duration pumping (days to weeks) are within the range of previous investigations that used different methods.

3.3.10 Electrical, Communications, Refuge, Maintenance

3.3.10.1 Electrical Distribution

An underground 480V transformer will be placed near the entrance to the portal at the start of mining. This will supply power to electrical equipment used to develop the decline and to portable fans. A main powerline will be installed along the rib of the decline to carry 1.4 kilovolt (kV) when development has advanced far enough that carrying power at 480Vs becomes too inefficient. This line will be connected to a transformer that will be moved underground. Line power will also be extended to the location of the exhaust to supply power to the ventilation fans.

Upon completion of the decline to the first production level, and commencement of mine production activities, a second underground transformer will be purchased for use in the lower areas of the mine.

3.3.10.2 Mine Communications

Inside the mine, a leaky-feeder very high frequency (VHF) radio system will be used as the primary means of communication. The system will allow for communications between the underground mine and surface operations.

3.3.10.3 Refuge Station

Two emergency refuge stations are necessary in case of emergencies. The refuges are mobile, each can accommodate up to 20 people, and they will be arranged so that they are always no more than 1,000 feet from the areas where the mine operation personnel are located. Figure 29 shows an example of a refuge station.

Figure 29. Typical Mobile Refuge Station

3.3.11 Mining Rate

The following discussion of the Mining Rate is taken from the 2018 PFS commissioned by Paramount (MDA 2018). They used the Proven and Probable mineral reserves defined by Ausenco to create a mine production schedule using MineSched™ (version 9.1), which allows for the scheduling of both underground development and production. The primary inputs used to develop the schedule include:

- The resource block model with defined material types;
- Development centerlines drawn in the direction of mining;
- Solids representing the stopes or production areas to be mined;
- Locations defining stockpiles, processing plant, and waste dumps;
- Material movement definition;
- Mining sequence among developments and production areas;
- Development and production rates by location; and
- Definition of the periods to be used.

The naming convention for material types considered either ore or waste. Ore was assigned to four categories based on grade: high-grade (HG), medium-grade (MG), low-grade (LG), and sub-grade. Sub-grade is material that is below the mining economic cut-off grade (COG), but above the resource COG. The basic assumption is that a production drift that is economic to be mined will be processed in its entirety.

Waste development in each sublevel was estimated using the ratio of waste development footage per ore ton, calculated from the main level. Material movement allowed for all of the waste to be sent directly to the waste dump, which includes development tonnages mined. Material mined from the drifts will be routed to the stockpile and then re-handled into the plant.

An advance rate of 15 feet per day was assumed, which would yield 290 tons per day in a single cut. It was anticipated that two stopes could be mined during the day on some levels where sufficient stoping areas would be available. Based on the number of headings, a maximum production of 290 tons per day would be possible with a single heading, or 580 tons per day for two headings on a level.

The PFS contemplates mining of primary and secondary stopes. This will require completion of the primary stope to allow placement and curing of the CRF before the secondary stope can be mined. Ausenco specified that there should be a 28-day delay between primary and secondary stopes to allow for curing time. Detailing the sequence between primary and secondary stopes will be completed as part of short-term mine planning. MDA reviewed each main level to determine a production rate based on the sequence of primary and secondary stopes. This was done by assigning a sequence number for each stope block and then reviewing the difference in the sequence number between the primary and secondary stopes. The difference between the primary and secondary stopes, together with the production rate, defined a maximum productivity that could be accomplished for secondary stoping based on the delay for the primary stopes to be backfilled. MDA determined the maximum tons per day for each main level (Table 74) and these values were also used for the sublevels below and above the main levels.

The final PFS production schedule was calculated in MineSched™ and then summarized in Excel. Ore loss and dilution were applied using Excel spreadsheets. Waste development rates were smoothed out in Excel by Ausenco. Table 75 , Table 76, Table 77 and Figure 30 are below.

Table 74. Maximum Productivity Estimate

		Max Number	Maximum Tons per Day		
	Level	of Headings	Secondary	Headings	Used
Lower Levels	3068	1	200	290	200
	3081	1	200	290	200
	3094	1	275	290	275
	3107	2	400	580	400
	3120	2	500	580	500
	3133	2	690	580	580
	3146	2	850	580	580
	3159	2	900	580	580
	3172	2	900	580	580
	3185	2	900	580	580
	3198	2	900	580	580
	3211	2	1000	580	580
Upper Levels	3224	2	1100	580	580
	3237	2	1200	580	580
	3250	2	1300	580	580
	3263	2	1500	580	580
	3276	2	1500	580	580
	3289	2	1500	580	580
	3302	2	1200	580	580
	3315	2	1000	580	580
	3328	2	900	580	580
	3341	2	800	580	580
	3354	2	700	580	580
	3367	2	500	580	500
	3380	2	400	580	400
	3393	2	275	580	275
	3406	2	275	580	275
	3419	2	200	580	200
	3432	2	200	580	200
	3445	2	200	580	200
	3458	1	200	290	200
	3471	1	200	290	200
	3484	1	200	290	200
	3497	1	200	290	200
	3510	1	200	290	200
	3523	1	200	290	200

Table 75. Mine Production Summary

	Units	Pre-Prod	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Total
Mined Ore Above Economic COG	K Tons	-	135	182	189	178	163	169	63	11	-	1,089
	oz Au/ton	-	0.296	0.385	0.278	0.259	0.298	0.322	0.254	0.395	-	0.304
	K ozs Au	-	40	70	53	46	48	54	16	4	-	332
	oz Ag/ton	-	0.298	0.328	0.331	0.312	0.359	0.422	0.506	0.335	-	0.352
	K ozs Ag	-	40	60	63	55	58	71	32	4	-	383
Subgrade Ore	K Tons	-	76	90	83	95	110	102	45	7	-	609
	oz Au/ton	-	0.062	0.064	0.067	0.065	0.066	0.068	0.070	0.049	-	0.066
	K ozs Au	-	5	6	6	6	7	7	3	0	-	40
	oz Ag/ton	-	0.193	0.213	0.218	0.198	0.236	0.252	0.265	0.227	-	0.224
	K ozs Ag	-	15	19	18	19	26	26	12	2	-	136
Internal Waste	K Tons	-	1	1	2	1	1	1	1	0	-	8
Level Access Mined as Ore	K Tons	0	1	-	-	-	-	-	-	-	-	1
	oz Au/ton	0.149	0.115	-	-	-	-	-	-	-	-	0.125
	K ozs Au	0	0	-	-	-	-	-	-	-	-	0
	oz Ag/ton	0.141	0.221	-	-	-	-	-	-	-	-	0.199
	K ozs Ag	0	0	-	-	-	-	-	-	-	-	0
Total Mined to Stockpile	K Tons	0	214	274	274	275	274	271	109	18	-	1,708
	oz Au/ton	0.149	0.210	0.277	0.213	0.190	0.203	0.226	0.175	0.256	-	0.218
	K ozs Au	0	45	76	58	52	56	61	19	5	-	372
	oz Ag/ton	0.141	0.259	0.288	0.295	0.271	0.308	0.357	0.401	0.290	-	0.304
	K ozs Ag	0	55	79	81	74	84	97	44	5	-	519
Backfill Dilution	K Tons	0	4	5	5	5	5	5	2	0	-	31
Total w/ Ore Loss & Dilution	Tons	0	220	282	282	283	282	279	113	18	-	1,759
	oz Au/ton	0.142	0.199	0.261	0.201	0.181	0.192	0.213	0.166	0.241	-	0.206
	ozs Au	0	44	74	57	51	54	59	19	4	-	362
	oz Ag/ton	0.143	0.252	0.279	0.285	0.263	0.297	0.343	0.383	0.281	-	0.294
	ozs Ag	0	55	79	80	74	84	96	43	5	-	517

Table 76. Material Sent to the Mill

	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Total
Internal Waste	K Tons	1	1	1	1	1	1	1	0	-	8
Sub-Grade Material	K Tons	74	83	76	88	103	98	87	7	-	616
	oz Au/ton	0.063	0.065	0.068	0.066	0.067	0.067	0.070	0.051	-	0.066
	K ozs Au	5	5	5	6	7	7	6	0	-	41
	oz Ag/ton	0.196	0.209	0.219	0.200	0.223	0.248	0.257	0.226	-	0.223
	K ozs Ag	14	17	17	18	23	24	22	2	-	137
Low-Grade Material	K Tons	94	114	130	130	111	121	45	5	-	750
	oz Au/ton	0.154	0.153	0.159	0.156	0.156	0.152	0.146	0.147	-	0.154
	K ozs Au	14	17	21	20	17	18	7	1	-	116
	oz Ag/ton	0.251	0.256	0.290	0.272	0.305	0.335	0.425	0.358	-	0.295
	K ozs Ag	24	29	38	35	34	41	19	2	-	221
Medium-Grade Material	K Tons	25	37	40	30	32	25	13	2	-	203
	oz Au/ton	0.315	0.318	0.310	0.301	0.297	0.304	0.319	0.321	-	0.309
	K ozs Au	8	12	12	9	10	7	4	1	-	63
	oz Ag/ton	0.294	0.327	0.341	0.334	0.294	0.395	0.683	0.372	-	0.352
	K ozs Ag	7	12	13	10	9	10	9	1	-	71
High-Grade Material	K Tons	19	34	22	20	21	25	6	3	-	150
	oz Au/ton	0.857	1.136	0.822	0.762	0.948	1.070	0.833	0.789	-	0.947
	K ozs Au	17	38	18	15	20	26	5	3	-	142
	oz Ag/ton	0.490	0.532	0.497	0.480	0.675	0.783	0.558	0.249	-	0.571
	K ozs Ag	10	18	11	10	14	19	3	1	-	86
Backfill Dilution	K Tons	4	5	5	5	5	5	3	0	-	31
Total to Plant	K Tons	217	274	274	275	274	274	154	18	-	1,759
	oz Au/ton	0.201	0.266	0.205	0.184	0.196	0.215	0.139	0.241	-	0.206
	K ozs Au	44	73	56	51	54	59	21	4	-	362
	oz Ag/ton	0.253	0.280	0.287	0.265	0.295	0.343	0.345	0.280	-	0.293
	K ozs Ag	55	77	79	73	81	94	53	5	-	516
Plant Throughput	TPD	594	750	750	750	750	750	423	50	-	

Table 77. Stockpile Balance

	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Added	K Tons	220	282	282	283	282	279	113	18	-
	oz Au/ton	-	-	-	-	-	-	-	-	-
	K ozs Au	44	74	57	51	54	59	19	4	-
	oz Ag/ton	-	-	-	-	-	-	-	-	-
	K ozs Ag	55	79	80	74	84	96	43	5	-
Removed	K Tons	217	274	274	275	274	274	154	18	-
	oz Au/ton	-	-	-	-	-	-	-	-	-
	K ozs Au	44	73	56	51	54	59	21	4	-
	oz Ag/ton	-	-	-	-	-	-	-	-	-
	K ozs Ag	55	77	79	73	81	94	53	5	-
Balance	K Tons	3	12	20	28	36	42	-	-	-
	oz Au/ton	0.067	0.071	0.073	0.072	0.071	0.075	-	-	-
	K ozs Au	0	1	1	2	3	3	-	-	-
	oz Ag/ton	2.752	3.382	3.184	3.120	3.693	3.546	-	-	-
	K ozs Ag	1	3	5	6	10	11	-	-	-

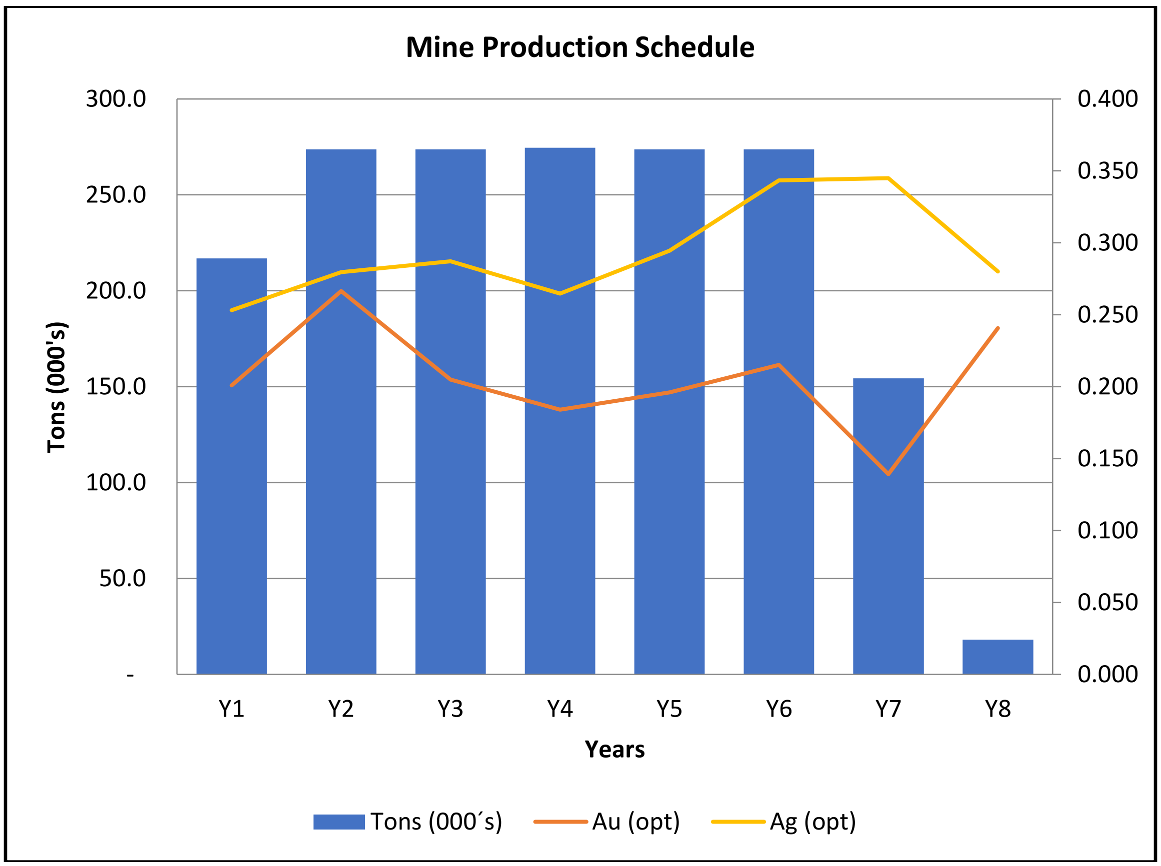


Figure 30. Mine Production Schedule

3.3.12 Milling and Refining

The following is a summary of the Mill Design Report, which is included with all drawings in Appendix D.

The intent of this section is to summarize the processes proposed for Grassy Mountain. It will address the following items from Chapter 340, Division 43 - Chemical Mining, by the Oregon Department of Environmental Quality:

- Description of the facilities to be constructed, including tanks, pipes, and other storage and conveyance means for processing chemicals, solutions, and wastewaters;
- Description of all chemical process and facilities for mixing, distribution, and application of chemicals associated with on-site mining operations, ore preparation, and beneficiation facilities;
- Description of all chemical conveyances (ditches, troughs, pipes, etc.) and the requisite equipment with secondary containment and leak detection means for preventing and detecting release of chemicals to surface water, groundwater, and soils.

The crushing and process plant consists of:

- Crushing and screening plant
- Ball mill grinding circuit
- Gravity and intensive cyanidation circuit
- Pre-aeration & CIL circuit
- Elution circuit
- Gold room
- Carbon regeneration
- Cyanide detoxification
- Reagent and air services
- Water services (raw water, process water, potable water)

The crushing plant consists of primary and secondary crushing producing a crushed ore product, which is then conveyed to feed the process plant. The CIL circuit cyanide is used to recover gold from the ore and activated carbon is used to adsorb the extracted gold from solution. Following the CIL circuit, the carbon is collected and treated in the elution circuit which separates the gold from the carbon. The carbon is regenerated and reused in the CIL circuit while the gold is removed from solution in the integrated electrowinning plant. The stripped gold is then smelted in a gold room to produce gold doré bars. Leached tails are detoxified in an INCO™ Air/SO_2 cyanide destruction circuit. Detoxified tails are pumped to a TSF for final deposition and recovery of decant water.

Figure 31 shows the key processing facility components.

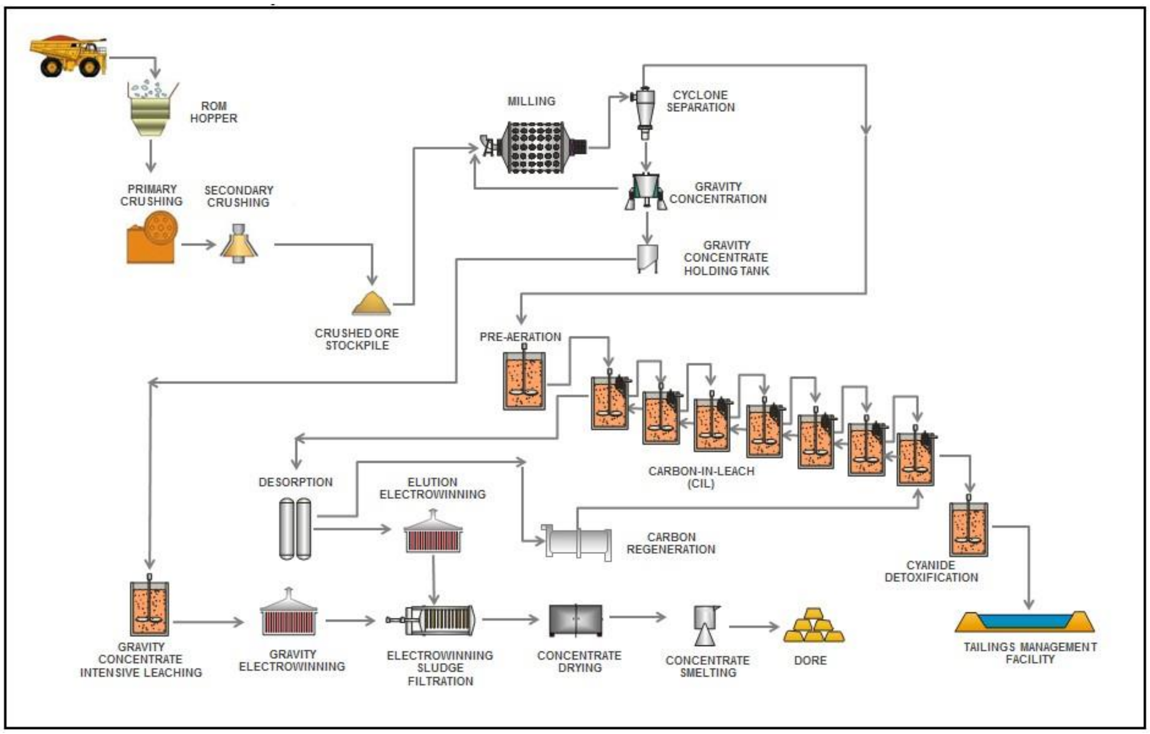


Figure 31. Grassy Mountain Process Flowsheet

3.3.12.1 Key Design Criteria

The key criteria selected for the plant design are:

- Average plant treatment rate of 700 short tons per day (st/d) on a solids basis
- Design crushing plant operating time of 70 percent (crushing/screening/conveying)
- Design process plant operating time of 91.3 percent (milling/leaching & adsorption/detoxification/elution/refining).

Drawing 101768-0000-F-001 in Appendix A of Appendix D shows the basic process design circuits and the selection of major equipment for the process plant.

The major process design criteria developed for the Project are outlined in Table 78.

Table 78. Grassy Mountain Process Design Criteria

Description	Units	Value
Ore Throughput	st/y	255,500
Design Grade - Au	oz/st	0.22
Design Grade - Ag	oz/st	0.35
Operating Schedule		
Crusher Availability	%	70

Description	Units	Value
Plant Availability	%	91.3
Throughput, Daily - average	st/d	700
Plant capacity, Hourly	st/h	32
Crushing (Two Stage)		
Primary Crusher	type	Single Toggle Jaw Crusher
Secondary Crusher	type	Cone Crusher
Fine Ore Stockpile Residence Time - Live	d	1
Grinding		
Circuit Type		Ball mill
Bond Ball Mill Work Index	Hp/st	25.8
Ball Mill, Dimensions	ft x ft	11 x 14
Ball Mill Power	hp	1072
Feed Particle Size, F80	in	0.394
Product Particle Size, P80	U.S. mesh	100
Gravity Concentration		
Overall Gravity Gold Recovery	%	10
Carbon-in-Leach		
Total Leach Time	h	24
Number of Tanks	#	1 pre-aeration + 7 leach / adsorption
Cyanide Addition	lb/st	0.82
Lime Addition	lb/st	2
Carbon Concentration	lb/ft^3	1.56
Carbon Loading (Au + Ag)	oz/st	175
Desorption		
Carbon batch size	st	3.3
Elution CIL strips per week	#	7
Gravity strips per week	#	7
Cyanide Destruction		
Method	-	Air / SO_2
Residence time	h	2
CNWAD not-to-exceed value	ppm	30

The descriptions in the following sections include references to Process Flow Diagrams (PFDs) which are included in Appendix B of Appendix D.

3.3.12.2 Crushing

ROM ore is transported by haul truck from the underground mining operation to the crushing plant area and fed either directly to the ROM hopper or to the coarse ore stockpile. Ore is received by the ROM hopper at the crushing plant before being discharged onto the vibrating grizzly feeder and fed to the primary crusher for the first crushing stage. The crushed ore is then collected onto the coarse ore conveyor which conveys the reduced ore to the coarse ore screen. The undersize from the screen is suitable for ball mill feed while the oversize is fed to the secondary crusher included in the crushing plant. The secondary crusher product is received by the coarse ore conveyor and is returned to the coarse ore screen along with new crushed product from the primary crusher, initiating the closed-circuit loop within the crushing plant. This process repeats itself to ensure that the ore has enough time to be reduced before moving on for further downstream processing. Reference PFDs: 101768-0000-F-002

3.3.12.2.1 Crushing Plant

The crushing plant operates seven days per week for the entire year with an availability of 70 percent. The nominal throughput is 42 short tons per hour (st/hr). The crushing plant consists of one of each of the following: ROM hopper, vibrating grizzly feeder, primary crusher, coarse ore screen, and secondary crusher. The ROM ore is received at a ROM hopper having a capacity 353 cubic feet (ft^3), filled either directly by the dump truck or by using a front-end loader that draws from the ROM ore stockpile. The ROM hopper is equipped with a static grizzly, and particles larger than the grizzly can be removed for individual breakage. The ore passes over a vibrating grizzly feeder leaving the ROM hopper before is fed to the primary crusher. The vibrating grizzly feeder allows for smaller material to pass directly though the feeder and onto the coarse ore conveyor, allowing for more efficient crushing in the primary crusher. The ore passing over the vibrating feeder is then reduced by a primary crusher and discharged onto the coarse ore conveyor as well.

The coarse ore conveyor transports the crushed ore to the coarse ore screen, where the undersize is collected and conveyed for mill feed, while the oversize is sent to the secondary crusher to be reduced further. The secondary crusher discharge is recirculated to the coarse ore screen to repeat the size classification step. A metal detector is included in the crushing plant to recognize any metal debris that could potentially cause damage to the crushing equipment.

The product from the crushing plant is conveyed to the crushed ore stockpile to be sent to the grinding circuit in the process plant. The stockpile conveyor is fitted with a weightometer to monitor crushing plant throughput and assist with operational and metallurgical accounting. The fine ore stockpile has a live capacity of one day, the equivalent of 750 short ton (st) of live material. This material is collected with a front-end loader which deposits the fine ore into the fine ore reclaim hopper.

3.3.12.3 Grinding

The grinding circuit receives the fine ore product at the ball mill feed conveyor which then deposits the material at the mill feed chute. The ore is ground to a desired product size with the addition of process water and steel ball grinding media. The ground ore slurry is discharged to the cyclone feed pumpbox and pumped to the cyclone cluster pack to be classified into cyclone overflow stream, dominated by fine particles, and cyclone underflow stream, dominated by coarse particles. The overflow stream is sent to leaching process while the underflow is split into two streams, which one reports back to the ball mill and the other one reports to the gravity concentration and intensive leaching circuit. Reference PFDs: 101768-0000-F-002; 101768-0000-F-003

3.3.12.3.1 Ball Mill

The fine ore stockpile allows for over 24 hours of continuous milling operation at the nominal feed rate of 31.9 st/hr. A front-end loader is used to transport the fine ore from the stockpile to the fine ore reclaim hopper, which has sufficient capacity to provide the grinding circuit with one hour of feed. The fine ore is fed to a 11 feet by 14 feet (d x EGL) overflow ball mill, which is operated at 75 percent of the critical speed and with a normal operating ball mill charge of 35 percent on a volumetric basis. Ore addition to the ball mill is supplemented with process water to achieve a milling density of 72 percent solids (by weight). The ball mill also receives a nominal circulating load of 350 percent from the underflow portion of the cyclone cluster. To avoid damage to the cyclone feed pumps and cyclone cluster, the ball mill discharge is screened through a trommel to scalp off oversized particles and broken grinding media. The scalped off materials are then stored in the scats bunker. The aperture size of the ball mill trommel is the same as the product size leaving the crushing plant. The oversize material will be manually removed periodically.

The trommel screen undersize slurry from the ball mill is discharged to the cyclone feed pumpbox, diluted to 61 percent solids with process water, and pumped to two classification cyclones (one duty and one standby).

3.3.12.3.2 Cyclone Classification

The cyclone cluster operates in a closed-circuit with the ball mill and is configured to achieve a target cyclone overflow product size. The cyclone cluster has one operating and one standby unit with pneumatically actuated valves that allow automated feed pressure control, as well as manually actuated isolation valves.

The slurry from the cyclone cluster underflow launder flows to the manual splitter box which splits approximately 33 percent of the cyclone underflow to the gravity concentrator via a scalping screen to remove particles larger than ten mesh (0.08”). The remaining portion is recirculated back to the ball mill for further grinding.

The cyclone overflow slurry from the cyclone clusters gravity flows to a trash screen distributor where the slurry is distributed over the trash screen to remove any plastic, steel, wood, and organic refuse coming from the mine. The overflow slurry density is nominally 42 percent solids.

A sump pump is installed in the grinding area to facilitate clean-up. The pump discharges into the cyclone pumpbox. Maintenance activities in the grinding and classification area are serviced by the mill area crane (33 st) and the grinding area hoist (3.3 st) which will be used for ball mill charging duties and minor lifts.

3.3.12.4 Gravity Circuit and Intensive Cyanidation

The gravity circuit included in the process plant receives a portion of the cyclone cluster underflow slurry that is passed through the gravity scalping screen. The slurry is treated by the gravity concentrator to recover free gold from the slurry into gravity concentrate. The concentrate is transported to the intensive leach reactor system by fluidization water. During this stage, the gravity concentrate is exposed to cyanide leaching resulting in high gold extraction. The pregnant solution is pumped to the electrowinning area while the tailings are recirculated back to the ball mill for further grinding. Reference PFDs: 101768-0000-F-003; 101768-0000-F-004

3.3.12.4.1 Process Background

The gravity concentration and intensive leaching reactor circuit offers several advantages by:

- Reducing the exposure and accumulation of gold in grinding equipment
- Reducing the quantity of loaded carbon to be eluted
- Reduces the chances of losing gold to tailings from the CIL circuit either from:
  - Incomplete leaching of gold, or
  - operational fluctuations causing inefficiencies in carbon adsorption.

The concentrating portion of the process allows for free gold to be separated from the gangue material through the principal of a centrifuge, where the heavier gold particles are collected in the bowl of the concentrator while the lighter gangue material overflows and are removed back to the ball mill. This allows the free gold to be recovered with minimal processing, reducing the risk of losing gold to tailings and grinding circuit. Once the gold concentrate has reached its specified loading, fresh water is used to move the concentrate to the intensive leaching area without exposing it to any contaminants in the process water. The size and number of gravity concentrators required depends on the throughput and rate at which free gold is collected.

The intensive leaching reactor circuit is typically a packaged system designed to receive a concentrated coarse gold bearing ore product from the gravity concentrator. These systems, as well as all other gold leaching circuits, rely on the fundamental leaching reaction seen below, known as the Elsner Equation.

$$4Au(s) + 8NaCN(aq) + O_2(g) + 2H_2O(l) \rightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

From this equation it can be observed that the reaction relies heavily on sodium cyanide and oxygen to complete the gold leaching reaction. Dissolved oxygen oxidizes the gold resulting in the formation of the soluble gold complexes. Sodium hydroxide is added to provide a basic pH environment required to prevent cyanide ions from reacting with hydrogen cations to form hydrogen cyanide. As such the reagents and dosages supplied to the intensive leaching reactor must be able to satisfy these requirements. Oxygen is supplied through a hydrogen peroxide tote and dosing pump located in the intensive-leach reactor (ILR) area. Adequate concentration of oxygen is essential for the cyanidation reaction, and its absence will prevent the reaction from occurring. Additional reagents can also be included depending on the specific process or a specific operational objective.

After the addition of the initial levels of reagents along with the required water and gravity concentrate, the agitator is started, and the leaching reaction begins. Dosing rates of reagents are calibrated to optimize the process, depending on the ore in question. The leaching reaction lasts several hours before the gold is leached into the pregnant leaching solution and transferred to the electrowinning area for gold plating. Tailings from the reactor typically are collected and recirculated to the grinding area. Gold recoveries using this process are typically above 95 percent.

3.3.12.4.2 Scalping Screen and Gravity Concentrator

A portion of the cyclone underflow slurry is directed to one gravity circuit scalping screen where oversized material is subsequently sent back to ball mill, while the undersize is supplied to a single gravity concentrator. Nominally 90 percent of the slurry received by the screen passes and is received by the gravity concentrator, while the remaining 10 percent is oversized and recirculated back to the ball mill. Process water is added to the screen feed stream to reduce the percent solids from 76 percent to 55 percent, allowing for improved screening efficiency.

The centrifugal gravity concentrator is an automated batch process. Feed is received from the cyclone underflow for a specified time. When one concentration cycle is finished, the feed stream is paused and the bowl stops spinning to allow the concentrate that has been built up in the bowl to be flushed to the concentrate holding tank. After the flushing, a new concentration cycle starts again. Gravity concentrator tails flow back to the ball mill during the feeding portion of the cycle. Cycle times are 45 minutes each and about 46lb of concentrate is expected from each cycle of the selected unit. Cycle time is manually adjusted based on the head grade and circuit performance.

Flushing water rinses the gravity concentrate to a gravity concentrate holding tank located beneath the concentrator. Water is continually decanted as the gravity recoverable gold concentrate accumulates in the hopper. Access to the gravity concentrator holding tank is restricted, and only authorized personnel are allowed access.

Once per day the concentrate accumulated in the gravity concentrate holding tank is pumped to the intensive leach reactor where it is dosed with sodium hydroxide and high levels of sodium cyanide.

3.3.12.4.3 Intensive Leach Reactor

Following gravity concentration, the concentrate is held by the gravity concentrate holding tank before being supplied to one intensive leach reactor. The agitated reactor is dosed with sodium hydroxide, sodium cyanide, hydrogen peroxide and flocculant/leach aid to facilitate the high-cyanide gold extraction reaction. A complete cycle for the concentrate to be fully leached will take 24 hours and is operated daily. The gold bearing pregnant solution is then pumped to the gravity electrolyte tank for the electrowinning process. Tailings from the reactor are collected and pumped back to the ball mill feed chute.

Given the nature of the process, cyanide specific design considerations are implemented for both personnel safety, equipment integrity and operational performance. Control valves and alarm interlocks are utilized to ensure the operation is performed within an acceptable pH range and will also monitor the presence of hydrogen cyanide; a toxic gas evolved from cyanide bearing solution when pH values are lowered out of the operating range. The area will be equipped with hydrogen cyanide monitors, and operators will wear hydrogen cyanide badges to alert them of any potential evolution of cyanide gas in the area. The sodium cyanide solution is monitored by operator titration, ensuring that the dosing concentration is suitable for the intensive leaching reaction. Piping providing cyanide solution is socket welded stainless-steel connection, with double block and bleed isolation valving. The area is also designed to account for complete containment of all process vessels. Standard operating procedures are developed to accurately describe the methods and equipment required to achieve these tasks safely.

3.3.12.5 Carbon-in-Leach

The overflow slurry from the cyclone cluster is initially screened by the trash screen to prevent any debris that could impact the gold extraction or recovery to reach the CIL circuit. After passing through the screen the slurry reports to the pre-aeration tank where the slurry is pre-treated with air to ensure optimal gold extraction and minimize cyanide consumption. Following pre-treatment, the slurry flows through the leaching tanks. During this stage the slurry and activated carbon flow counter-currently throughout the CIL tanks. Carbon is added to the last tank and sequentially pumped to the first tank, while slurry is added to the first tank and flows to the last. Most of the metal extraction from ore to solution occurs at the front end of the circuit, while adsorption from solution to the carbon primarily occurs towards the end of the circuit. The slurry exits the final tank and is sent to the carbon safety screen before being treated for tailings storage. The loaded carbon exiting the first CIL tank is pumped to the loaded carbon screen in the elution circuit to be prepared for acid washing and elution. Reference PFDs: 101768-0000-F-005

3.3.12.5.1 Process Background

The CIL circuit is responsible for the gold leaching and carbon adsorption of the main slurry stream coming from the grinding circuit. It utilizes a counter-current flow of activated carbon in reference to the slurry flow to optimize the gold extraction and recovery. After the grinding circuit the ore particle size should be sufficiently reduced so that the gold in the ore is exposed allowing for the leaching reaction to occur.

In the presence of sulphide species native to the ore, the leach rate of gold into solution can be influenced by the amount of dissolved sulphur and the oxygen concentration in solution. A pre-aeration tank is used to oxidize and precipitate soluble species such as sulphides to prevent them from consuming oxygen during the process. A pre-aeration tank can also prevent a passivation layer from forming over the ore that hinders the leaching process. This passivation layer is often caused due to sulphide species forming sulphur monolayers on the surface of the exposed gold in the ore.

In this circuit the leaching reaction follows the same reaction shown in the intensive leaching reaction.

$$4Au(s) + 8NaCN(aq) + O_2(g) + 2H_2O(l) \leftrightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

Sodium cyanide is dosed into the front end of the circuit along with air additions to facilitate the dissolution of gold into solution. The rate of the gold extraction is highest in the first tank where the reaction begins and rapidly decreases as the gold in the ore becomes scarcer. The extraction eventually reaches a plateau point where all the recoverable gold has been leached into solution in the form of a soluble and stable cyanide-gold species. With the gold in solution, the adsorption process will then recover the dissolved gold onto activated carbon to be recovered in the elution circuit.

The availability of free cyanide in solution is dependent on the pH of the solution. At a lower pH less cyanide ions are retained in solution while more are evolved as hydrogen cyanide molecules. From this relationship we can determine that the desired result is to have the free cyanide ions stay in solution at high pH. This is true for both safety and operation, as hydrogen cyanide gas is toxic to operators and cyanide must be in solution to perform the leaching reaction. For this reason, the CIL circuit is operated in a basic environment maintained through the addition of hydrated lime.

In solution the sodium-gold-cyanide complex dissociates into a negative gold-cyanide anion and a positive sodium cation. The negative gold-cyanide ion in solution preferentially pairs with a positive ion found in solution based on reduced activation energy. The addition of lime in the CIL circuit ensures sufficient calcium is available to produce an ionic pair between the gold-cyanide anion and the calcium cation resulting in a stable pair with neutral charge. The importance of this lies in the fact that the surface of activated carbon has a neutral charge and for species to adsorb to it they also require a neutral charge.

$$2Au(CN^{-})^{-} + Ca^{2+} \leftrightarrow_{2} Ca\ (Au(CN2))2\ (ion\ pair)$$

As both the ion-pair and the surface of the carbon are neutral, no reaction occurs between the two items and the adsorption process is dependent on process parameters. Key parameters include mixing efficiency, slurry density, particle size of carbon, cyanide concentration, slurry pH and gold concentration among others used to design the adsorption process of a specific operation.

With the activated carbon being introduced in the last tank and moving towards the first tank the greatest gold recovery occurs in the last tank of the CIL circuit and progressively diminishes as the carbon advances through the tanks with increasing gold loading. After the fully loaded carbon is reaches the first tank of the circuit, the final transfer pump transports the loaded carbon to the next stage for the acid wash and elution stages.

Test work determined that the gold is leached to completion with a residence time of 24 hours. Carbon management modelling determined that seven leach stages were required, the optimum carbon concentration is 1.56 lb/ft^3 and advance rate to minimize solution losses is three tonnes per day.

3.3.12.5.2 Pre-Aeration and Carbon-in-Leach Tanks

The leach feed slurry from the cyclone cluster overflow reports to the pre-aeration and CIL circuit. The slurry will first reach one pre-aeration tank where low-pressure air addition is added prior to the introduction of cyanide. Lime is added to adjust the solution to a pH of 10-10.5. Following the pre- aeration step the slurry will then flow to a series of seven open top CIL tanks.

In the CIL tank train, the gold bearing slurry is brought into contact with cyanide and dissolves the gold from the ore into solution by forming stable gold-cyanide complexes in the presence of sparging air. The pH of slurry in the tanks is monitored and lime is added as necessary at several points in the CIL circuit to maintain target (10-10.5 pH typical). Low pressure compressed air is blown into slurry in the tank through blowers and dispersed using dispersion cones located at the bottom of the agitator.

Slurry exiting each tank flows by gravity to the next through an up-comer inside the tank to an overflow launder. Each tank is connected to the next two tanks via overflow launders with knife gate valves for tank isolation on each discharge point. This arrangement will allow the slurry to bypass the next tank in the series if one of the downstream tanks must be taken out of service for maintenance. Once the slurry discharges at the final tank, the slurry gravity flows to the carbon safety screen.

The purpose of the activated carbon is to recover gold from leached slurry. The gold is recovered by bringing the leached slurry, containing gold in solution, in contact with the carbon so that the dissolved gold can be loaded onto it through the process of adsorption. Each CIL tank is equipped with an agitator, an inter-stage screen to retain the carbon and a carbon advance transfer pump. Slurry in the first tank flows through the inter-stage screen to the next tank via an overflow launder while the screen holds back the carbon from moving to the next tank. Each subsequent tank in the series sends slurry to the next tank until the slurry reaches the last tank which then gravity flows out to the cyanide destruction circuit by the carbon safety screen. Carbon flows through the circuit in the opposite direction, through carbon advance pumps in a batch process. The carbon is transferred once per day and is retained in the tanks by the inter-stage screens. Once the carbon has been transferred through all CIL tanks to the first tank in the train, the loaded carbon recovery pump will transfer the loaded carbon to the loaded carbon screen before being treated in the elution circuit.

As the nature of the process is similar to that of intensive leaching, similar safety considerations are implemented. Cyanide monitors will be installed at the top of the tanks and at ground level. Control valves, and alarm interlocks are utilized to ensure the operation is performed within an acceptable pH range and will monitor the presence of hydrogen cyanide. Operators are also equipped with hydrogen cyanide badges to alert them of any potential generation of cyanide gas. The sodium cyanide solution will be monitored by operator titration, ensuring that the dosing concentration is suitable for the leaching and adsorption reactions. Standard operating procedures are developed to accurately describe the methods and equipment required to achieve these tasks safely.

3.3.12.6 Acid Wash and Elution

Carbon containing slurry from the CIL circuit is transferred by the loaded carbon recovery pump to the loaded carbon screen in preparation for the acid wash and elution steps. The undersize slurry from the screen is sent back to the pre-aeration tank while the carbon retained in the oversize fraction reports to the acid wash column. During the acid wash stage, acid soluble contaminants that were adsorbed onto the surface of the loaded carbon are removed using a dilute HCl stream followed by a rinse water cycle to clean the acid washed carbon before moving onto the elution step. The acid rinsed carbon is then transferred from the acid wash column to the elution column. During this step a strip solution of sodium hydroxide and cyanide is heated and is passed through the carbon in the elution column. This process reverses the kinetics of the gold loading onto the carbon and brings the gold into solution. The gold bearing solution also known as the pregnant solution then flows to the gold room where the gold will be recovered in the electrowinning process. Once the loaded carbon has been stripped of gold it is considered barren carbon and is transferred to the carbon regeneration area. Reference PFDs: 101768-0000-F-006

3.3.12.6.1 Process Background – Elution

Loaded carbon will undergo the desorption process where the loaded carbon is acid washed and eluted. The underlying principle during these stages is that the stable gold complexes loaded on the carbon must be changed so that they separate from the carbon.

The loaded carbon is initially received from the adsorption stage to a loaded carbon screen, where the carbon and slurry are separated. The carbon is then fed to one acid wash tank where a dilute HCl solution is passed through. This process removes undesirable contaminants such as calcium carbonate from the surface of the carbon that would otherwise move forward to the elution column. The acid wash cycle is done at ambient conditions. Rinse water is passed through to remove residual acid and protect downstream equipment from low pH conditions.

Once the loaded carbon is acid washed it is transferred from the acid wash column to one elution column. In the elution stage a solution of sodium hydroxide and sodium cyanide, called the strip solution, is heated under pressure and flows up through the elution column. During elution the adsorption kinetics that initially bonded the gold complexes to the carbon are reversed and the gold is brought back into solution. This solution flows from the elution column to the electrowinning cells.

After the stripping of the pregnant solution by the electrowinning cell, the solution has trace amounts of gold remaining that will not be recoverable in electrowinning. Due to need for new reagent additions and water top ups, a certain portion of the barren solution will be bled to the CIL circuit, where the gold has the potential to be re-adsorbed.

3.3.12.6.2 Loaded Carbon Screening

Once the carbon in the first CIL tank is completely loaded, carbon slurry is pumped to the loaded carbon screen where the loaded carbon is screened and separated from the slurry under water spray. Water sprays on the vibrating screen decks wash off process slurry from the loaded carbon. The loaded carbon gravity flows to the acid wash column ahead of the elution cycle, and the slurry returns to the pre-aeration tank.

3.3.12.6.3 Acid Wash

The loaded carbon from CIL tanks recovered on the loaded carbon screen is directed to an acid wash column. Acid soluble foulants which have loaded onto the carbon are dissolved during the acid washing stage. Hydrochloric acid (HCl) is diluted with fresh water to provide the required acid wash solution concentration of 3 percent HCl and injected into the acid wash column. The solution will soak in the acidic solution for 30 minutes.

Following acid solution contact, the carbon is rinsed with fresh water to remove residual acid of the liquor in the carbon column at a rate of two bed volumes (BVs) per hour. The neutralized acid solution is drained back to the acid solution circulation tank. Washed carbon is then hydraulically transferred to the elution column using pressurized transport water supplied by a transport water pump.

3.3.12.6.4 Elution

The elution system comprises an elution column, strip solution tank, strip solution pump and an elution heater package. Strip solution (eluate) is made up in the strip solution tank using raw water dosed with two percent sodium hydroxide and 0.2 percent cyanide to form an electrolyte for the electrowinning process. The eluate flows upwards through a stationary bed of loaded carbon at a flow rate of about two BVs per hour at 275°F. The elution system is pressurized to keep the solution from flashing to steam in the heater or elution column. At this temperature gold that was previously adsorbed on the carbon is desorbed from the carbon by a reversal of the adsorption kinetics.

The direct electric strip solution heater is designed to increase the temperature of the strip solution up to 275°F (135°C) for the stripping cycle. Additionally, an elution recovery heat exchanger ensures that the nominal temperature of the pregnant solution directed to the electrowinning cells is below boiling to prevent flashing.

Following the elution process, gold is recovered from the pregnant strip solution with a single electrowinning cell located inside the gold room (the gravity circuit has its own electrowinning cell). The pregnant and barren solution streams will be pumped between the elution plant and electrowinning cell in a dual contained pipe with flow meters positioned at both ends for leak detection.

The gold depleted solution from electrowinning is then re-heated and recycled to the elution column for additional stripping.

Given the use of sodium cyanide during the elution of the loaded carbon, additional steps are included to ensure safe and efficient operation. The pH of the solution will be properly buffered using sodium hydroxide, utilizing control valve interlocks to ensure the process is operating at the designed operating parameters.

3.3.12.7 Carbon Regeneration and Management

After the completion of the elution stage, the barren carbon is transported to the carbon regeneration area to treat the used carbon to be recycled for the adsorption process. The carbon is first screened through the kiln dewatering screen, where the oversize will report to the horizontal kiln while the undersize carbon and water are collected in the carbon fines clarifier. The carbon in the kiln is exposed to elevated temperatures to remove any remaining foulants that could impact the adsorption process. The carbon is then received by the quench tank for cooling before being sent to the carbon sizing screen in the CIL circuit. The fine carbon reporting to the clarifier is collected with the use of a filter press for further off-site processing, while the process water from the clarifier overflow is received by the transfer water tank for application in the elution circuit. Reference PFDs: 101768-0000-F-007

3.3.12.7.1 Carbon Regeneration

After completion of the elution process, barren carbon is hydraulically transferred from the elution column to a kiln dewatering screen. The screened carbon is fed into the kiln feed hopper then metered into a carbon regeneration kiln. The carbon regeneration kiln is a horizontal, rotary, electrically heated unit and reaches a temperature of at least 1400°F (750°C) to regenerate the stripped carbon.

Regenerated carbon discharges by gravity from the kiln to a quench tank to cool down and is then transferred via recessed impeller transfer pump to the carbon sizing screen. The barren carbon is then screened and reports to the last tank in the CIL adsorption train.

Fine carbon is received by the carbon fines clarifier, which then settles to the bottom of the tank while water overflows out of the top. The underflow of the clarifier is batch fed to the carbon fines filter, which removes additional water allowing the fines to be bagged and may be sold for further gold recovery at an offsite location.

3.3.12.7.2 Carbon Pre-attrition

Bags of new carbon are processed in a pre-attrition tank before being sent to the leach circuit. This process breaks off the corners of the angular coconut shell-based carbon particles, and the fine particles are collected. The fine particles are too small to be retained by the leach tank inter-stage screens and would therefore pass through to leach tails. Without this step the sharp corners of the loaded carbon particles would be broken off in the leach circuit and these carbon fines would flow to tails carrying the gold they had adsorbed causing gold losses.

The new carbon is charged to the pre-attrition tank via a bag breaker where water is added to produce an effective solids density of about 50 percent carbon. A high intensity agitator stirs the carbon slurry vigorously to break off the sharp corners, reducing the angular particles to a more rounded shape. Once complete, the new carbon is pumped to the regeneration kiln quench hopper where it is stored before being added to the leach circuit. Fresh and regenerated carbon passes over a barren carbon sizing screen, which also separates and removes fines.

3.3.12.7.3 Carbon Transport Water

All carbon movements in the elution and regeneration circuits are accomplished using carbon transport water. A transport water tank and pump are provided to supply transport water to carbon movement demands as needed.

As an example; when moving carbon from the acid wash column to the elution column, the carbon is drained into a venturi with transport water passing through it in sufficient quantity and velocity to carry it to the next destination at an effective solids density of about 20 percent. As the carbon arrives at the elution column, strainers in the column discharge ports allow the transport water to exit the column while retaining the carbon.

Transport water picks up fines when moving carbon from one place to another as a result of both the previous process and the attrition associated with the carbon movement itself. Once the movement is complete, strained or decanted transport water reports to a carbon fines clarifier where flocculant settles the fines and the overflow water recharges the transport water tank. Process water is added as necessary to maintain the level in this tank. The carbon fines are removed from the clarifier underflow periodically and shipped to the refinery to recover contained precious metal values.

3.3.12.8 Electrowinning and Gold Room

The elution circuit and the intensive leach reactor circuit both produce a gold bearing solution that will flow through electrowinning cells to remove the gold from solution and onto cathodes. The flow of pregnant solution and the electrical current is controlled for operation under optimal gold plating parameters. The plated gold is removed from the cathodes with the use of a high-pressure cleaner and the gold sludge is collected in the electrowinning sludge filter feed tank. The sludge is pumped through a filter and then moved by hand to the drying oven. The smelting of the dried sludge is then completed by hand and ultimately produces the final doré bars. Reference PFDs: 101768-0000-F-008

The gold room houses the electrowinning cells, smelting furnace, and associated support equipment within a security envelope which limits access to authorized gold room personnel only. Access and egress are controlled by security personnel at both a man door and a vehicle access roll up door for the armored car. The armored car door is enclosed by a fence with an automated gate controlled by security personnel. The exception to this is an emergency exit door which sets off alarms when opened from the inside.

3.3.12.8.1 Electrowinning

Two electrowinning sludging cells are located on the upper floor within the gold room. One electrowinning cell is dedicated to the intensive cyanidation circuit and the other to the elution circuit. The rectifiers associated with the electrowinning cells back onto the gold room wall, allowing easy access for operations and maintenance outside the secure area of the gold room.

The electrowinning cell dedicated to the intensive cyanidation circuit is fed eluate via a fixed speed centrifugal pump from the gravity eluate storage tank. Eluate is pumped to the electrowinning cell and then gravitates back into the gravity eluate storage tank in a closed loop until suitable gold recovery is achieved. The electrowinning cell dedicated to the elution circuit operates in a closed loop with the elution column and associated equipment. Eluate flows directly from the top of the elution column to the electrowinning cell after cooling through heat exchangers. The eluate flows through the electrowinning cell and then gravitates back to the strip solution tank and is pumped to the elution column in a continuous closed loop. Both cells extract gold by passing a current through the liquid solution, resulting in metal extraction through electroplating onto the cathodes within the cell.

Periodically, high pressure spray dislodges sludge from the cathodes and cell floor to a sludge hopper. A positive displacement pump feeds a plate and frame filter from the sludge hopper where the moisture content of the sludge is reduced. The pressed filter cake (gold sludge) is loaded from the plate and frame filter into trays on the electrowinning sludge trolley. The trays slide into the gold room drying oven, which heats the sludge to remove the entrained moisture.

3.3.12.8.2 Smelting

The dried and cooled sludge is combined with fluxes (silica, nitre, borax and sodium carbonate) in the flux mixer. The fluxes are manually added to the flux mixer after they are weighed. The sludge- flux mix is direct smelted in an electric furnace. The fluxes react with base metal oxides to form a low viscosity, free flowing slag, whilst the gold and silver remains as a molten metal.

The gold doré is poured into a cascade pouring table of doré moulds. The slag (non-precious metal compounds) is separated from the precious metal and collected in slag trays at the bottom of the cascade tables. The doré bars solidify and are quenched in water, cleaned to remove slag, weighed, stamped for identification, sampled for analysis and stored in a safe while awaiting dispatch.

3.3.12.9 Cyanide Detoxification

Tailings from the CIL circuit that no longer contains economically recoverable gold will flow to the carbon safety screen prior to reaching the cyanide detoxification stage. The slurry contains cyanide species that are not suitable for release from the process plant, and therefore a detoxification process is completed. In this circuit reagents are added to facilitate the breakdown of cyanide species to acceptable levels before reporting to the tailings pumpbox and sent to the TSF. Reference PFDs: 101768-0000-F-009

3.3.12.9.1 Process Background

The cyanide detoxification stage of a gold processing operation is the location where the process slurry reports prior to tailings storage to reduce the level of WAD cyanide and in turn the total cyanide released from the plant.

WAD cyanides are described as weak metal complexes that form during the leaching stage of the operation. Typical metals seen in these complexes include copper, zinc and nickel. The concern with these complexes is that they dissociate in solution to produce an environmentally significant concentration of free cyanide that could pose a risk to the environment and wildlife or persist on a longer-term basis due to a resistance to natural degradation.

The detoxification circuit receives all of the slurry from the upstream processes with the addition of acid rinse solution from the elution circuit and sump slurry on an intermittent basis from several areas within the plant. During the detoxification process the reaction will convert the free cyanide in solution to the less toxic cyanate ion. This is achieved through the SO2/Air reaction utilizing a copper catalyst, and the reaction is shown below.

$$CN^{-} + SO_2 + O_2 + H_2O \rightarrow OCN^{-} + H_2SO_4$$

The free cyanide and WAD cyanide are oxidized during the reaction to form cyanate and sulphuric acid. The reaction typically operates in the pH range of 8 to 9 therefore requires the addition of lime to counteract the acid production.

Sodium metabisulphite (Na2S2O5), also known as SMBS, is the source for SO_2 in the Air/SO_2 process. The reaction also requires a soluble copper catalyst to achieve the cyanide reduction. The copper is typically administered in the form of a soluble copper sulphate pentahydrate solution.

Iron cyanide removal is initiated by the reduction of iron from the ferric to the ferrous state. Following this step, the reaction will then react with a soluble metal cation to produce a precipitate. The same will be the case for trace metals that will be precipitated as their hydroxides. The remaining thiocyanate and cyanate are reduced by means of oxidation and hydrolysis respectively.

Through this process the key cyanide species of interest are converted into chemical species acceptable for discharge to the tailing's storage facility.

Once in the tailing's management facility processes such as photodegradation by UV light and biodegradation will also contribute to the minimization of cyanide species in a lined TSF where precautions are implemented to minimize the impact to wildlife.

3.3.12.9.2 Carbon Safety Screen

Tailings from the CIL circuit flows by gravity to a carbon safety screen. The safety screen retains any carbon that has reported with the slurry due to a leak in inter-stage screen mesh or seals in the CIL circuit. Water sprays are used on the vibrating screen deck to wash off process slurry from the carbon particles before reporting to a tote box. Screen underflow flows to the cyanide detoxification tanks.

3.3.12.9.3 Cyanide Detoxification Tanks

The cyanide detoxification circuit provides sufficient residence time for the detoxification reaction. In addition to leach tails, the tanks receive acid wash effluent from the acid wash column and the area sump pump discharge on an intermittent basis.

The cyanide detoxification circuit reduces weak acid dissociable cyanide (CNWAD) to a target value. Air supply for the detoxification reaction is supplied to each cyanide destruction tank via a dispersion cone mounted to the bottom of each tank to maintain a high redox potential, maximizing oxidation of cyanide. The tanks utilize dual-impeller high shear agitators to enhance air dispersion and dissolution in the slurry to meet the oxygen demand of the cyanide destruction process. A SMBS solution (the source of SO_2) is added to the slurry in the tanks. Copper sulphate solution, when needed, is dosed as catalyst for the cyanide detoxification process while lime slurry is added from a ring main into each tank to maintain a desired pH between 7.0 and 9.0. pH monitoring and HCN gas monitors will be interlocked with control valves to prevent detect the evolution of HCN gas. Operators will also wear personal HCN badges or monitors. The slurry will be reduced from a CNWAD concentration of 100 ppm from the CIL circuit to below the not-to-exceed limit of 30 ppm. The final CN concentration will be monitored by operator titration to ensure compliance with the target discharge limit and the not-to-exceed regulatory limit of 30 ppm.

3.3.12.9.4 Tailings Discharge

Detoxified slurry overflows the second detoxification tank to the final tailings pump box, where it is then pumped to the TSF by two final tailings pumps (1 duty / 1 standby). The tailing slurry flows through a tailings discharge pipeline and will have dual containment initially provided through a buried pipe-in-pipe configuration, before daylighting to an HDPE lined containment trench. At the TSF the tailings are deposited using spigotting manifolds positioned along the rim of the impoundment to create low angle deposition beaches.

The position of the spigotting manifolds are moved periodically to produce an even beach head and push decant water towards the decant water pool. A pontoon mounted decant return water pump is provided to pump decant water back to the process water tank plant for re-use in the plant.

3.3.12.10 Reagents and Services

Given the properties of the reagents and their interactions with each other, design of the reagent preparation area will largely focus on the isolation of the cyanide. The cyanide preparation area is located away from incompatible reagents and in a low traffic area of the process plant. The cyanide preparation area will also be separated from the acidic reagents preparation area by the alkaline reagents. In this configuration the basic chemicals act as a buffer to prevent the exposure of acidic reagents and sodium cyanide, which would lead to the generation of cyanide gas.

Reference PFDs:101768-0000-F-010; 101768-0000-F-011; 101768-0000-F-012; 101768-0000-F-013

3.3.12.10.1 Hydrated Lime

Preparation of the hydrated lime will require:

- A bulk storage silo
- A mixing tank
- Dosing pumps feeding a ring main
- Automatically controlled dosing points from the ring main.

Hydrated lime is used in leaching and detoxification for pH control. The hydrated lime is delivered to site by bulk tanker and blown into a bulk storage silo.

When the mixing tank level is low, hydrated lime is added to the tank via a rotary valve and screw feeder. Process water is added at the same time to maintain the mixture strength of 20 percent forming a milk-of-lime suspension.

Milk-of-lime is distributed to the various dosing points using a ring main that provides constant flow to various destinations. Dosing is accomplished with drop lines off the ring main with automated on- off valves that open when pH is low and close when the operator specified target is reached.

3.3.12.10.2 Sodium Hydroxide

Preparation of Sodium hydroxide will require:

- Dosing pumps.

Sodium hydroxide (NaOH), also known as caustic soda, is used as a pH modifier in the intensive cyanidation and in the elution circuit to prepare the stripping solution used to recover the gold from the loaded carbon. The reagent will be delivered in a 1,000 L tote received by truck and unloaded near sodium hydroxide area. The solution is supplied at a concentration of 50 percent by weight basis. Three positive displacement pumps will then each provide the required dosages of sodium hydroxide to their dedicated area. These areas include the intensive leach area, the elution circuit and the sodium cyanide preparation area.

3.3.12.10.3 Sodium Cyanide

Preparation of sodium cyanide will require:

- A bulk handling system
- Mixing and holding tanks
- Dosing pumps

Sodium cyanide is used in leaching as a lixiviant and in elution as a carbon stripping aid. Cyanide is delivered to site in one-ton bulk bags contained within wooden boxes and is stored in a separate area of the plant from the other chemicals.

When the storage tank level is low, a cyanide mix batch is started by removing a cyanide bulk bag from its box and dropping it onto a bag breaker, which discharges cyanide into the mix tank. The mix tank has been previously filled with sufficient raw water and buffered with sodium hydroxide to pH 12 to produce a cyanide mixture strength of 28 percent. Once mixing is complete and there is sufficient room in the holding tank, the mixed cyanide solution is pumped to the holding tank by a sodium cyanide transfer pump.

Sodium cyanide is dosed from the storage tank to dosing points via dedicated positive displacement metering pumps. The discharge piping is arranged such that the infrequently utilized pumps can be used as back-up spares for the leach dosing pump. For additional information on the equipment and procedures for the handling of cyanide, reference the Cyanide Management Plan in Appendix F of the Consolidated Permit Application.

3.3.12.10.4 Sodium Metabisulphite

Preparation of SMBS will require:

- A bulk handling system
- Mixing and holding tanks
- Dosing pumps.

SMBS is the source for SO_2 in the Air/SO_2 process and will be supplied in 2000-pound bulk bags with a minimum quality of 67 percent SO_2. It will be shipped by road to site, offloaded by forklift, and stored in the reagents storage area.

When the storage tank level is low a SMBS mix is started by dropping a bulk bag of SMBS onto a bag breaker which discharges SMBS into the mix tank. The mix tank has been previously filled with sufficient process water to produce a mixture strength of 20 percent. Once mixing is complete, and there is sufficient room in the holding tank, the mixed SMBS solution is pumped to the holding tank by a SMBS transfer pump.

SMBS is dosed from the storage tank to the detoxification circuit via dedicated positive displacement metering pumps for each stage. A third pump is provided as an installed spare for the detoxification dosing pumps.

3.3.12.10.5 Copper Sulphate (Pentahydrate)

Preparation of Copper Sulphate will require:

- A bulk handling system
- A combined mixing/storage tank

- Dosing pumps

Copper sulphate (pentahydrate) (CuSO2.5H2O) is supplied in 2000-pound bulk bags at a purity of 98 percent on a weight basis. It will be shipped by road to site, offloaded by forklift and stored in the reagents storage area adjacent to the reagents mixing facility. Copper sulphate is mixed and stored in a combined mixing/storage tank laid out such that the mixing tank is directly above the storage tank and mixed solution drops by gravity into the storage tank.

When the storage tank level is low copper sulphate is added to the mixing tank by dropping a bulk bag of onto a bag breaker which discharges copper sulphate into the mix tank. The mix tank has been previously filled with sufficient process water to produce a mixture strength of 15 percent. Once mixing is complete, and there is sufficient room in the holding tank, the mixed copper sulphate solution is transferred by gravity to the holding tank.

Copper sulphate is dosed from the storage tank to the detoxification circuit via duty / standby positive displacement metering pumps.

3.3.12.10.6 Hydrochloric Acid

HCI is used in the elution circuit and is supplied in 275-gallon totes in liquid form at 32 percent concentration on a weight basis. The acid will be dosed directly to the acid wash column through the use of a metering pump.

3.3.12.10.7 Flocculant

Flocculant will be used in the carbon fines clarifier and intensive leach reactor to assist in solids settling. The flocculant will be supplied in 1,000L totes and dosed directly through two metering pumps.

3.3.12.10.8 Blower Air

The blowers will supply low pressure process air to the CIL tanks and the cyanide detoxification circuits. Both the CIL and cyanide detoxification trains will have a dedicated blower fan, with one common standby fan, able to supply process air to any of the four usage points.

3.3.12.10.9 Plant & Instrument Air

An air compressor will provide high pressure compressed air operating in lead-lag mode, to meet the demand for plant and instrument air requirements.

Plant air will be stored in the plant air receivers to account for variations in demand prior to being distributed throughout the plant. Instrument air will be dried in an instrument air dryer before being stored in the instrument air receivers and distributed throughout the plant.

3.3.12.10.10 Assay and Metallurgical Laboratory and Quality Control

The plant is equipped with automatic samplers to collect shift and routine samples for aqua regia digestion, atomic absorption, and fire assays. Those samples include plant feed, intermediate products, tailings, and final products. The data obtained will be used for product quality control and routine process optimization.

The metallurgical laboratory will perform metallurgical tests for quality control and process flowsheet optimization. The laboratory will include equipment such as laboratory crushers, ball mill, sieve screens, laboratory flotation cells, balances, and pH meters.

3.3.12.11 Water Services

The overall process has a negative water balance and requires raw water makeup from site wells. The raw water is used for gland water, makeup water, and treated to produce potable water. Raw water that has entered the process becomes part of the process water circuit and may be eventually discharged to the TSF. Decanted water from the TSF is recycled back to the process plant for reuse in the process water circuit. Reference PFDs: 101768-0000-F-014; 101768-0000-F-015

3.3.12.11.1 Tailings Storage Facility

The TSF receives the treated tails from the process plant and allows for material to settle while water is decanted and recovered at the process water tank for re-use in the process plant. Two centrifugal pumps (one duty and one standby) located on a barge at the TSF return water through a decant water pipeline, which runs in the same containment trench used for the tailings discharge pipeline.

The TSF also allows for the natural degradation of remaining trace cyanide. Degradation is achieved through exposure to ultraviolet light received from the sun and metabolic processes from micro- organisms native to the environment in the water of the supernatant pool.

The TSF is described in detail in Section 3.3.13 and Appendix C.

3.3.12.11.2 Raw Water

Raw water will be pumped from site wells to the raw water tank for distribution throughout the operation. Raw water in the tank is used to supply the following services:

- Reagent preparation water
- Slurry pumps gland seal water
- Intensive cyanidation
- Make-up water for the process water system
- Fire Water

- Potable water treatment plant, potable water is then sent to the potable water tank for safety showers and eyewash stations.

3.3.12.11.3 Gland Water

Water for the gland water system is supplied by fresh water from the raw water tank and distributed to each slurry pump by the gland seal water pumps in a duty/standby configuration.

3.3.12.11.4 Process Water

Process water is comprised of decant water from the TSF and raw water additions. Process water is stored in the process water storage tank and distributed by the Process Water Pumps, in a duty/standby configuration, to the circuits throughout the process plant, select reagent preparation areas and the truck washing station.

3.3.12.12 <u>Process Solution Containment</u>

The containment strategy associated with the process plant can be divided between the containment of process flows and reagents, and the collection and containment of surface contact water.

3.3.12.12.1 Process Flows and Reagents

There are eight primary areas which require containment at the plant site. Each area is located on a cast in-situ concrete slab, which will have curbs providing the required containment volume. The required volume is determined by the equipment located in the area, and in each case, this has been determined to be 110 percent of the volume of the largest vessel plus allowance for adequate freeboard for precipitation. Adequate precipitation freeboard is defined as the height required to provide a volume capable to contain a 25-year 24-hour storm event. The containment areas drawings are included in Appendix D of Appendix D.

The concrete bund for the air services area is mainly for housekeeping purposes, and the required volume is only related to the 25-year 24-hour storm event for the catchment area.

3.3.12.12.2 Surface Contact Water

For a detailed description of contact water management and the design of water management structures, reference Appendix Y of the Consolidated Permit Application.

Diversion ditches will be constructed above plant infrastructure where required to prevent runoff from entering the process plant areas. Precipitation that falls directly on the pad will be collected in a system of ditches and culverts and directed by gravity towards the collection pond.

The contact collection pond is sized to contain the runoff from a 100-year 24-hour storm event and includes other allowances such as sediment deposition and freeboard. The pond will be double lined with a fluid evacuation zone between the liners.

3.3.12.13 Dust Suppression and Collection

Considerations for the design of the dust suppression and collection facilities is intended to comply with applicable federal and state regulations for air quality, including the Cleaner Air Oregon objectives.

Detailed information pertaining to the regulations, identification and control of air emissions can be found in Appendix M.

3.3.12.13.1 Dust Generating Sources and Controls

The key dust generating sources and identified control methods for the plant site are identified as follows:

Table 79. Selected Air Quality Controls

Dust Source	Control Method
Unpaved Roads	Dust suppression chemicals and water application
Stockpiles (ROM and Crushed Ore)	Inherent moisture content of the ore
Primary and Secondary Crushing Unit	Inherent moisture content of the ore
Ball Mill Feed Conveyor	Inherent moisture content of the ore
Carbon Kiln	Wet dust scrubber
Barring Furnace	Baghouse
Lime Silo	Bin ventilation baghouse

3.3.12.14 General Foundation Recommendations for Mine Process Facilities:

Mine process and support facilities are situated directly north of the proposed mine portal as shown on the Design Drawings. These facilities will include office buildings, truck maintenance facilities, crushers, mill, and additional structures. Based on the subsurface exploration, the subsurface beneath the proposed location for the mine facilities can generally be separated into two areas as summarized below:

- East portion: Approximately five to 20 feet of Quaternary deposits comprising lean to fat clay soils and clayey sands overlying lacustrine clays.
- West portion: About three to ten feet of Quaternary deposits comprising lean to fat clays and poorly graded gravel to silty sand overlying sandstone bedrock encountered at depths ranging from 3.5 to ten feet below ground surface (bgs).

In general, planned structures may be founded on conventional shallow foundations. Foundations may be supported by undisturbed medium dense to very dense granular, native alluvium/colluvium or weathered sandstone, or properly placed engineered fill. Lacustrine and overburden clay soils are not suitable to support foundations.

Topsoil, soil supporting plant growth, or loose soils are not considered suitable for the support of floor slabs, footings, or mat foundations, and should be removed from the site prior to grading.

Due to the presence of clay with a high potential for swelling, a minimum of four feet of separation between the bottom of foundations and the clay soils is recommended. If clay soils are located within four feet of the base of foundations and slabs-on-grade, the clays are to be over-excavated and replaced with granular engineered fill.

The extent of over-excavation will depend on final grades established for the area. Maintaining positive site drainage away from foundations will be imperative to reduce the potential for swelling of the clays that may affect performance of the foundations. This is particularly important for the truck wash and other areas where water is likely to be present with an increased risk of ponding.

3.3.13 Tailings Disposal

The proposed TSF will be located in the broad valley immediately west of the Grassy Mountain mine portal and process facilities. The TSF will fill the native valley and require staged embankment constructions on the north and west sides. The embankments will be constructed in stages using downstream construction techniques. At an average deposition rate of 680 dry st/d and total available tailings capacity of 3.67 mtons, the facility will have an approximate design life of 14 years. The overall disturbance area approximately 108 acres at completion of operation. Total disturbance will include the following:

- Embankments constructed of benign run-of-quarry basalt or other quarried materials;
- Geomembrane-lined tailings impoundment area;
- Process water and tailings delivery pipelines;
- Process water collection systems;
- Light vehicle access roads;
- Stormwater diversion channels;
- Closure and reclamation components.

The fundamental objectives of the TSF design are as follows:

- Zero-discharge facility design;
- Designed for closure;
- Permanent and secure storage of all tailings;
- Protection of the Project Area’s groundwater and surface water;
- Diversion of surface water flows around the facility to the maximum extent practicable during operation;
- Routing of surface water over the TSF closure cover;

- Achievement of a stable, drained inert tailings mass that will be suitable for reclamation soon after operations cease, and will not pose a long-term threat to downstream water quality;
- Tailings disposal will be consistent with OAR 340-043-0130.

The TSF will be a 100 percent geomembrane-lined facility with continuous primary and secondary containment and leak detection systems where process solutions are expected to be localized. Process solution will be managed with two independent return water systems that return collected water from the TSF back to the mill for reuse in the process circuit.

Freeboard water at the tailings surface will be collected and managed at the supernatant pool. A tailings seepage selection system above the geomembrane liner will convey underdrain flows via gravity to the reclaim pond at the northern downstream toe of the facility where the water is pumped back to the mill for use in the process circuit. The anticipated maximum flow rates for each system is estimated using a monthly time-step deterministic water balance. The supernatant pool will be maintained away from the embankments on the eastern side of the facility as shown on the Design Drawing in Appendix C.

The TSF has been designed as a zero-discharge facility capable of storing the 500-year, 24-hour storm and an allowance for wave action above the anticipated normal operation pool. Permanent and temporary storm water diversion channels will collect and divert a majority of the storm water runoff around the facility to a natural drainage north of the TSF.

Adjacent to the TSF, a geomembrane lined storage area has been designed to provide temporary containment of waste rock produced during ongoing mining operations. Design concepts for containment leak detection, and underdrain collection systems for the WRD are the same as those for the TSF. The underdrain collection piping system will be hydraulically separate from the TSF and collected underdrain flows will be routed to the TSF reclaim pond through a solid wall pipe for independent monitoring and sampling.

3.3.13.1 <u>Design Criteria</u>

The design criteria presented below are based on OAR, requirements of the Project as defined by Calico, and Golder's experience designing and constructing TSFs in similar environments. The following OAR Divisions have been used to develop minimum acceptable design levels:

- Oregon Water Resources Department (OWRD), Dam Safety Regulations, OAR 690, Division 20.
- DOGAMI, Chemical Process Mine Regulations, OAR 632, Division 37
- ODFW, Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420
- ODEQ, Chemical Mining, OAR Chapter 340, Division 43

The following TSF Design Criteria Tables present the minimum design criteria proposed for the Project TSF and the corresponding OAR Regulation or Guideline.

Table 80. General TSF Design Criteria Table

Parameter	Value	Reference or Regulation
Capacity	3.67 million dry st	Calico
Life of Mine	~14 years	Calico
Average Tailings Deposition Rate	248,346 tons/year (680 tons per day)	Ausenco
Tailings Slurry Concentration	46% solids (by weight)	Ausenco
Settled Tailings Density	-80 lb/ft³	Golder
Slope of Tailings Surface	1.0%	Golder
Dam Construction Method	Staged Downstream Construction	Golder
Dam Construction Material	Heterogeneous RF and/or soil fill	Golder
Tailings Deposition System	Subaerial discharge spigots	Golder
Reclaim Water System	Decant pumping and gravity underflow reclaim pond	Golder
Supernatant Pool Location	East side hill, not in contact with dam	Golder

Table 81. Division 20- Dam Safety Minimum Design Criteria Table

Parameter	Value	Reference or Regulation
Embankment Geometry		
Upstream Slope Angle	Overall 3 horizontal to 1 vertical (3H:1V), or flatter local slopes 2.5H:1V	OAR 690-020-0038
Downstream Slope Angle	2.5H:1V	OAR 690-020-0038
Geotechnical Criteria		
Hazard Classification	Low	OAR 690-020-0100, Golder recommended
Design Earthquake, Operational	Median MCE	Exceeds OAR 690-020-0038 for Low Hazard Dams
Peak Ground Acceleration, PGA	0.15g	Golder
Horizontal PGA Factor, k, for pseudo-static stability analyses	½ of the PGA	Haynes-Griffin, Franklin (1984) and Seed (1982)
Static Stability, Factor of Safety	1.5 (minimum)	Golder[1]
Closure Seismic Stability (pseudo-static), Factor of Safety Hazard Classification	1 (minimum) Low	Golder[1] OAR 690-020-0100
Impoundment Storage Requirement[2]		
Watershed and Hydrologic Inflows	Precipitation on TSF, small area of run-on into impoundment	Golder
Minimum Freeboard Above Supernatant Pool	3 feet above maximum operating water surface elevation for peak design storm event and wave action	Golder and Partial OAR 690-020-0042
Minimum Freeboard Above Tailings Beach	2 feet against dam embankment	Golder

Parameter	Value	Reference or Regulation
Water Conveyance		
Tailings Underflow Collection System	Perforated and solid CPE and HDPE piping network	OAR 690-020-0038

Table 82. Chemical Mining Minimum Containment Design Criteria Table

Parameter	Value	Reference or Regulation
Containment and Leak Detection		
Facility Discharge	Zero discharge facility	Calico, Golder, and OAR 340-043-0000
TSF Basin Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, GCL, prepared subgrade	Golder and OAR 340-043-0130
TSF Reclaim Pond Containment System (top to bottom)	Continuous 80-mil HDPE geomembrane, geonet leak collection and recovery system (LCRS), 60-mil HDPE geomembrane	Golder
Overall TSF and WRD Leak Detection System	Up gradient and down gradient groundwater monitoring wells	OAR 340-043-0050
Underdrain Channel Leak Detection System	Geomembrane lined channel will provide secondary containment, leak detection will be visual	Golder
Reclaim Pond Leak Detection System	LCRS between two geomembranes, and evacuation port	Golder
Process Water Management		
Tailings Underflow Collection System	Perforated and solid CPE and HDPE gravity piping network in 18-inch-thick drainage layer 6-inch-thick filter layer Gravity flow to reclaim pond	Golder and OAR 340-043-0050
Supernatant Water	Decant pumping system	Golder
Surface Water Management		
Perimeter Diversion Channels	100-year, 24-hour storm event plus nine-inches freeboard or 500-year, 24-hour storm event to channel crest	OAR 340-043-0090
Temporary Diversions Channels	25-year, 24-hour storm event plus 9-inches of freeboard, or 100-year, 24-hour storm event to channel crest	

3.3.13.2 TSF Design Summary

Site Layout: The proposed TSF is located in the broad valley immediately east of the Grassy Mountain mine portal and process facilities. Native slopes within the valley range between approximately four and 20 percent. Embankments will be constructed on the north and west sides to impound the tailings. The north embankment will span the width of the valley (generally east to west) while the smaller west embankments will be used to bridge saddles along the western ridge. The TSF will cover an approximate area of 108 acres and has been designed to accommodate 3.67 M dry st of tailings. An overall layout of the site is presented on the Design Drawings in Appendix C.

Hazard Classification: The Project TSF is designed to meet or exceed the minimum OAR design requirements for a hazard rating of "Low" in accordance with OAR 690-020-0022 (22). This classification is based on OWRD's definition of a low hazard classification as:

"*if the dam were to fail, loss of life would be unlikely and damage to property would not be extensive*".

Although a dam breach analysis is not required for a low hazard dam, one was performed and is presented in Appendix C.

Embankments: As shown on the Design Drawings in Appendix C, embankments will be constructed to impound the tailings along the north and west sides. The main embankment will cross the natural drainage to the north, and small secondary embankments will be constructed across saddles along the western ridge. The embankments with have a maximum overall upstream slope of 3H:1V with a downstream slope of 2.5H:1V. The north and west embankments will have a maximum height of 82 feet and 30 feet, respectively. The crest width of the north embankment will be 50 feet, with 30-feet wide crests for the smaller west embankments. The upstream slope of the embankments will be geomembrane-lined to maintain the continuous lining within the facility. A discussion on the embankment lining system is presented in Appendix C.

The TSF will be constructed in a maximum three stages utilizing downstream construction techniques. Embankment construction materials will be soil or RF sourced from the on-site basalt borrow area and during impoundment grading operations. A detailed discussion on construction materials and construction quality assurance and control (QA/QC) is presented in Appendix C.

Staged construction will provide incremental increases to the facility's storage capacity. The staged storage capacity has been calculated based on a measured settled dry density of 80 lb/ft^3. The following table presents a summary of the storage capacity relationship of the TSF.

Table 49. Stage Capacity Relationship Summary Table

Stage	Main Embankment Crest Elevation (ft)	Maximum Tailings Surface Elevation (ft)	Maximum Tailings Surface Area (acres)	Stage Storage Capacity (million tons)	Cumulative Storage Capacity (million tons)
1	Varies (Min. 3595)	3593	37.0	1.00	1.00
2	Varies (Min. 3609)	3607	59.5	1.07	2.07
3	Varies (Min. 3622)	3620	83.0	1.60	3.67

Lining System: The TSF impoundment area and upstream slopes of each embankment will be continuously lined with both primary and secondary lining systems to provide continuous containment of process solution. The overall lining system will vary depending on the location within the facility. The proposed lined areas are presented on the Design Drawings in Appendix C.

Golder performed an evaluation to compare an alternative lining system to the one prescribed in OAR 340-043-0130 (3). The OAR guidelines for secondary containment are:

"*an engineered, stable, soil/clay bottom liner (maximum coefficient of permeability of 10^{-7} cm/sec) have a minimum thickness of 36 inches*".

The evaluation compared the OAR guideline with both a standard GCL and an enhanced GCL. Both GCL's consist of a sodium bentonite layer between two geotextiles needle-punched together. The enhanced GCL contains an additional laminated thin flexible membrane barrier to offer an increased level of hydraulic performance (decreased hydraulic conductivity). To perform the comparison, the potential fluid travel time through each of the lining systems was evaluated for the following scenarios:

- Comparison of secondary containment alternatives alone (Soil/clay liner versus GCL)
- Comparison of a 60-mil primary containment geomembrane liner with the secondary containment
- Comparison of an 80-mil primary containment geomembrane liner with the secondary containment

Using the comparison of fluid travel times, the standard GCL did not meet the same performance standard as the soil/clay secondary layer (OAR requirement), however the enhanced GCL exceeded the performance based on fluid travel time for all three scenarios. The enhanced GCL in place of the soil/clay secondary liner is proposed. The detailed evaluation is presented in Appendix C.

Within the impoundment, the lining system will consist of (from bottom to top) a 6- to 12-inch thick native prepared subgrade, a 300-mil thick enhanced GCL, 80-mil HDPE geomembrane liner, an 18-inch thick drainage layer, and a six-inch thick filter layer. Perforated piping will be located within the drainage layer to promote drainage of the tailings and to reduce hydraulic head on the lining system.

On the upstream embankment slopes, the lining system will be the same, but without the overlying piping, drainage layer, and filter layer. Placement of a drainage layer above the geomembrane on the upstream embankment slopes is impractical due to the relatively steep side slopes and erosion potential of a cover from tailings deposition. Additionally, the TSF underdrain channel, WRD underdrain channel, and tailings delivery channel from the process area will utilize the same lining system as the TSF embankment slopes.

3.3.13.3 Water Management

Process Fluid Circuit: Water is used in the process circuit for both the metallurgical process and transportation of the tailings to the TSF. Tailings are thickened in the mill after metals extraction. Prior to transport, water is added back into the tailings slurry to decrease the solids concentration. Based on rheological requirements for transport, the tailings will be deposited into the TSF at an average solids concentration of 46 percent solids by weight (w/w).

Tailings are then transported to the TSF and discharged sub-aerially into the lined impoundment through evenly spaced discharge pipes (spigots). As tailings are deposited into the impoundment, the solids separate from the slurry. A portion of the separated water flows to a low point within the impoundment to form the supernatant pool. The remaining water within the tailings mass will drain down to the underdrain collection and lining system.

All piping and pumping systems comprised of HDPE pipes that are either dual containment pipelines or are located above geomembrane-lined channels. Leak detection is performed by visually monitoring flows within the secondary containment systems.

Tailings Distribution System: Tailings will be delivered to the TSF from the mill via a dual containment HDPE tailings delivery pipe. The tailings delivery pipe consists of a 4-inch diameter DR17 HDPE carrier pipe and an outer 8-inch diameter DR17 HDPE containment pipe. The tailings delivery pipe will be parallel the proposed reclaim water pipe located along the access road from the mill to the TSF as shown on the Design Drawings in Appendix C.

The tailings delivery pipe will tie into a 4-inch diameter DR17 HDPE tailings distribution pipe that will route along the TSF perimeter access road where tailings will be deposited via evenly spaced spigots. Spigots are 1-inch diameter HDPE drop pipes with manual control valves to allow for tailings deposition as needed to maintain the appropriate supernatant pool configuration and location.

The tailings distribution pipe and spigots are located above the TSF basin containment system, providing dual containment at all times. Detailed design of the tailings delivery pipe and discharge spigots is being performed by other parties and is not included in the TSF design presented in Appendix C.

Supernatant Pool: Water collecting in the supernatant pool is comprised of free water produced during tailings deposition and precipitation falling on the impoundment surface. Water in the supernatant pool is pumped back to the mill for reuse in the process circuit. The supernatant pool will be maintained on the eastern side of the facility away from the facility embankments as shown on the Design Drawings in Appendix C. As outlined in Section 3.3.12.9, the tailings discharged to the TSF will be detoxified to minimize cyanide concentration of the water in the supernatant pool. An Ecological Risk Assessment (ERA) of the constituents in the supernatant pool was completed and is incorporated in the application as Appendix T. The ERA shows the supernatant pool would not be detrimental to wildlife.

Water from the supernatant pool will be extracted via pumping and delivered back to the mill for reuse through a return water pipe. The supernatant pool is designed to fluctuate seasonally depending on climatological conditions. The supernatant pool will have an average operating depth of five feet that is controlled by the pumping system and is adequately deep enough to prevent drawing tailings solids from the pool bottom.

The return water pipe will combine the flows from the supernatant pool and the reclaim pond. The combined flows will be pumped in a single return water pipe consisting of a four-inch diameter DR17 HDPE carrier pipe and an outer 8-inch diameter DR17 HDPE containment pipe that will parallel the tailings delivery pipe located along the access road from the mill to the TSF as shown on the Design Drawings in Appendix C.

Underdrain Collection System: As deposition continues, the tailings will consolidate due to increased vertical pressure as the tailings surface elevation increases. In addition to water bleeding upward into the tailings surface, water will also be released from the tailings downward. To capture the water released downward, an underdrain collection piping system will be installed above the geomembrane liner within the drainage layer in the TSF basin as shown on Design Drawings in Appendix C. The intent of the underdrain collection system is to reduce the hydraulic head on the geomembrane liner and promote drainage of the tailings for long-term closure.

This network of perforated pipes will capture and convey underflow via gravity to the reclaim pond located downstream of the main embankment as shown on the Design Drawing in Appendix C. The underdrain collection system will consist of variable diameter and pipe types depending on their location and vertical pressure. In general, primary and secondary collection pipes will be perforated 6-inch diameter double-wall CPE and tertiary collections pipes will be 4-inch diameter double-wall CPE. Tertiary collection pipes will be installed with greater density adjacent to the north embankment and beneath the supernatant pool.

The primary collection pipes will transition to solid wall HDPE outlet pipes and then penetrate through the geomembrane liner at the upstream toe of the north embankment and pass under the dam via solid wall HDPE gravity conveyance pipelines to the reclaim pond. For redundancy, the primary collection pipes will interconnect within the TSF basin and flow to the reclaim pond.

Where the underdrain outlet pipes pass beneath the embankment, the pipes will be encased in reinforced concrete to protect against deformation and maintain the integrity of the pipes. The pipes and reinforced concrete will be located above a geomembrane-lined channel below the embankment to provide further protection and containment of the system. Beyond the Stage 3 downstream toe, the reinforced concrete encasement will terminate, and the outlet pipes and geomembrane-lined channel will continue to the reclaim pond.

Prior to discharging into the reclaim pond, each underdrain pipe will enter a monitoring flume. Valves will be located upstream of the monitoring flumes to restrict flows or be closed in the event that flows to the pond need to be limited for short periods of time for maintenance or emergencies.

Reclaim Pond: The reclaim pond will be a double-lined pond north of the main embankment and will contain the TSF underdrain flows as shown on the Design Drawings in Appendix C. The lining system for the reclaim pond will consist of (from bottom to top): a native prepared subgrade, 60-mil HDPE secondary geomembrane liner, HDPE geonet, and 80-mil HDPE geomembrane primary liner. The geonet located between the two geomembranes will serve as the LCRS.

The reclaim pond was sized to contain, at a minimum, the total volume of water generated during the following:

- 500-year, 24-hour design storm event falling on the surface of the pond,
- Gravity underdrain flow from the TSF for the duration of a 48-hour power outage,
- Volume of water within the entire length of the reclaim water pipe between the reclaim pond and the mill.

The reclaim pond has a storage capacity of 146,000 gallons to the underdrain channel invert elevation which is 3.6 ft below the pond crest. The total storage capacity of the reclaim pond is 215,000 while maintaining two feet of freeboard beneath the pond crest. In this scenario, water in the pond would also back up into the portion of the lined underdrain channel for additional emergency storage above the minimum required. Pond sizing calculations are presented in Appendix C.

Water from the reclaim pond will be pumped back to the mill for reuse in the process circuit. The reclaim water pipe consists of a 4-inch diameter DR17 HDPE carrier pipe and an outer 8-inch diameter DR17 HDPE containment pipe. The reclaim water pipe will be installed along the access road downstream of the TSF and along the eastern TSF perimeter access road as shown on the Design Drawings in Appendix C. The reclaim water pipe will connect with the supernatant return water pipe where the combined flows will be pumped in a single dual containment pipe installed parallel with the tailings delivery pipe located along the access road from the mill to the TSF.

At all times, process fluid pipelines will be located above secondary containment that consists of either geomembrane liners or concrete containment structures.

Development of Climate Data: Climate data for the Grassy Mountain project site was developed using nearby weather station data and regression analysis based on elevation of the proposed Project TSF dam. For this project, climate data and station metadata of the closest Remote Automated Weather Stations (RAWS) and Cooperative Observer Network (COOP) stations to the Project site were identified and compared, along with the PRISM Climate Group (PRISM) spatial data, using statistical and regression analyses.

Details of the climate model are presented in Appendix C.

Water Balance: A deterministic spreadsheet-based monthly time step water balance was developed for each stage of the TSF based on a tailings deposition rate of 680 st/d and a slurry concentration of 46 percent solid, by weight.

Inflows to the system include precipitation above lined areas, surface water run-on from up-gradient catchment areas below the permanent and temporary storm water diversions, and water being deposited within the tailings slurry at a rate of 133 gpm.

Outflows/losses include evaporation from the tailings beach area, evaporation from the supernatant pool area, interstitial water permanently stored within the tailings mass, and estimated reclaim flow rates to the mill. Results from this water balance estimate reclaim water flow rates from the TSF to the mill in order to effectively manage water in the supernatant pool.

The average reclaim rate from the supernatant pool is 44 gpm for Stages 1 through 3 and varies between zero during summer months (July and August) to 106 gpm during winter months (December and January). Make-up water required was defined as the rate of evaporation from the tailings beach and supernatant pool (outflow) plus interstitial water loss (outflow) minus precipitation (inflow). The make-up water rate is less than or equal to the rate that water is reporting to the TSF in the tailings slurry. The average make-up water rate is 68 gpm for Stages 1 through 3 and varies between 133 gpm during summer months (July and August) to 1 gpm during winter months (December and January).

The detailed water balance and supporting discussions are presented in Appendix C.

TSF Freeboard: For TSFs (non-water impounding structures), freeboard is generally defined separately for the area with free water in the supernatant pool and dry tailings beach areas. The OAR guidelines do not define these separately. The minimum freeboard definition presented in OAR 690-020-0042 is generally intended for water storage reservoirs where water is in contact with the embankments. However, for tailings storage facilities in arid climates, tailings deposition and reclaim water can be managed to prevent free water from contacting the embankment, similar to the proposed TSF, as shown on the Design Drawings in Appendix C.

The proposed TSF is designed to provide a minimum freeboard depth of 3 feet above the maximum supernatant pool water surface where it is impounded against the geomembrane-lined southern hillside. This freeboard will provide suitable dam storage height above the maximum water surface elevation to contain wave action above the 500-year, 24-hour storm event falling on the TSF impoundment and the upgradient catchment areas below the permanent and temporary diversion channels. Wave run-up calculations were developed assuming the TSF had experiences of a 500-year, 24-hour storm with waves generated from sustained wind loading using the average wind speed and the longest reach length of the supernatant pool in the prevailing wind direction. Wave run-up calculations have been included in Appendix C.

Tailings beach areas are defined as areas where the impoundment surface is free of pooled water and only comprised of drying or dry tailings. The TSF is designed so that only tailings will impound against the embankments. In the tailings beach areas, a minimum freeboard of 2 feet will be provided from the highest beach elevation to the lowest dam crest elevation.

In addition to the above freeboard dimensions, the TSF is designed such that the lowest tailings surface and pool elevation is away from the facility embankments. This results in the overall tailings surface sloping away from the perimeter embankments southeast toward the Supernatant Pool. With the fluid management for the TSF as presented in Appendix C, overtopping or freeboard encroachment is not expected.

A closure spillway has been sized to accommodate surface water flows from the TSF closure cover while the permanent diversion channels (discussed below) remain in place. This spillway can be constructed and implement at any point during operation or closure.

Storm Water Control: Permanent and temporary storm water diversion channels have been included in the design to convey surface water run-off from up gradient catchment areas around the TSF to decrease the amount of run-on water that needs to be managed within the TSF. The permanent storm water diversion channels are sized to contain the peak discharge from the 500-year, 24-hour storm event of 2.91 inches, and will be lined with riprap in areas where erosion protection is required.

To prevent overtopping, all channels have been designed with a minimum freeboard of 9 inches above the maximum anticipated flow depth resulting from the 100-year, 24-hour storm event. The total depth of each channel is designed to fully contain, with little to no freeboard, the 500-year, 24-hour storm event. A detailed summary of the hydrologic and channel hydraulic calculations is presented in Appendix C.

3.3.13.4 Geotechnical Considerations

The following sections present the general subsurface soil and groundwater conditions at the site along a summary of the stability and settlement analyses performed for the TSF embankment. Slope stability analyses were conducted to evaluate performance of the north TSF embankment for long-term, post-closure conditions based on design criteria of the facility.

Settlement analyses were conducted to evaluate potential impacts of settlement within native and engineered materials on performance of the underdrain collection piping beneath the embankment. Brief summaries on stability and settlement analyses are presented in the following section, and presented in detail in Appendix C.

Geotechnical Investigations: Subsurface geotechnical investigations were performed throughout the design of the TSF and WRD, which included:

- December 2017 – 15 geotechnical boreholes, 44 test pits and six in-situ field falling head permeability tests on native subgrade materials;
- March 2019 – Six geotechnical boreholes;
- July 2019 – 11 cone penetrations test soundings.

Geotechnical laboratory testing was performed on selected soil samples deemed representative of the materials encountered during the investigation. The laboratory testing program focused on providing information for the more critical aspects of the design. These included the north TSF embankment and potential borrow areas, with a majority of the laboratory tests performed on the lacustrine clay deposits within the footprint of the north embankment. Laboratory testing completed on the lacustrine foundation clays included moisture content, grain size analyses, Atterberg Limits, consolidated-undrained triaxial, and one-dimensional consolidation tests.

To further support the selection of materials strength parameters used in the stability analyses, a Cone Penetration Test (CPT) program was completed within the foundation of the TSF embankments and basin. This program further refined the material properties of the lacustrine clay deposits below the embankments including pre-consolidation, saturation level, stiffness, grain size distribution, and pore-pressure dissipation potential.

General Subsurface Soil and Groundwater Conditions: Subsurface soil and water conditions are described in detail in Appendix C.

In general, topsoil was generally observed to be about ½ feet thick across the majority of the TSF site. The topsoil is underlain by near surficial alluvial and colluvial deposits across the site with depths ranging from about ½ feet to 25 feet below the existing ground surface (bgs). These deposits were generally unconsolidated Generally, the upper portion of the deposit was classified as fine-grained soils classified as lean and fat clay with varying amounts of sand and gravel and were underlain by coarse-grained soils classified as clayey- to silty-sand, clayey- to silty-gravel, and poorly- to well-graded sand and gravel.

Lacustrine deposits were encountered across a majority of the TSF site and primarily classified as lean to high plasticity clay with varying sand content. Abundant evaporites were often found in the upper three (3) feet of the deposit and continued in limited amounts throughout. Based on similar units in the region, these units are estimated to be Miocene-age deposits. This horizon was encountered up to depths of 120 feet bgs (maximum depth of exploration) within the footprint of the TSF and may extend deeper.

Relatively shallow (less than 15 feet) weathered arkosic sandstone was observed within the north-central portion of the TSF and west portion of the mine process facilities. The sandstone is similar to a silty- to poorly graded sand. In general, the west portion of the mine process facilities consisted of Quaternary deposits underlain by weathered arkosic sandstone, and the east portion of the mine process facilities area consisted of Quaternary deposits overlying lacustrine fat clay deposits.

No subsurface water was encountered during the field exploration with boreholes extending to a maximum depth of approximately 120 feet bgs. In the *Groundwater Resources Baseline Data Report* prepared by SPF it was reported that the groundwater depth beneath the southern portion of the TSF basin ranged between 155 feet at the BLM well located within the TSF footprint and 232 feet at the GW-3 well located just southwest of the TSF (SPF 2019a). Inferred groundwater contours presented in the same report indicate groundwater beneath the reclaim pond area may be as shallow as 55-feet, however, no groundwater was encountered in any of the boreholes.

Groundwater depths in this area will be refined after the installation of proposed groundwater monitoring wells as presented in SPF's report. In addition, no springs were observed in the TSF or mine facility areas during the field investigation. However, fluctuations in precipitation may occur that could affect subsurface water conditions at the sites.

Seismic Hazard Analysis: Golder completed a seismic hazard analysis (SHA) for the Project site and is presented in Appendix C. The purpose of the SHA was to identify faults that have the potential for surface rupture and to estimate earthquake ground motions for the operational and closure design earthquakes at the site for input into stability modelling. The Grassy Mountain site is located in the Columbia Plateau, a region of relatively low historical earthquake activity.

A probabilistic seismic hazard analysis (PSHA) using the USGS 2014 National Seismic Hazard Model indicates that the earthquakes for the 475-year return period has a mean peak ground accelerations (PGAs) of 0.08 gram. The complete SHA has been included in Appendix C.

A deterministic seismic hazard analysis (DSHA) indicates that the Cottonwood Mountain fault is the controlling Maximum Credible Earthquake (MCE) for the Project TSF. The Cottonwood Mountain fault has a surface trace mapped about 18 miles (28 km) from the TSF at its closest approach and generates an MCE M7.2 earthquake. Using the geometric mean of four equally weighted ground motion models, the median PGA value for the MCE is 0.15 g. The median deterministic PGA has return periods estimated from the 2014 USGS National Seismic Hazard Model (NSHM) at about 1,500 years.

By comparing the PSHA and DSHA, Golder selected the PGA resulting from the median MCE as determined by the DSHA as the design seismic event for the Project TSF for operation and closure. The event results in a PGA of 0.15g.

A seismic coefficient (k) of 0.075 g (one half the peak acceleration) was utilized for the pseudo-static slope stability analysis to model the earthquake loading of the embankment. This reduction in PGA is in line with the commonly accepted state-of-practice by Hynes-Griffin and Franklin (1984).

Embankment Slope Stability: Slope stability of the north and west TSF embankments were analyzed along cross sections that were considered to be the critical embankment section based on anticipated geotechnical conditions in the embankment foundation and the current design configuration (e.g., embankment height, slope angles, and existing topography).

For the north embankment, downstream critical failure surfaces were analyzed at the ultimate Stage 3 height of the 3.67 mtons capacity TSF through the natural drainage. The analysis considered both drained effective stress and undrained strength considering both circular and block-type failures. Circular failures included both global failures through the embankment and foundation soils and shallow ‘sloughing’ failures of the downstream slope. Block-type failures were assumed to occur at the interface between the embankment fill and the underlying foundation material. Based on the stability analyses, the controlling scenario for geotechnical stability is a deep foundation circular failure using drained effective stress parameters for the clay foundation. Therefore, block-type failures are not presented.

All calculated FOS values were found to be above the minimum criterion (FOS≥1.5 for static, FOS≥1.1 for pseudo-static) as summarized in the table below. Based on the stability analyses, the controlling scenario for geotechnical stability is a deep foundation circular failure using drained effective stress parameters for the clay foundation.

Table 83. Summary of Critical TSF Stability Analysis Results

Analysis Method	TSF Stage	Static FOS (Target design minimum = 1.5)		Pseudo-static FOS (k = 0.075 g) (Target design minimum = 1.1)	
		North Embankment	West Embankment	North Embankment	West Embankment
		Section A	Section D	Section A	Section D
Effective Stress	1	1.5	1.9	1.2	1.4
	2	1.5	1.7	1.2	1.3
	3	1.5	1.5	1.2	1.2
Total Stress	1	2.1	-	1.7	-
	2	1.8	-	1.3	-
	3	1.5	-	1.1	-

Settlement: Settlement analysis was performed to evaluate impacts to the integrity and performance of the underdrain collection piping due to settlement of engineered fills and native foundation materials below the facility. Material properties for settlement calculations were estimated from Golder’s geotechnical field and laboratory testing programs presented in Appendix C. Subsurface soils generally consist of alluvium and colluvium Quaternary deposits of varying thickness (approximately two feet to 25 feet) overlying over-consolidated, lean to fat clays with varying sand content. Clays below the embankment were generally stiff to hard and settlement in both the engineered fills and native materials was evaluated using elastic theory.

Post-settlement grades along the underdrain collection piping must remain adequately steep for positive solution flow. To maintain this flow, underdrain collection pipes are designed to be installed at steeper grades and expected to flatten as the dam is constructed and tailings deposition progresses.

In order to achieve a minimum post-settlement of one percent, the underdrain outlet pipes will be installed at grades between one and 2.5 percent. Results of the settlement analysis indicate that beneath the upstream and main portions of the north embankment, the underdrain outlet pipes will have a post settlement grade of one percent and beneath the downstream portion of the main embankment, the underdrain outlet pipes will have a post settlement grade between 1.4 and 2.5 percent. Appendix C presents detailed foundation settlement calculations of the TSF embankment and minimum underdrain collection pipe design grades below the North Embankment.

Borrow Material: Borrow material will be needed for construction of the TSF embankments and potential fill below planned structures. Several areas were explored during the design to determine potential borrow source areas within the project boundary. The borrow area on the east side of the Permit Area will supply aggregate for the Project. Embankment fill material will generally consist of native granular soils such as sand, gravel, clayey to silty sand, and clayey to silty gravel and run-of-quarry fill materials. Embankment fill will be generated from the proposed borrow area east of the process facility as shown in Appendix C.

Basalt material encountered on the hillsides east of the project area is suitable for use as embankment fill. Development of this area as a borrow source will likely require ripping and/or blasting. Weathered arkosic sandstone is considered unsuitable for embankment material as it is generally brittle and erosive. If material meeting the requirements for embankment fill is used as fill beneath planned structures, screening may be required to remove over-sized material.

3.3.13.5 Tailings Testing

Golder completed geotechnical laboratory testing, consolidation modeling, and thin lift modeling on two pilot mill tailings sample delivered to Golder's Denver, Colorado, geotechnical laboratory. Detailed discussions on the laboratory classification, consolidation properties, and results are included in Appendix C.

The tailings sample tested in the laboratory had about 46 percent solids (by weight) and a specific gravity of 2.62. Consolidation modelling was completed using a tailings deposition rate of 680 tons per day and consolidation properties developed during the laboratory testing were used for the consolidation modelling to estimate the settled dry density of the deposited tailings with time.

Consolidation modeling did not show a significant change in settled dry density with time or staging. Estimated settled dry densities range between 79 and 82 pcf. For design of the TSF, an overall settled dry density of 80 pcf was selected.

3.4 Chemical Storage and Use

The volume and shipment frequency of fuels and reagents used in process is shown in the Fuels and Reagents Volumes and Shipments table below. Acid solutions, caustic soda, and concentrated cyanide solutions will be delivered to the site in liquid form. Containment of process solutions is based on 110 percent of the largest containment volume for each reagent.

Acid will be stored in the absorption, desorption, and refining (ADR) building and limited to individual totes or barrels that are used in the acid area and will not exceed 1,300 gallons. The volume of acid stored in the building will be less than the largest acid tank, which will be the acid wash vessel having a volume of 2,320 gallons.

Caustic soda solution will be received in a 10,000-gallon tank, diluted, and then distributed to the plant. Liquid caustic soda will be delivered to the mine site at 50 percent concentration and diluted to 20 percent concentration for use on site. Transfer of caustic soda solution will occur on the same concrete slab used for cyanide solution.

Hydrocarbon products, including lubricants, oils, antifreeze, and used oil will be stored at the truck workshop (Figure 6). Reagents will be transported, stored, and used in accordance with federal, state, and local regulations. Diesel fuel and hydrocarbon products will be stored in primary (tanks, tote bins, barrels) and secondary containment to prevent release to the environment. Used oil and used containers will be disposed or recycled according to federal, state, and local regulations.

Table 84. Fuels and Reagents Volumes and Shipments

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Mill Ore Processing				
Sodium Cyanide - Mixed to 25% NaCN	10,000 gallons	10,000 gallons		1
Lime - Dry pebble at 90% CaO	25-ton truckload	100-ton silo	30 tons/day	3 - 4
Anti-Scalant (liquid surfactant)	240 lb carboy	2 carboys	30 lb/day	
Carbon Acid Wash & Neutralization				
Hydrochloric Acid (HCl) - Liquid 30%	HDPE totes	3,000 gallons	10 lbs/day	7
Acid Wash Vessel	2,320 working gallons			
Acid Mix Tank	282 working gallons			

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Caustic Soda - Sodium Hydroxide (NaOH) - Liquid	4,887 working gallons	5,000 gallons	5 lbs/day	7
Fluxes				
Borax (pentahydrats) - Dry	50 lb sacks	20 sacks	20 lb/day	*
Silica (SiO_2) - Dry	50 lb sacks	10 sacks	10 lb/day	
Niter ($NaNO_3$) - Dry	50 lb sacks	5 sacks		
Feldspar - Dry	50 lb sacks	5 sacks		
Mercury Control				
Sulfide-impregnated Carbon - Dry	50 lb sacks	40 sacks	25 lbs/day	*
Mercury Recovered				
Mercury	80 lb flask		5 lbs/day	*
Electrolytes				
Sodium Hydroxide (NaOH) - Dry	20 lb sacks	10 sacks	15 lbs/day	*
Assay and Met Lab				
Sulfuric Acid (H_2SO_4) Reagent Grade	1 gallon	6 gallons		
Nitric Acid (HNO_3) Reagent Grade	1 gallon	10 gallons	1lb/day	
Hydrofluoric Acid (HFI) Reagent Grade	1 gallon	2 gallons		
Hydrochloric Acid (HCl) Reagent Grade	1 gallon	4 gallons		
Sodium Cyanide (NaCN) Reagent Grade – Dry	5 lb box	10 boxes	1 lb/ day	*
Buffer Solution Reagent Grade - Dry	5 lb box	10 boxes		
Lead Nitrate ($PbNO_3$)- Dry	20 lb bag	1 bag		
Acetylene	Size 45 industrial Acetylene Cylinder	3 in lab/15 in shop	2 cylinders per week	
Fluxes				
Borax Penta - Use Plant Source			18 lbs/day	*
Silica - Use Plant Source				
Lead Oxide - Reagent Grade	80 lb pail	1 pail	2 lbs/day	*
Methyl Ethyl Ketone (MEK)	5-gallon pail	1 pail		
Silver Inquart	10 lb package	1 pkg		
Fuel/Lube/Oil				
Diesel- Truck Shop	30,000 gallons	Up to 30,000 gal	6,000 gal/day	1
Ammonium Nitrate/Fuel Oil (ANFO)	60-ton silo	Up to 60 tons	8 tons/day	
Gasoline	10,000 gallons	Up to 10,000 gal	250 gal/day	
30WT Motor Oil	4,000 gallons	Up to 4,000 gal	15-20 gal/day	
Used Motor Oil	4,000 gallons	Up to 4,000 gal	15-20 gal/day	

Chemical	On-Site Storage	Anticipated Stored Amount	Estimated Consumption Rate	Shipment Frequency (per week)
Antifreeze	2,000 gallons	Up to 2,000 gal	1-l5 gal/day	
Hydraulic Fluid	2,000 gallons	Up to 2,000 gal	10-15 gal/day	
90WT Gear Lube	2,000 gallons	Up to 2,000 gal	10-15 gal/day	
Waste Antifreeze	2,000 gallons	Up to 2,000 gal	10-15 gal/day	
Grease bins	4 x 120-gallon totes, 4 x 30-gallon drums	Up to 4 totes, up to 4 drums	5-10 gal /day	

3.4.1 Petroleum Contaminated Soil Management

A Petroleum Contaminated Soil Management Plan is included in Appendix Z.

3.4.2 Waste Disposal Management

Used lubricants and solvents will be characterized according to the Resource Conservation and Recovery Act (RCRA) requirements and will be stored appropriately. Calico may obtain a Hazardous Waste Identification Number from the ODEQ. The mine is expected to be in the "conditionally exempt small quantity generator" category as defined by the EPA. Used solvents are the only identified potentially hazardous wastes at this time. Calico will institute a waste management plan that will identify the wastes generated at the site and their means of disposal.

Used oil and coolant will also be stored at the truck workshop in secondary containment. These will be either recycled or disposed of in accordance with state and federal regulations. Used containers will be disposed of or recycled according to federal, state, and local regulations.

Solid wastes and industrial solid wastes generated by the mine and process departments will be collected in dumpsters near the point of generation. A training program will be implemented to inform employees of their responsibilities in proper waste disposal procedures.

Calico will have a trained response team at the site 24 hours per day to manage potential spills of regulated materials at the site. Response for transportation-related releases of regulated materials bound for the site will be the responsibility of the local and regional agencies. However, where appropriate, Calico may assist with response to off-site incidents, including providing resources, based on agency requests.

3.4.3 Explosive Storage and Use

Explosive agents will be purchased, transported, stored, and used in accordance with the BATFE, Department of Homeland Security (DHS) provisions, and MSHA regulations. The primary explosive used will be ANFO. Explosive agents, boosters, and blasting caps will be stored within a secured area. Boosters and detonators will be stored in separate storage magazines.

Explosives-storage facilities will be constructed at the southwest side of the Project (Figure 6). This location uses the hill as a natural barrier between the explosives-storage facility and other infrastructure. The storage facilities will consist of leased powder magazines as per vendor quotation. Dirt berms will be places around the magazines for additional security.

Explosives will be delivered to site by vendors using the main access and will be delivered to the working face using stainless-steel totes on flatbed trucks.

3.4.4 Cyanide Management

Cyanide transporters are expected to comply with the International Cyanide Management Code for the implementation of appropriate emergency response plans and capabilities in the event of a release or spill, and with the Federal Motor Carrier Safety Administration's regulations for transportation of hazardous materials on public highways (49 CFR Part 397). Cyanide will be delivered to the Project in dry form by truck from Winnemucca, Nevada, and will be supplied as one-ton bulk bags packed in wooden crates. The crates will be stored on site in a cyanide mixing and storage area, which will be completely fenced and secured, and placed on an impervious concrete slab with walls providing a 110 percent containment. The dry cyanide is dissolved in water in an agitated mix tank. After the cyanide is mixed, the solution gravitates towards a 10,000-gallon storage tank. The cyanide solution will then be metered to various points throughout the plant. Additional information on cyanide management is in the Cyanide Management Plan (Appendix F).

3.5 <u>Mine Site Infrastructure</u>

3.5.1 Haul and Access Roads

The roads used to access the Mine and Process Area are described in detail in the Road Design Report (Appendix AC) and summarized in Section 3.2. The Road Design Report describes the design specifications and where the existing road will be upgraded, widened, and realigned. See Table 56 in Section 3.2.1 for select access road specifications.

The roads within the Mine Permit Area are shown on the Site Arrangement map (Figure 6). These roads will be upgraded in accordance with MSHA regulations, and best management practices (BMPs) will be used where necessary to control erosion.

3.5.2 Power Supply

Electrical power will be supplied to the mine via a powerline owned and maintained by Idaho Power. Idaho Power will apply for authorization to construct from the BLM under a ROW. The power demand will be approximately five megawatts (MWs) throughout the life of the mine. The Idaho Power powerline will connect to the Project substation, located near the processing facility. The powerline will be within the Access Road portion of the Permit Area.

During construction of the powerline, one emergency diesel generator capable of producing 2,000 kilowatts (kW) will be located at the process facility. It will be used for slightly more than one year during construction and initial mining of the decline. After the powerline is complete, this generator will provide sufficient emergency power to operate critical components at the facility in the event of a power outage.

3.5.2.1 On-Site Power Generation

Quotations for portable power generation, including the leasing of generation equipment, were obtained from vendors. Once construction of the primary powerlines has been completed, the generators would remain on site for backup in case of power outages. Power generation is estimated based on monthly rates and fuel, as the rate per kilowatt hour (kWh) will vary depending on power consumption.

3.5.2.2 Line Power

HDR, an engineering company with offices in Boise, Idaho, coordinated with Idaho Power to design the line power to deliver approximately 5.3 MW of power to site, including a 23-mile distribution circuit, a new 69/34.5 kV to 14 millivolts (mV) transformer, and a new 34.5-kV 167-amp regulator. The powerline would be constructed from the Hope Substation near Vale, Oregon, to the mine site along the main access road, within the Access Road portion of the Permit Area. Figures 32 through 34 show the planned line pole configurations.

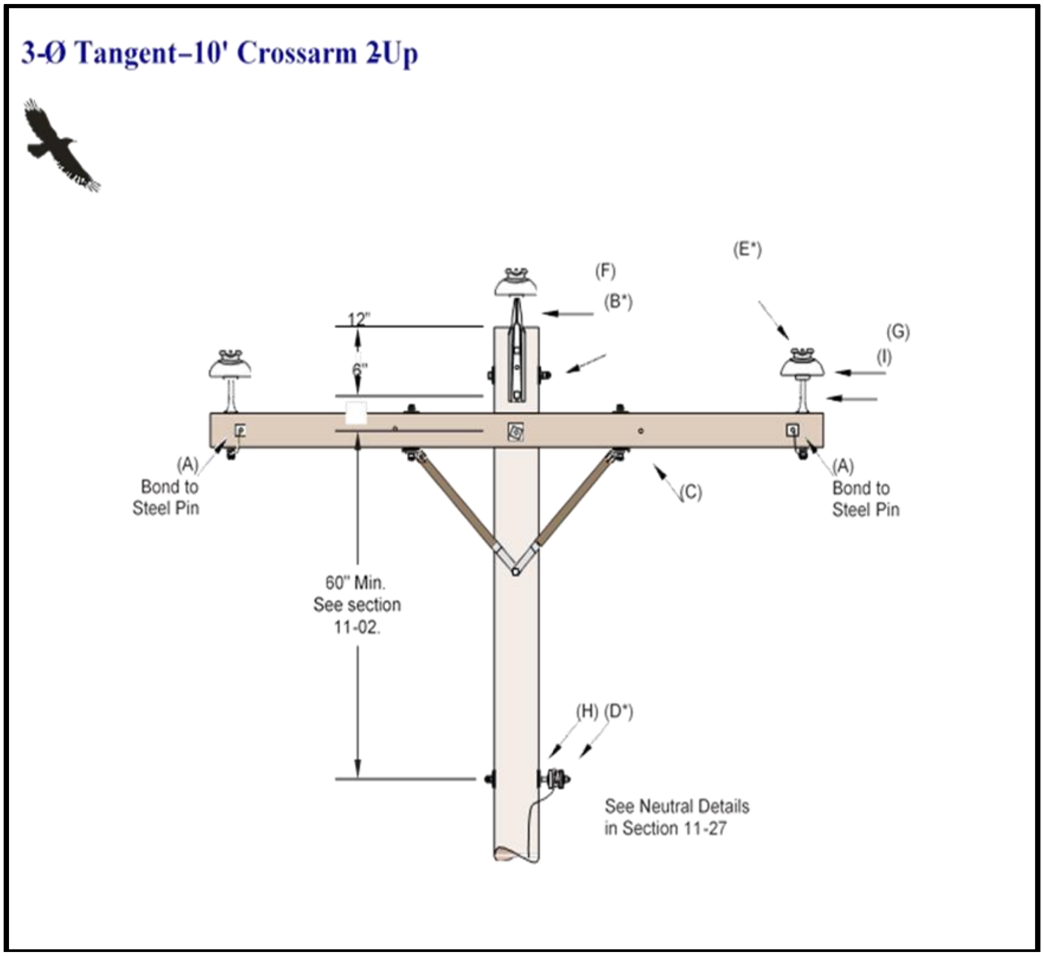


Figure 32. Planned Line Pole Configurations

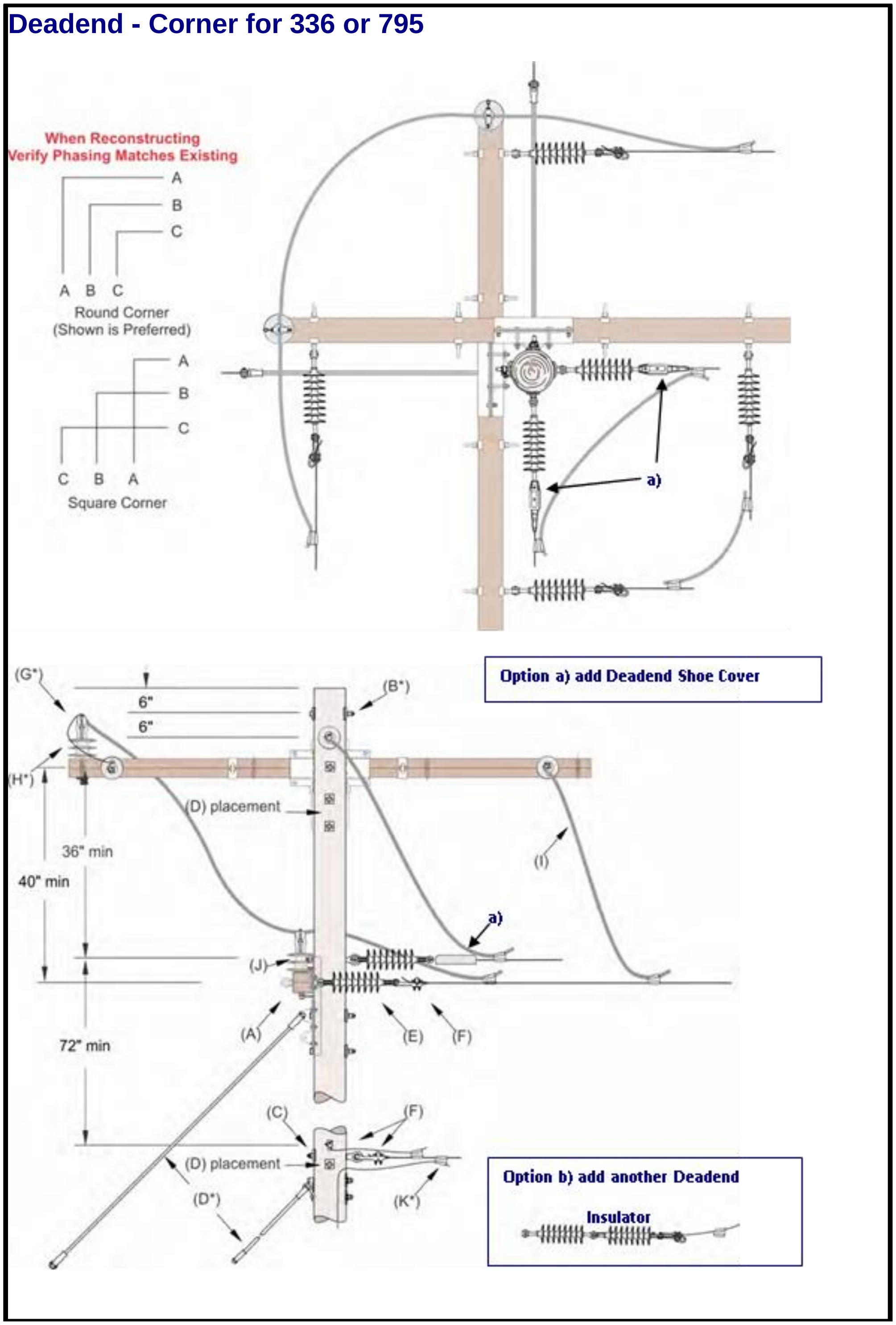


Figure 33. Planned Line Pole Configurations

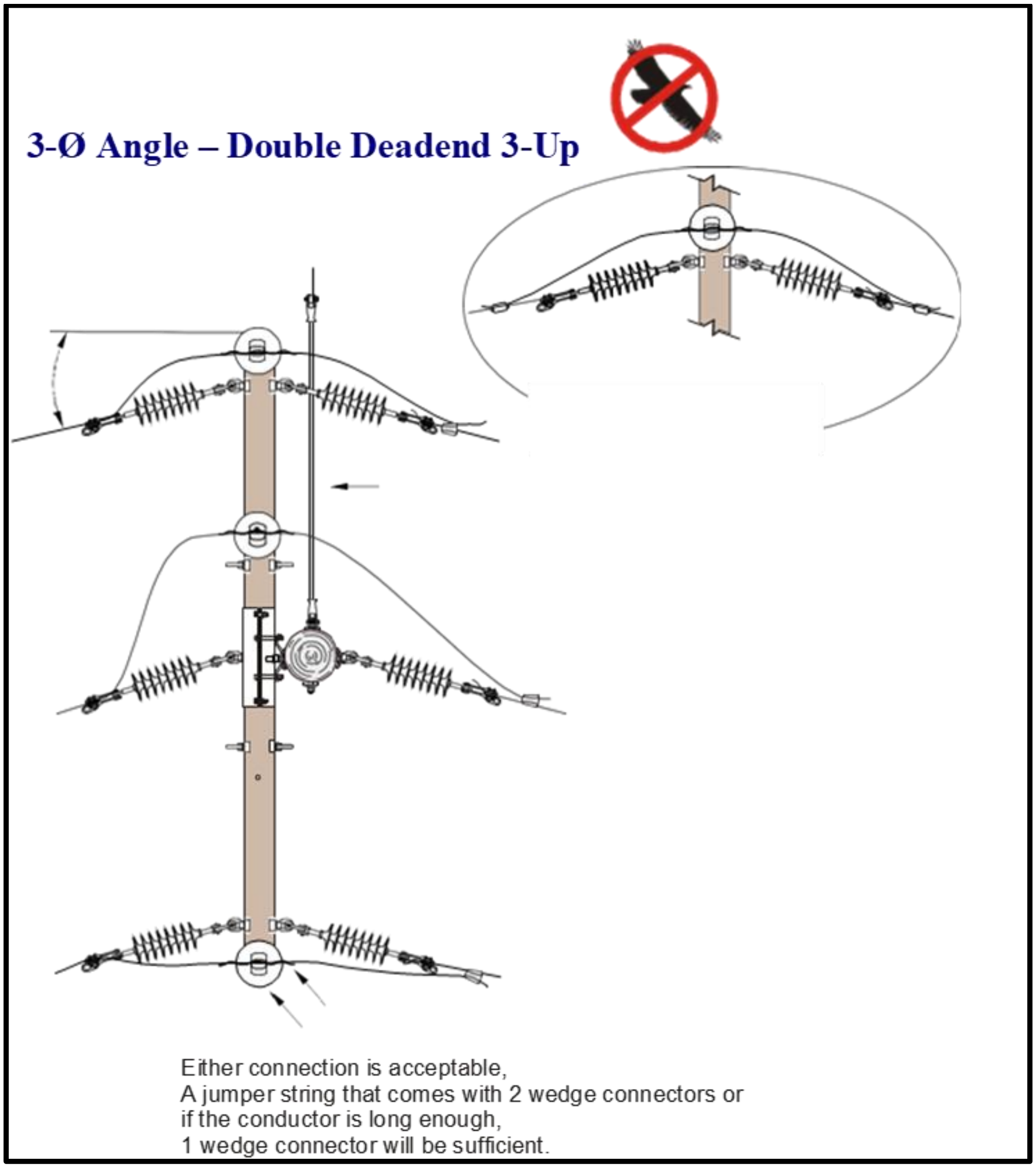


Figure 34. Planned Line Pole Configurations

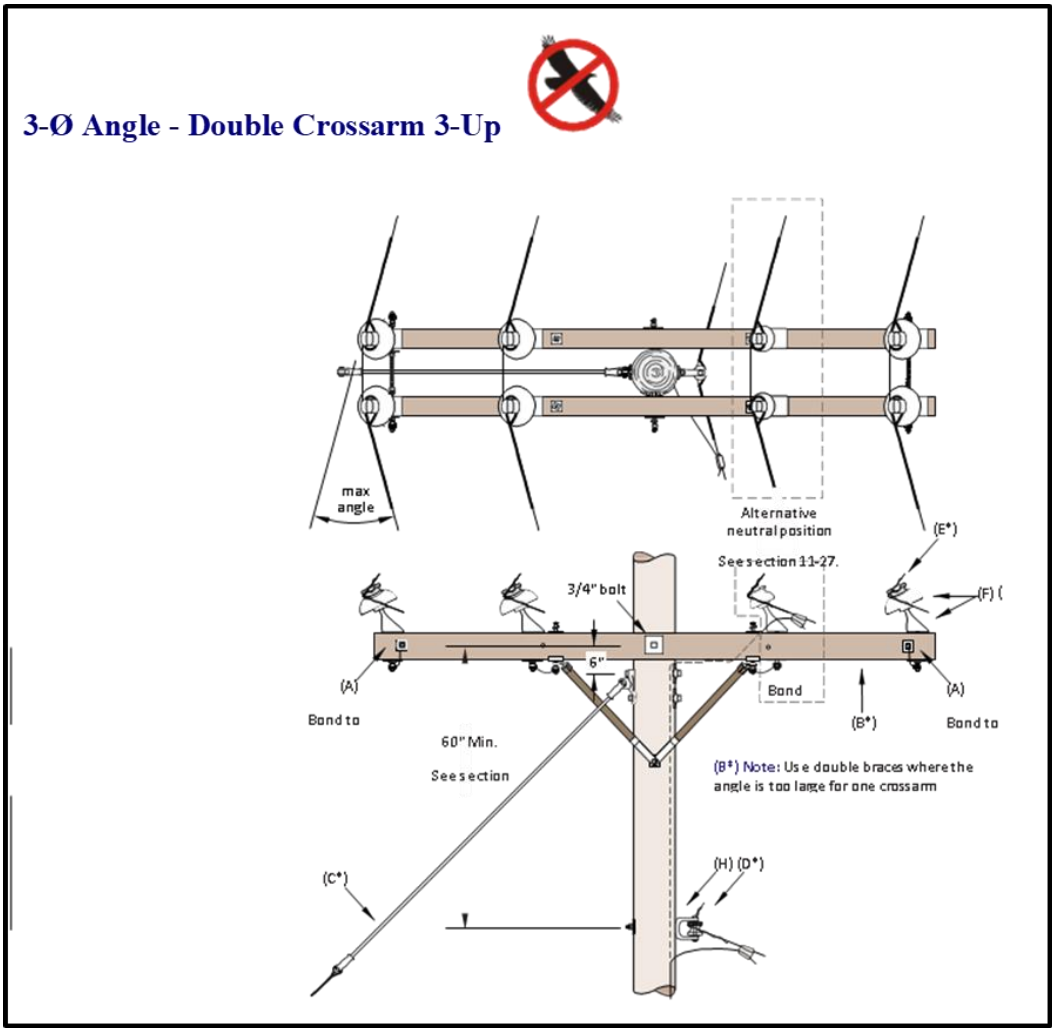


Figure 35. Planned Line Pole Configurations

3.5.2.3 Site Power Distribution

The plant power distribution from the powerhouse will be via overhead powerlines. The distribution voltage to the local electrical rooms will be 4.16 kV. There will be a combination control-room and motor-control-center room, which will be prefabricated and loaded with electrical equipment prior to delivery to site. The power distribution from the electrical rooms will be 480 volts.

The total connected load for the process plant is expected to be 4.9 MW, with an average power draw of 3.3 MW.

3.5.2.4 Underground Mine Power Distribution

At the start of mining an underground 480-volt transformer will be placed near the entrance to the portal. This will supply power to electrical equipment used to develop the main decline and portable fans. Once development has advanced far enough that carrying power at 480-volt becomes too inefficient, a main powerline will be installed along the rib of the decline to carry 4.16 kV and connected to the transformer, which will be moved underground.

Upon completion of the decline to the 3,224 level, and the initiation of production-mining activities, a second underground transformer will be purchased for use in the lower areas of the mine.

Line power will also be carried up the hill to the location of the ventilation shaft to supply power to the ventilation fans.

3.5.3 Ancillary Facilities

Planned ancillary facilities will include access roads and other facilities, laydown areas, maintenance facilities, a meteorological station, and other support facilities on similar flat terrain where the future disturbance will be reclaimed in a similar manner. Figure 6 presents the planned site layout.

3.5.3.1 Support Facilities

Support facilities will consist of the mine maintenance shop, warehouse, and administration buildings. The maintenance shop will have a concrete floor with rails to support the heavy equipment. The buildings will typically be insulated, prefabricated office trailers without concrete foundations. Heat will be provided by electric forced air furnaces in the office and personnel buildings and propane gas radiant heat in the maintenance bays. Gas will be provided from a propane tank located near the ADR plant building. Air conditioning will be provided by electrical cooling units.

Mobile equipment maintenance will be performed at the maintenance shop. The maintenance area will consist of an enclosure and concrete pad of appropriate size and an oil/water separator. Reclamation of support facilities are addressed in Section 4.7.

A fuel storage depot will be located near the Processing Facilities. It will include separate diesel above-ground tanks for fueling of light/intermediate and heavy vehicles. Gasoline will also be stored in an above tank in the fuel storage depot. Spill containment will be designed for 110 percent of the largest tank or tanker within the containment. Fuel will be delivered via highway-legal trucks directly to the depot. Drivers off-loading fuel will be certified and trained. Camlock fittings or other appropriate fittings will be located within the containment to collect spilled fuels. A sump will be located at one end of the containment so that spilled fuels can be pumped for appropriate disposal from the containment using a portable pump. Refer to

Appendix E for the Emergency Response Plan and Appendix Z for the Petroleum-Contaminated Soils Management Plan.

Lubricants, antifreeze, and used oil and coolant will be managed and stored in the area in a manner complying with MSHA requirements and other state and federal regulations.

A centralized oil-water separator will be installed adjacent to the truck workshop to treat water from drains located at each maintenance bay and from the wash rack. The floor drains in the truck workshop will be intended for collection of rainwater and snow melt from vehicles and equipment. Gray water from the oil/water separator will be collected in a tank within containment or a lined impoundment. The gray water will be recycled back to the wash system; excess water will be used for dust control. The separated oil will be stored either in a double-lined tank or a single-wall tank in a concrete containment and collected by a licensed waste collection contractor.

Administration and security offices will be located northwest of the process building as shown on Figure 6. These offices will house the reception area, offices for administrative staff, a first aid clinic, and a meeting/training room.

A septic field with the capacity to treat waste for up to 100 persons will be installed to the west of the administration and warehouse buildings (Figure 6).

3.5.3.2 Water Supply and Management

Process water will be provided from the Project well field and recycled process water. The current and proposed water supply areas are described in Appendix AD, Well Field Design Report. Water from the well field will be piped through a combination of underground and above ground steel and HDPE piping to a freshwater tank, located south of the processing facility. From the freshwater tank, the fresh water will be distributed around the mine area. The full Water and Wastewater Design is described in Appendix AE. The nominal capacity of the freshwater delivery system will be approximately 750 gpm (Figure 6).

Potable water will be supplied from the freshwater tank. Water quality is expected to meet drinking water standards. Water will gravity flow from the freshwater tank to the potable water tank. Calico will secure appropriate permits for the potable water system.

Calico has water rights from the OWRD in the amount of two cfs (see Appendix P - Water Rights Amendment). This equates to approximately 900 gpm, which is more than the planned water demand for the Project.

3.5.3.3 Growth Media and Stockpiles

As shown in Table 85, Table 86, and Figure 36, there are seventeen soil map units. Each map unit description provides basic information about the map unit such as predominant soil or soils of the unit, slope, and rock fragment content.

Table 85. Soil Survey Map Unit Descriptions

Map Unit [1]	Name - Description
1	Farmell- Rock outcrop complex,eight to 30 percent slopes
2	Farmel-Chardoton very cobbly soil, 15 to 30 percent slopes
3	Farmell-Chardoton very cobbly soil,four to 15 percent slopes
4	Farmell-Chardoton extremely stony soil,four to 15 percent slopes
5	Farmell-Chardoton soil, 8 to 15 percent slopes
6	Ruckles very stony loam,eight to 30 percent slopes
7	Shano silt loam, two to six percent slopes
8	Soil A extremely gravelly sandy loam, 15 to 30 percent slope
9	Virtue loam, two to eight perfect slopes
10	Xeric Torriorthents, eight to 30 percent slopes
11	Soil B very gravelly sandy loam, eight to 30 percent slopes
12	Nyssa silt loam, two to six percent slopes
13	Drewsey very fine sandy loam, two to six percent slopes
14	Ruclick cobbly loam, four to 15 percent slopes
15	Drewsey-Quincy-Solarview Complex, eight to 30 percent slopes
16	Owsel silt loam, two to six percent slopes
17	Powder silt loam, zero to three percent slopes
1 Map units 1-11 were obtained from IMS report (IMS, Inc. 1989, 1991)	

Table 86. Taxonomic Classification of Soil Series

Series	Family
Chardoton [1]	Fine, montmorillontic, mesic Xerollic Paleargids
Farmell [1]	Fine, montmorillontic, mesic Xerollic Haplargids
Ruckles [1]	Clayey-skeletal, montmorillonitic, mesic lithic Argixerolls
Shano [1]	Coarse-silty, mixed, mesic Xerollic Camborthids
Soil A [1]	fine-loamy, mixed mesic Xerollic Haplargids
Soil B [1]	Clayey-skeletal, montmorillonitic, mesic Xerollic Durargids
Virtue [1]	Fine-silty, mixed, Xerollic Duragids
	Xeric Torriorthents[1]
Nyssa	Coarse-silty, mixed, mesic Xeric Haplodurids
Drewsey	Coarse-loamy, mixed, mesic Xeric Haplocambids
Ruclick	Clayey-skeletal, smectitic, mesic Aridic Argixerolls
Owsel	Fine-silty, mixed, mesic Durinodic Xeric Haplargids
Powder	Coarse-silty, mixed, mesic Cumulic Haploxerolls
Source: IMS, Inc. 1989, 1991	
[1]Soil Series data obtained from IMS report (IMS Inc, 1989, 1991)	

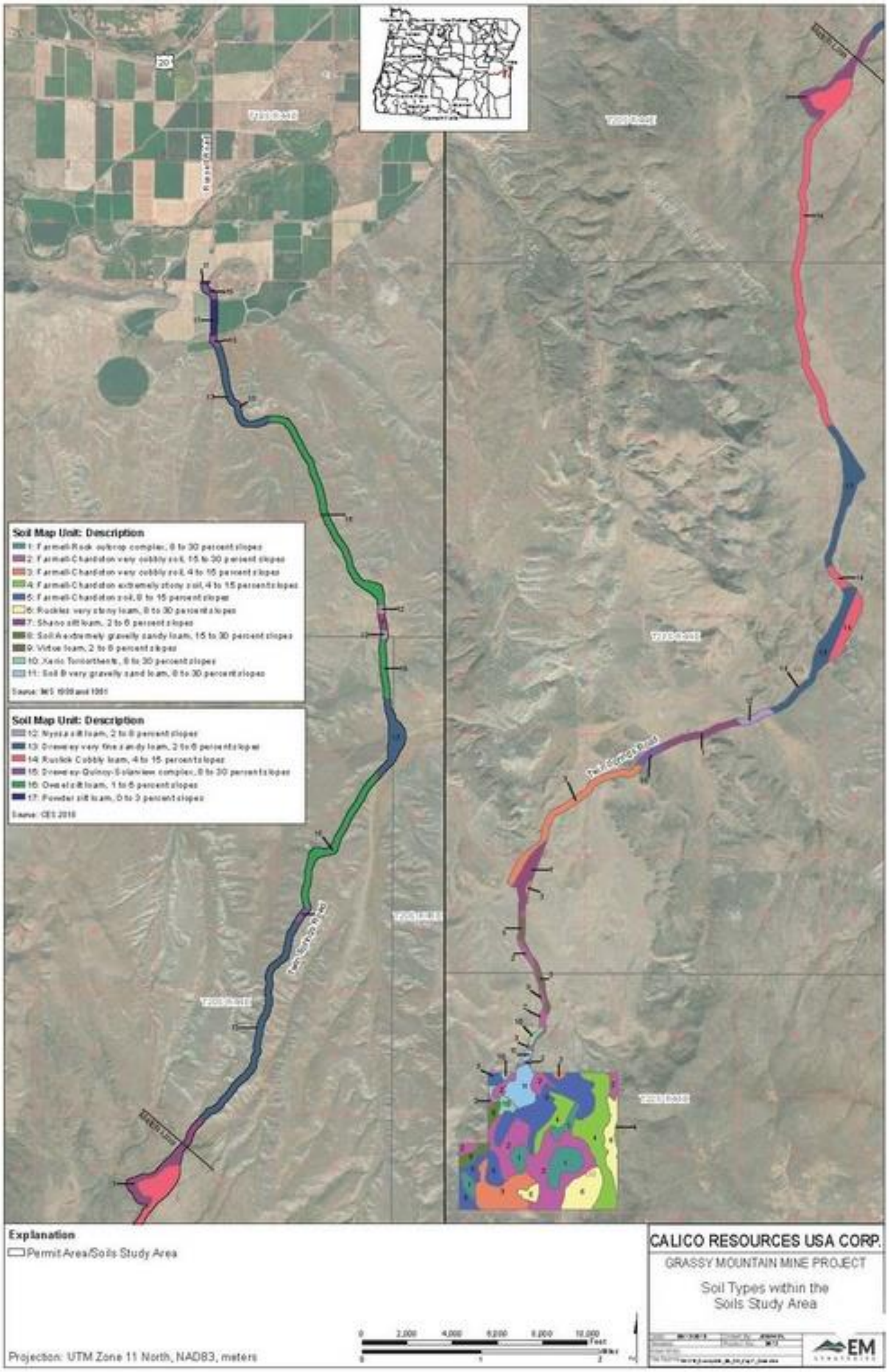


Figure 36. Soil Types Within the Soils Study Area

The following description of the soils is from the Geology and Soils Baseline Report in Appendix B. Soil found on the ridges is typically less than 30 inches deep and is high in rock fragments throughout the profile. Farmell and Chardoton soil, with high amounts of clay in the sub-soil and varying amounts of surficial rock fragments, is found throughout the Mine and Process Area. The moderately fine textured Virtue soil has a hard silica and carbonate hard pan layer at about 20 to 30 inches below the surface. Deep, coarse-textured Shano soil is found along drainage channels. Ruckles soil is typically found over areas where the underlying bedrock is basalt. Soils A and B have high percentages of surficial rock fragments. Soil A is found on slopes of 15 to 30 percent. Soil B is found in areas with slopes of approximately eight percent.

The soils located in the valleys consist predominately of alluvium, loess (wind-blown silt) and eolian (wind-blown) sand. These soils belong to the Drewsey, Shano, Power, and Owsel series. The Drewsey series is a deep, coarse-textured soil with a weakly-developed subsoil. The Owsel series is a deep, finer soil with a well-developed subsoil. The Shano series is similar to the Owsel series but lacks a well-developed subsoil. Nyssa soil, encountered sporadically, are generally silty throughout the profile and exhibit a cemented silica and carbonate layer between 25 to 30 inches. Soils located on and along ridges were formed from the underlying bedrock which generally consisted of conglomerate sandstone and basalt. The soils underlain by basalt were predominantly the Ruclick series, a moderately deep, fine-textured soil. These soils exhibited many surficial and subsurface coarse fragments. The soils underlain by conglomerate sandstone were the Drewsey and the Drewsey-Quincy-Solarview complex. These soils were generally deeper to rock and coarser-textured. Soils further south along Twin Springs Road generally consist of the Shano series and Farnell-Chardoton complex. The Farnell-Chardoton complex exhibited high amounts of clay and rock throughout the profile. The map unit characteristics of these soils are listed in Table 30. Suitability for reclamation is also included in the table.

Salvageable growth media from the Project surface disturbance will be stockpiled at centralized locations, as shown on Figure 6. Growth media will be salvaged for reclamation. Soils on slope that are less than ten percent will be salvaged to a depth of three feet. Soil on slope at 15 percent or less will be salvaged to a depth of two feet. Soils on slopes greater than 15 percent will be salvage to a depth of one foot. Section 4.1 presents further discussion on growth media salvage. Growth media will consist of soils and alluvium stripped prior to surface disturbance activities. Any growth media remaining in the stockpiles for one or more planting seasons will be seeded with an interim seed mix to stabilize the material to reduce erosion and minimize the establishment of undesirable weeds.

Approximately 551,759 bank cubic yards (bcy) of growth media will be salvaged from the footprint of the facilities. Facilities that will not have growth media salvaged are the water pipeline, fence, growth media stockpiles, and exploration areas. These bcy convert to approximately 690,000 cubic yards based on a 25 percent swell factor. Figure 36 shows the distribution of the growth media (soils) within the area of Project surface disturbance. This volume could change based on actual field conditions encountered. On sloped terrain, some soil may be salvaged by pushing available natural growth media cover downhill with a dozer to construct toe berms to prevent rocks from scattering on the hillside below the stockpile toes.

3.5.3.4 Storm Water and Sediment Control Structures

Surface water diversion channels and ditches will be constructed as necessary around surface facilities and waste rock storage areas to control storm water run-on to these sites (Figure 3). Surface water control ditches and sediment retention ponds will be constructed in accordance with BMPs as outlined in the Best Management Practices for Reclaiming Surface Mines in Washington and Oregon (DOGAMI 1997) and in the Tailings Facility and Ancillary Facilities Design Report (Appendix C). Sediment retention ponds and diversion ditches are sized to contain a 100-year, 24-hour precipitation event. Run-on diversion channels and ditches will remain as permanent features after final reclamation and mine closure.

Run- off control structures include silt traps and fences constructed of certified weed-free straw bales, or geotextile fabric, and sediment retention ponds. Sediment control measures are implemented as necessary to reduce soil movement within the site and to minimize off-site effects. These structures will be maintained throughout the life of the Project. Soil collected in these structures will be periodically removed and placed in soil stockpiles or used for reclamation. These features will be removed once vegetation is established and sediment runoff has stabilized.

3.5.3.5 Borrow Areas

One borrow area is located on the east edge of the Project Area. The DOGAMI Aggregate Application is in Appendix V. Borrow material will be required for areas that need prepared subgrade materials, drainage materials, pipe bedding materials, road surfacing materials, retarding layer materials, closure cover materials, growth media, underground mine backfill, and riprap.

The surface mining operation will cover approximately 43 acres, with a maximum depth of 125 feet, with the lowest elevation at 3,790 feet amsl. Quarry benches will be approximately 40 feet vertical faces separated by 60-foot horizontal benches, resulting in an interim sloping configuration of 1.5H:1V. The Permit Boundary setback is 50 feet from all operations. Activities associated with the borrow surface mining will require drilling and blasting, shovel/loader/scraper for moving the material, crushing, stockpiling and screening. Water will be used for dust control. Detailed drawings are included in Appendix V.

Surface water diversion channels and surface water run-on diversion berms are included in the design. These features will be removed during final reclamation grading. Precipitation that falls into the quarry footprint will be managed within the quarry using internal sloping, retention berms and a stormwater management sump. Additional BMPs will be implemented to minimize erosion and sedimentation. All stormwater will be managed under the Stormwater Management Plan (Appendix Y). The process material will be stockpiled at the borrow areas until it is needed.

3.5.3.6 Fencing

A perimeter fence, approximately 22,358 feet in length, will be constructed around the Project facilities to prevent access by livestock, wildlife, and the public (Figure 6). In general, three-strand barbed wire fences will be constructed in accordance with BLM fencing standards per BLM Handbook 1741-1. The area within the perimeter fence is approximately 540 acres. Within the perimeter fence in areas where a higher level of security is needed, chain-link fences will be erected. Gates or cattle guards will be installed along roadways within the Project Area, as appropriate. The perimeter fence will be monitored on a regular basis and repairs made as needed.

3.5.4 Safety and Fire Protection

3.5.4.1 Safety

The Project will operate in conformance with all MSHA safety regulations (30 CFR 1 199). Site access will be restricted to employees and authorized visitors.

3.5.4.2 Fire Protection

Water for fire protection will be distributed from the fire water tank located on Grassy Mountain near the mine facilities via a network of piping and will be maintained under a constant pressure with a jockey pump. The piping will be looped and sectionalized to minimize loss of fire protection during maintenance. Where located outside buildings, fire water piping will be buried below the ground surface to eliminate the potential of pipes freezing.

Yard hydrants will be limited to the fuel storage tank area. Wall hydrants will be used in lieu of yard hydrants, and these will be located on the outside walls of the buildings in cabinets that will be heated during winter months.

Fire protection within buildings will include standpipe systems, sprinkler systems, and portable fire extinguishers. Standpipe systems will be provided in all structures that exceed 46 feet in height, as well as where required by building code, local authorities, or the insurance underwriter.

Sprinklers will be provided at the following locations or to protect the following items:

- Truck workshop;
- Assay laboratory;
- Over hydraulic or lube packs that contain more than 120 gallons of fluid;
- Lube-storage rooms;
- Any conveyor belts that are within tunnels or other enclosed spaces which would be hazardous to fight fires manually;
- Transformers; and

- Warehouse.

3.5.5 Additional Infrastructure

3.5.5.1 Fuel Supply, Storage, and Distribution

A single double-walled steel tank will be used for diesel storage. There will be one 8,200-gallon tank for mobile mining equipment. The fuel will be used by both underground and surface mobile equipment. The surface equipment will primarily be fuelled at a fuel island near the storage tanks. The underground-mining equipment includes a fuel truck that will be used to fuel underground equipment as required. This fuel truck may be used to fuel surface equipment as needed.

A small portable tank will be maintained for unleaded gasoline as required for light vehicles and other small equipment (e.g., portable pumps). This tank will be stored in a location away from fire hazards and will be placed within a lined berm area as required by local regulations. Light vehicles that return off-site overnight will be fuelled in other locations, thereby reducing the storage requirements for gasoline on site.

3.5.5.2 Compressed Air Supply

High-pressure compressed air will be provided by two duty screw compressors, one standby screw compressor, and a duty-plant air receiver. There will be two high-pressure air uses: instrument air and plant air. The instrument air will be dried and then stored in a dedicated air receiver. The plant air will be fed straight from the plant air receiver without a drying step.

Low-pressure air for pre-aeration tank air requirements will be provided by two duty and one standby centrifugal blowers.

3.5.5.3 Communications

On-site communications will comprise inter-connected mobile and fixed systems, including a land-line telephone network, portable two-way radios, and internet. Access for internet and corporate network connection will be made via satellite connections or a cable line.

Underground communication with the surface will be via a leaky-feeder system as described in Section 3.3.10.2.

3.5.5.4 Transportation

Main transportation of personnel and supplies will be via the main access road. No provisions have been made at this time for the transport of employees, as they will be required to drive out or carpool at their own expense.

3.5.5.5 Buildings

A total of nine buildings are planned to be constructed at the site to support mining, processing, and administrative activities. The locations of these buildings are shown in Figure 6.

Administration Building: The administration building will be a double-width Atco trailer of approximately 3,600 square feet (ft^2). It will contain the mine general manager's office, as well as accounting and human resources offices.

Plant Office and Changehouse: The plant office building and changehouse will constructed as a single-level modular wood-frame building of approximately 2,900 ft^2. It will contain the plant offices and change rooms for the process plant staff and labor force. These facilities will be complete with showers, basins, toilets, lockers, and overhead laundry baskets.

Plant Maintenance and Warehouse: The process-plant maintenance and warehouse building will be a pre-engineered steel-frame and metal-clad building of approximately 1,075 ft^2. This building will be used to perform maintenance for process equipment, as well as for the storage of equipment spare parts.

Mine Office: The mine office and changehouse will be constructed as a single-level modular wood-frame building of approximately 4,300 ft^2. This building will include Engineering and Geology offices as well as mine-operations offices. The building will also have showers, basins, toilets, lockers, and overhead laundry baskets. The building will also include first-aid facilities, along with safety-training areas to be used for site-wide training.

Truck Workshop and Warehouse: The truck workshop and warehouse building will be a pre-engineered steel-frame and metal-clad building with an area of 7,100 ft^2 and will be positioned adjacent to the mine-office building. This area will be divided into two sections, one for warehousing spare parts and tool storage and the other for a maintenance workshop. An overhead crane will be included in this building, above the maintenance workshop.

Vehicle Wash-Bay Facility: The vehicle wash-bay facility will be an open-air, 50- by 50-foot concrete slab with a fluid-collection sump and will be located adjacent to the truck workshop and warehouse. Wash water will be collected in the sump where settling will occur prior to the water being recirculated back to the wash system. An oil-water separation system will be included in the facility to recover hydrocarbons prior to re-use of the wash water. The recovered hydrocarbons will be collected and shipped offsite for disposal in accordance with applicable environmental regulations.

Laboratory: The laboratory will be constructed as a single-level modular wood-frame building of approximately 1,850 ft^2 situated adjacent to the process building. The laboratory building will house all laboratory equipment for assaying, metallurgical, and environmental requirements. Dust-collection equipment will be located external to the laboratory building.

3.6 Operational Environmental Protection Measures

3.6.1 Air Emissions

Appropriate air quality permits will be obtained from the ODEQ for the Project facilities and land disturbance (Appendix M). As per ODEQ regulations, the Project air quality operating permit will be authorized by the ODEQ prior to Project commissioning. Committed air quality practices will include dust control for mine unit operations as described by the ODEQ-required Fugitive Dust Control Plan. In general, the Fugitive Dust Control Plan will provide for water application of haul roads and other disturbed areas, chemical dust suppressant application (such as magnesium chloride) where appropriate, and other dust control measures as per accepted and reasonable industry practice. Also, disturbed areas will be seeded with an interim seed mix to minimize fugitive dust emissions from surfaces without vegetation, where appropriate.

Appropriate emission control equipment will be installed and operated in accordance with the construction and operating air permits. Where required, pollution control devices installed by equipment manufacturers will control combustion emissions. Pollution control equipment will be installed, operated, and maintained in good working order to minimize emissions.

3.6.2 Cultural Resources

A Class III cultural resources survey is being performed for the Project Area. The Cultural Baseline Report is described in Section 2.3 of this report. Avoidance is the Oregon SHPO and BLM-preferred treatment for preventing effects to historic properties (a historic property is any prehistoric or historic site eligible to the NRHP) or unevaluated cultural resources.

If avoidance is not possible or is not adequate to prevent adverse effects, Calico will undertake data recovery at the affected historic properties in accordance with the Programmatic Agreement between the BLM, Oregon SHPO, and the Advisory Council on Historic Preservation. Development of a treatment plan, data recovery, archaeological documentation, and report preparation will be based on the "Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation," 48 CFR 44716 (September 29, 1983), as amended or replaced. If an unevaluated site cannot be avoided, additional information will be gathered, and the site will be evaluated. If the site does not meet eligibility criteria as defined by the Oregon SHPO, no further cultural work will be performed. If the site meets eligibility criteria, a data recovery plan or appropriate mitigation will be completed under the Programmatic Agreement (Appendix U). Once data recovery has been completed at a historic property, the BLM will issue a Notice to Proceed for work at that location.

3.6.3 Erosion and Sediment Control

Calico will obtain coverage under the Mining General Stormwater National Pollutant Discharge Elimination System (NPDES) permit for the operations within the Mine and Process Area. The application is included under Appendix O and the Stormwater Management Plan is included under Appendix Y. The Stormwater Management Plan addresses the necessary BMPs, as well as the monitoring requirements under the permit.

BMPs will be used to limit erosion and reduce sediment in precipitation runoff from Project facilities and disturbed areas during construction, operations, and initial stages of reclamation. BMPs may include, but are not limited to, diversion and routing of storm water using accepted engineering practices, such as diversion ditches, and the placement of erosion control devices, such as sediment traps, and rock and gravel cover. Sediment removed from the sediment control structures will be placed on the waste rock storage areas during operations and will be disposed of in an approved disposal site after closure.

Re-vegetation of disturbed areas will reduce the potential for wind and water erosion. Following construction activities, areas such as cut-and-fill embankments and growth media stockpiles will be seeded as soon as practical and safe. Concurrent reclamation will be maximized to the extent practicable to accelerate revegetation of disturbed areas. All sediment and erosion control measures will be inspected periodically, and repairs performed as needed.

3.6.4 Waters of the State

Process components will be designed, constructed and operated in accordance with DOGAMI and ODEQ regulations. Proposed process facilities will be zero discharge and the TSF will have a composite liner system in accordance with ODEQ design criteria. Waste rock has been determined to have the potential to generate acid and/or mobilize deleterious constituents and therefore will be managed on containment (Appendix C).

If any ponds will be over ten feet in height or impound over approximately nine acre-feet of water, a dam permit will be obtained from OWRD.

3.6.5 Hazardous Materials Management

Hazardous materials will be transported, stored, and used in accordance with federal, state, and local regulations. Employees will be trained in the proper transportation, use, and disposal of hazardous materials. Spill contingency and emergency preparedness measures are laid out in the Emergency Response Plan, included as Appendix E.

3.6.6 Solid Waste

Employee training plans will cover appropriate disposal practices, which will include which wastes may be placed in a dumpster or in the WRD, management of used filters, oily rags, fluorescent light bulbs, aerosol cans, and other regulated substances. Solid waste will be stored onsite in dumpsters and transported to an off-site landfill periodically. All other wastes will be disposed of off site. Used solvent, liquids drained from aerosol cans, accumulations of mercury fluorescent lights, and used antifreeze may be regulated by RCRA. Calico anticipates that the mine will fall in the “small generator” category.

3.6.7 Monitoring

A plan for monitoring the proposed Project that was developed for the Project Chemical Mining application is included in Appendix G.

3.6.8 Growth Media and Cover Salvage and Storage

Suitable growth media will be salvaged and stockpiled during the development of the facilities, during construction of the waste rock storage areas and the TSF, and construction of other Project facilities. See Section 4.1 for details on growth media management.

Following stripping, growth media will be stockpiled within the proposed disturbance areas. Growth media stockpiles will be located such that they will not be disturbed by mining operations. The surfaces of the stockpiles will be contoured with slopes no steeper than 2.5H:1V to reduce erosion. To further minimize wind and water erosion, growth media stockpiles will be seeded after contouring with an interim seed mix developed in conjunction with the BLM. Diversion channels and/or berms will be constructed around the stockpiles as needed to prevent erosion from overland runoff. BMPs such as silt fences or staked weed-free straw bales will be used as necessary to contain sediment in runoff.

3.6.9 Wildlife and Migratory Birds

Calico will implement a Wildlife Mitigation Plan for the Project (Appendix I). This plan addresses the avoidance, minimization, and mitigation of potential impacts to wildlife. Operators will be trained to monitor mining and process areas for the presence of larger wildlife such as deer. Mortality information will be recorded. Calico will establish wildlife protection policies that will prohibit the feeding or harassment of wildlife.

If possible, land clearing and surface disturbance will be timed to prevent destruction of active bird nests or young of birds during the avian breeding season (annually in accordance with the BLM policies) to comply with the Migratory Bird Treaty Act (MBTA). If surface disturbing activities are unavoidable during the avian breeding and nesting season, Calico will have a qualified biologist survey the areas proposed for disturbance to determine the presence of active nests immediately prior to the disturbance. If active nests are located, or if other evidence of nesting is observed (mating pairs, territorial defense, carrying nesting material, transporting of food) the area will be avoided to prevent destruction or disturbance of nests until birds are no longer present.

3.6.10 Protection of Surface Monuments

To the extent practicable, Calico will protect all survey monuments, witness corners, reference monuments, bearing trees, and line trees against unnecessary or undue destruction, obliteration, or damage. If in the course of operations any monuments, corners, or accessories are destroyed, Calico will immediately report the matter to the appropriate authority. Prior to obliteration, destruction, or damage during surface disturbing activities, Calico will contact the BLM to develop a plan for any necessary restoration or reestablishment activity of the affected monument. Calico will bear the cost for the restoration or re-establishment activities including the fees for an Oregon Professional Land Surveyor.

3.6.11 Noxious Weeds and Invasive Nonnative Species

Calico recognizes the economic and environmental impact that can result from the establishment of noxious weeds and has committed to a proactive approach to weed control. A noxious weed monitoring and control plan will be implemented during construction and continuing through operations. The plan, provided as Appendix H, contains a risk assessment, management strategies, provisions for annual monitoring and treatment evaluation, and provisions for treatment. The results from annual monitoring will be the basis for updating the plan and developing annual treatment programs.

3.6.12 Inadvertent Cultural Discoveries

All Inadvertent Cultural Discoveries will follow the BLM and Oregon SHPO regulations. Calico has created an Inadvertent Discovery Plan for Cultural Resources-Grassy Mountain, which will be used throughout all aspects of the exploration, mining and reclamation activities at Grassy.

Pursuant to 43 CFR 10.4(c) and (d), Calico will immediately stop all activities in the vicinity of the inadvertent cultural discovery and not commence again for 30 days after certification is received from the BLM-authorized officer, or a binding agreement is executed between the federal agency and the affiliated Indian tribes. According to 43 CFR 10.4d(2): "The activity that resulted in the inadvertent discovery may resume thirty (30) days after certification by the notified Federal agency of receipt of the written confirmation of notification of inadvertent discovery if the resumption of the activity is otherwise lawful. The activity may also resume, if otherwise lawful, at any time that a written, binding agreement is executed between the federal agency and the affiliated Indian tribes or Native Hawaiian organizations that adopt a recovery plan for the excavation or removal of the human remains, funerary objects, sacred objects, or objects of cultural patrimony following 10.3(b)(1) of these regulations. The disposition of all human remains, funerary objects, sacred objects, or objects of cultural patrimony must be carried out following 10.6."

3.6.13 Fire Protection Measures

All applicable state and federal fire laws and regulations will be complied with and all reasonable measures will be taken to prevent and suppress fires in the Project Area.

All equipment will be properly muffled and equipped with suitable and necessary fire suppression equipment, such as fire extinguishers and hand tools. All Project-related traffic will observe prudent speed limits to enhance public safety, protect wildlife and livestock, and minimize dust emissions. All activities will be conducted in conformance with applicable federal and state health and safety requirements.

3.6.14 Public Safety Measures

Public safety will be maintained throughout the life of the Project. All equipment and other facilities will be maintained in a safe and orderly manner.

In the event that any existing roads in the Project Area are severely damaged as a result of Project activities, Calico will return them as close as possible to their original condition.

3.6.15 Quality Assurance Plan

A plan for ensuring quality assurance developed for the proposed Project is included in Appendix AA.

4 RECLAMATION AND CLOSURE

Reclamation of disturbed areas resulting from activities outlined in this Reclamation Plan will be completed in accordance with the BLM, DOGAMI, and ODEQ regulations. The purpose of Subpart 43 CFR 3809 - Surface Management is to prevent unnecessary or undue degradation of public lands by operations authorized by the mining laws. Anyone intending to develop mineral resources on public lands must prevent unnecessary or undue degradation of the land and reclaim disturbed areas. This subpart establishes procedures and standards to ensure that operators and mining claimants meet this responsibility and provide for the maximum possible coordination with appropriate state agencies to avoid duplication and to ensure that operators prevent unnecessary or undue degradation of public lands by operations authorized by the mining laws. The State of Oregon requires that a reclamation plan be developed for any new mining project and for expansions of existing operations (OAR 632-037-0070).

The Project disturbance areas are summarized in Table 54. The areas proposed for disturbance can be divided into the following: underground mine opening (portal); waste rock storage areas; milling and processing facility; a TSF; borrow area; growth media stockpiles; haul roads; buildings and yard areas around mine; process plant; administration; laboratory; and ancillary facilities. Calico anticipates that the surface mine components will be reclaimed and revegetated.

Costs to support financial surety associated with this Plan will be developed and submitted for approval prior to Plan approval. In this manner, the reclamation plan cost estimate will be as accurate as possible.

Surface management regulations 43 CFR 3809.420 establish the performance standards that apply to this Plan. The State of Oregon has established mining, reclamation, water quality, and air quality regulations. The following measures designed to prevent unnecessary or undue degradation will be implemented during the design, construction, operation, and closure of the Project:

- All regulated components of the facility will be designed and constructed to meet or exceed BLM/DOGAMI/ODEQ/OWRD design criteria;
- Mineral exploration and development drill holes, monitoring and observation wells, and production wells subject to State of Oregon regulations will be properly abandoned to prevent potential contamination of water resources;
- Roads will be constructed to the minimum necessary width;
- Regulated wastes will be managed according to applicable regulations;
- Surface disturbance will be minimized while optimizing the recovery of mineral resources;
- Fugitive dust and other air emissions from disturbed and exposed surfaces will be controlled in accordance with ODEQ regulations and permits;
- Calico will comply with applicable federal and state water quality standards, including the Federal Water Pollution Control Act, as amended (30 United States Code [U.S.C.] 1151 et seq.);

- Through successful revegetation utilizing the seed mix provided by the BLM and recontouring of the topography to mimic the surrounding environment, wildlife habitat will be rehabilitated (43 CFR 3809.401(b)(3)(v) and 43 CFR 3809.420(b)(3)(iii)(E);
- Surface water drainage control will be accomplished by diverting storm water, isolating facility runoff, and minimizing erosion;
- Where suitable as a growth media, surface soils and alluvium will be managed as a growth media resource and removed, stockpiled, and replaced during reclamation; and
- A reclamation plan will be implemented that addresses earthwork and re-contouring, re-vegetation and stabilization, detoxification and disposal, and monitoring operations necessary to satisfactorily reclaim the proposed disturbance including roads, ponds, tailings facilities, stockpiles, buildings, and equipment.

4.1 Growth Media Balance

As outlined in the soils survey for the Project area (Section 2 and Appendix B), have limited depth and variable suitability for reclamation uses. Generally, soils salvage is on the order of 0.5 foot, though some soils are salvageable to a depth of 2.5 feet. Therefore, the depth of growth media salvage will vary based on soil type. A preliminary growth media balance for the Project, shown below in Table 87, indicates approximately 533,261 cubic yards of material will be required to establish growth media on the Project facilities to a depth of six to 24 inches, depending on the facility component.

Table 87. Growth Media Balance Needed

Facility	**Area (acres)[1]**	**Growth Media Depth (feet)[2]**	**Volume (cubic yards)**
Mine Portal	0.5	0.5	403
Waste Rock Storage Area	8.4	0.5	7,476
Tailings Storage Facility	99.2	2.0	320,085
Process/Administration Area	7.2	1.0	11,616
Laydown/Yard Area	73.7	1.0	118,903
Roads	24.9	1.0	40,172
Water Tank	0.1	0	0
Water Wells and Water Pipelines	7.1	0	0
Fence	15.5	0	0
Borrow Pit	42.9	0.5	34,606
Diversion Ditches and Sediment Basins	11.9	0	0
Growth Media Stockpiles	18.2	0	0
Exploration	10	0	0
Total	**319.6**	**-**	**533,261**

[1]The acres are the same as those presented in Table 54.
[2]The growth media depth on the fence, water tank, water wells and pipeline, growth media stockpiles, and the exploration is set at zero since the construction of these facilities will incorporate the soils into the construction and reclamation and there will be no growth media applied. The diversion ditches and sediment basins and the barrow pit will be permanent features and no growth media will be applied. Any remaining waste rock in the waste rock storage area would be moved to the TSF as part of reclamation and the site reclaimed at the original grade.

Based on the soil survey completed in the Project area, the following amounts of growth media, as outlined in Table 88, are available and will be salvaged from each of the mine components prior to component construction. This amount exceeds the amount planned for growth media application.

Table 88. Growth Media Salvaged

Facility	Area (acres)[1]	Growth Media Depth (feet)[2]	Volume (cubic yards)
Mine Portal	0.5	0	0
Waste Rock Storage Area	8.4	2.5	33,880
Tailings Storage Facility	99.2	2.5	400,107
Process/Administration Area	7.2	1.0	11,616
Laydown/Yard Area	73.7	1.0	118,903
Roads	24.9	1.0	40,172
Water Tank	0.1	0	0
Water Wells and Water Pipelines	7.1	0	0
Fence	15.5	0	0
Borrow Pit	42.9	1.0	69,212
Diversion Ditches and Sediment Basins	11.9	0	0
Growth Media Stockpiles	18.2	0	0
Exploration	10	0	0
Total	**319.6**	**-**	**673,890**

[1] The acres are the same as those presented in Table 2.1 of the Plan, except the waste rock storage areas and the TSF, which are based on the area of the constructed slopes.
[2] The growth media depth on the fence, water tank, water wells and pipeline, growth media stockpiles, and the exploration is set at zero since the construction of these facilities will incorporate the soils into the construction and reclamation and there will be no growth media applied. The diversion ditches and sediment basins and the barrow pit will be permanent features and no growth media will be applied. Any remaining waste rock in the waste rock storage area would be moved to the TSF as part of reclamation and the site reclaimed at the original grade.

Growth media will be loaded from the growth media stockpiles using front-end loaders into end-dump trucks and then hauled to the needed locations. Once there the growth media will be dumped and then spread using a rubber-tired dozer.

4.2 Revegetation, Seeding, and Planting

Reclaimed surfaces will be re-vegetated to control runoff, reduce erosion, provide forage for wildlife and livestock, and reduce visual impacts. Seed will be applied with either a rangeland drill or with a mechanical broadcaster and harrow, depending upon accessibility. Seedbed preparation and seeding will take place in the fall after grading and growth media application to the reclaimed areas.

Reclamation seed mixtures and application rates, which are based on BLM requirements, as shown below in the Seed Mix for the Project Area table (Table 89), will be used in the reclamation cost estimate (RCE). This mixture will provide forage and cover species similar to the pre-disturbance conditions, facilitating the post-mining land uses of livestock grazing and wildlife habitat. In addition, the seed mix has been determined, according to the species' effectiveness in providing erosion protection, the ability to grow within the constraints of the low annual precipitation experienced in the region, suitability for site aspect, and the elevation and soil type.

Table 89. Seed Mix for the Project Area

Species Common Name (Species Scientific Name)[1]	Pounds/Acre (PLS[2])
Shrubs	
Wyoming big sagebrush	0.10
Grasses	
Bluebunch wheatgrass	8.00
Bottlebrush squirreltail	2.00

[1] Early contemporaneous re-vegetation will be monitored, and final seed mixtures will be evaluated and modified depending on monitoring results.
[2] Pure live seed

The proposed seed mixture and application rates are subject to modification by the BLM. The actual seed mixture and application rates will be determined prior to reseeding based on the results of reclamation in other areas of the mine, concurrent reclamation, or changes by the BLM in its seed mix requirements.

4.3 Proposed Reclamation Schedule

The proposed Project will be active for approximately 14 years, which includes one year of construction, ten years of mining and processing, and three years of closure and reclamation. Several years beyond that date, as determined by ODEQ, may be anticipated for groundwater monitoring, which is currently estimated at five years. This schedule may be modified based on the rate of mining and future commodities prices. The projected reclamation schedule for the Project is shown in on Figure 37.

Concurrent reclamation will be ongoing over the life of the Project in areas that have reached their final configurations. Reclamation of TSF dam face will be started in Year 8 when final build-out is expected to be completed. At final build-out, the TSF dam face will be recontoured to an overall slope of 2.5H:1V or less. Upon completion of mining, the TSF recontouring, cover and growth media placement, and seeding will be completed pursuant to the Final Plan for Permanent Closure and reclamation schedule submitted for the Project.

MINE COMPONENT	Mining and Processing Operations (Years)											Reclamation and Closure (Years)					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	15	16
Underground Mine																	
Portal Plugging													■				
Portal Pad Regrading													■	■			
Portal Pad Revegetation														■	■		
Waste Rock Disposal Facilities																	
Regrading													■				
Growth Media Application													■				
Revegetation													■	■			
Tailings Storage Facility																	
Earthworks and Conceptual Cover Placement															■		
Revegetation															■	■	
Mining and Processing Plant																	
Buildings/Structure Demolition & Removal													■	■			
Haul & Access Roads																	
Haul Roads Earthwork/Revegetation												■	■				
Access Roads Earthwork/Revegetation														■			
Ancillary Facilities																	
Growth Media Stockpiles												■					
Borrow Pit												■					
Sediment Control Structures													■				
Utility Corridors														■			
Exploration																	
Regrading/Revegetation																	
Reclamation Monitoring[1]												■	■	■	■	■	■
Process Fluid Management																	
Tailings Storage Facility																	
IFM and Phase I Fluid Management												■					
Phase II Fluid Management												■	■				
Phase III Fluid Management													■				
Phase IV Fluid Management														■			
Reclaim Pond E Cell Conversion/Construction														■			

[1] Reclamation monitoring includes three years of monitoring of the revegetation for success.

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GRASSY MOUNTAIN PROJECT
Reclamation Schedule
Figure 6

Figure 37. Reclamation Schedule

Closure of the TSF will commence in Year 11. Reclamation of this facility is expected to be concurrent with drain down operations. Closure and reclamation of the process facilities and ancillary facilities will begin after the completion of mining and ore processing.

4.4 Post-Mining Land Use and Reclamation Goals

The same land uses of mineral exploration and development, livestock grazing, wildlife habitat, and dispersed recreation will remain following closure with an emphasis on the last three uses. Calico will work with the agencies and local governments to evaluate alternative land uses that could provide long-term socioeconomic benefits from the mine infrastructure. Post-closure land uses are in conformance with the BLM Vale District Management Plan and Malheur County Land Use Plans.

The objectives of the reclamation program are as follows:

- Provide a stable post-mining landscape that supports defined land uses;
- Maintain existing access to private land;
- Minimize erosion damage and protect water resources through control of water runoff and stabilization of components;
- Establish post-reclamation surface soil conditions conducive to the regeneration of a stable plant community through stripping, stockpiling and reapplication of growth media;
- Revegetate disturbed areas with appropriate plant species in order to establish long-term productive plant communities compatible with existing land uses; and
- Maintain public safety by stabilizing or limiting access to landforms that could constitute a public hazard.

4.5 Post-Mining Contours and Topography

The final grading plan for the Project is designed in part to minimize the visual impacts of the disturbance proposed by Calico. Slopes will be recontoured with standard mine mobile equipment (i.e., dozers, trucks, loaders, scrapers) to blend with surrounding topography, interrupt straight-line features and facilitate revegetation, where practicable. Where feasible, large constructed topographic features, such as the TSF dam, may have rounded crests and variable slope angles to resemble natural landforms. The post-mining topography is shown on the Post Reclamation Topography Map located in Appendix A.

4.6 Final Grade and Slope Stability Criteria

4.6.1 Mine Portal

The decline will be plugged with rock approximately 100 feet inside the portal entrance. Then the portal entrance will be filled with the material that was used to construct the portal pad. The slopes in the vicinity of the portal area will be returned to near original grade. Once this is completed the surface will be covered with growth media and revegetated.

4.6.2 Waste Rock Storage Facility

All 0.2 million tons of waste rock will be removed from the waste rock storage area and placed on the TSF, along with a lime amendment, to aid in the development of the final surface slope of the TSF. As a result, the final grade of the waste rock storage area will be returned to near original contour.

4.6.3 Tailings Storage Facility

Slope stability analyses on the TSF were performed using industry practices and experience from similar projects (Appendix C).

4.6.4 Erosional Stability

Soils salvaged during construction of mine components as well as some of the near-surface alluvial material mined from the open pits will be used as growth media cover during reclamation. The soils survey completed in the Project Area by the NRCS provides an inventory of available growth media (Table 88). This inventory has been utilized to estimate the likely mix of growth media available for each component and to allow a detailed evaluation of the site-specific stability of the proposed major reclamation components.

Analyses and recent similar experience at Nevada mines indicate that the use of erosion control BMPs during reclamation activities will greatly reduce the sediment migration from the facilities until vegetation can be established. Calico will maintain BMPs (sediment control structures) at the base of reclaimed slopes to prevent or limit excessive erosion until vegetation has established.

4.7 Facility Reclamation

4.7.1 Tailings Storage Facility and WRD Closure

Reclamation methods for the TSF will recognize ore and solution characteristics, site conditions, and climatic conditions. Pursuant to the requirements of ODEQ, a summary of the principal closure steps follows.

Upon completion of mining operations, active deposition into the TSF will cease. During this time, water collected in the TSF reclaim pond will be recirculated to the supernatant pool for active water management. Over time, the supernatant pool will evaporate and the underdrain flows reporting from the TSF will reduce as the tailings consolidate and drain. This is considered the active management period of closure.

Once the tailings surface no longer has a free water surface and the tailings continue to desiccate and densify, a closure cover can be constructed over the tailings surface and TSF embankments. The closure cover should be installed at a point in time where the majority of tailings consolidation has occurred and is not expected to negatively impact drainage of the closure cover.

The closure cover proposed for the TSF tailings surface and embankments is presented on the Design Drawings in Appendix C and will be constructed with the following (bottom to top):

- Operational layer of waste rock (if available) or other materials to provide vehicle access
- Four to 12 inches of Liner bedding (if required)
- Geomembrane liner
- Twelve to 18 inches of non-acid generating drainage layer
- Twelve to 24 inches of growth medium

Once tailings draindown flow rates reduce to levels considered appropriate for passive water management, the reclaim pond will be retrofitted to a geomembrane-lined evaporation pond. With installation of the closure cover and gravity drainage from the underdrain collection system, it is expected that draindown from the TSF will cease.

Upon completion of closure cover construction, stormwater falling on the TSF and upgradient catchment areas will be routed over the covered impoundment surface to a closure drop chute channel located at the eastern abutment of the North embankment. To provide long-term redundancy, the closure drop chute and impoundment surface swale are designed to safely convey all stormwater flows resulting from the 500-year, 24-hour storm. The upgradient catchment area assumed for closure does not include permanent stormwater diversion channels around the TSF.

Although the permanent diversion channels will remain in place during long-term closure, in the event that the channels overtop and discharge on to the TSF closure clover during the 500-year, 24-hour storm event, the proposed closure cover and drop chute channel are designed to accommodate these additional inflows and are expected to operate as intended.

Upon cessation of mining operations, the remaining waste rock (if any) stockpiled on the WRD will be removed and placed as an operation layer above the tailings surface when it is safe to do so. The WRD lining system will either be removed or buried in-place and precipitation collected on the closed area will be routed to the TSF during the active management period. Once the TSF closure cover is constructed, run-off from the closed WRD area will be routed onto the TSF closure cover and conveyed to the drop chute channel. Conceptual closure designs for the TSF, WRD, and drop chute channel are presented on the Design Drawings in Appendix C.

All growth media originally stockpiled from clearing the area will be used in constructing the tailings cap to promote final reclamation and revegetation. The conceptual closure design of the TSF is intended to meet the OAR requirements. In accordance with the OAR 340-043-0140 (5) requirement, the tailings surface will be covered with a composite cover designed to prevent water and air infiltration. The closure cover will consist of (from bottom to top) the regraded tailings surface, operation layer of mine waste or on-site borrow (as needed for equipment access), a geomembrane liner, 18 to 24 inches of growth medium, and seed mix to revegetate the growth medium with native species. Contact precipitation (snowmelt and rain) from the capped revegetated TSF will be routed to the two sediment retention ponds. From the sediment retention pond and rocked spillway, flows will then be routed to open natural areas and constructed dispersion terraces to slow the velocity of the flow to enhance infiltration and evaporation. The sediment retention pond will be designed for the 100-year, 24-hour storm event. The typical closure cover system is detailed in Appendix C.

The following design components have been considered during the TSF design and will help facilitate closure once mining has ceased:

- During the staged construction of the TSF, the growth medium beneath the embankments and within the TSF basin will be removed prior to embankment construction and stockpiled for use during closure.
- At the end of milling, water will be evaporated from the supernatant pool. The surface of the TSF will then be allowed to dry for one to two years.
- Once the surficial tailings have sufficiently dried out, the TSF surface will be graded to maintain positive surface flow to the northeast to prevent ponding water. Surface water run-off developing on the surface of the impoundment will be directed off the impoundment through an open channel that will tie into the permanent diversion channel on the east side of the TSF as shown on Drawing C10.
- There are no back-dams that will permanently impound the natural tributary drainages upstream of the TSF below the permanent diversion channels. During the reclamation period, the perimeter access road and any temporary storm water diversion channels can be backfilled and reclaimed to facilitate surface flows and prevent ponding.
- The downstream embankments have been designed with 2.5H:1V downstream slopes that exceed the OAR 632-037-0130 (9) requirement for closure.
- The underdrain collection system installed above the geomembrane liner will help speed consolidation, settlement and drain down of the tailings during the closure period.
- Monitoring and management of TSF drain down will be required for a period of time after the completion of mining. During this time, monitoring and measurement of drain down flow rates and quality will be performed to assist with refinement of long-term closure plans.
- Drain down water may be managed with spray evaporators, if needed but not anticipated, until flow rates decrease to the point that the reclaim pond can be retrofitted into an evaporation cell.

4.7.1.1 Tailings Storage Facility Cover

Calico will implement a tailings cover system that is intended to isolate and control the deposited tailings and waste rock. Calico will use various types of earthmoving and other equipment to construct the cover system. The specifics on the number and type of equipment are included with the RCE in Appendix J. Growth media will be hauled to the TSF surfaces from growth media stockpiles and the borrow area located on the east side of the Permit Area, as shown on Figure

6. The closure cover will consist of (from bottom to top) the regraded tailings surface, operation layer of mine waste rock and on-site borrow, a geomembrane liner, 18 to 24 inches of growth medium, and seed mix to revegetate the growth media with native species. The cover for the TSF is generally designed to accomplish the following:

- Limit infiltration of meteoric water;
- Isolate process materials from storm water runoff;
- Limit erosion; and
- Support successful revegetation.

4.7.1.2 Tailings Storage Facility Recontouring, Resoiling, and Revegetation

The TSF will be recontoured to an average final slope configuration not steeper than 2.5H:1V on the dam face to provide for long-term mass stability. As discussed above, the surface of the impounded tailings will be covered, and the cover will slope to a drainage system to shed water off the relatively flat surface. A figure of the closed facility is included in Appendix C. The toe of the recontoured slopes will end inside and at the edge of the lined facility such that the subsequently placed cover material will direct surface runoff off the lined area of the TSF. The dam face will also include slope breaks horizontally along contour approximately every 100 vertical feet. Slope breaks will be small flat benches up to 20 feet wide and blended into the slopes. The toe and crest of the facility will also be rounded to blend into the adjacent slopes. Minimizing the total continuous slope length with benches and rounding the toe and crests will help to limit erosion until vegetation is established.

4.7.1.3 Solution Management

At the time of the TSF closure, drain down will be managed by a regime of passive evaporation within the supernatant pool, the reclaim pond (E-cell), and recirculation back to the TSF. As the solution is removed from inventory through evaporation, portions of the TSF surface will be reclaimed and covered with the above described cover system. Once drain down flows are low enough to be managed through evaporation at the reclaim pond below the TSF, the remainder of the TSF will be reclaimed as described above.

Four phases of solution management or process fluid stabilization could be required throughout the closure process, with blending of strategies from one phase to another. However, given the limited anticipated volumes in the supernatant pool and the underdrain flow, Phase I is not planned for with this TSF closure and only passive evaporation under Phase II:

- Phase I - active evaporation at the supernatant pool and reclaim pond and recirculation;
- Phase II - active evaporation at the reclaim pond only, and passive evaporation at the supernatant pool. Latter stages of Phase II are characterized by intermittent active evaporation within the pond footprints. Pond inventories are eliminated at maximum in-pond active evaporation rates, and then evaporation is halted, and inventories allowed to accumulate to maximum operating volumes prior to the next active evaporation event;

- Phase III - passive evaporation only at the reclaim pond and conversion of the pond to an E-Cell; and
- Phase IV – long-term passive evaporation using the reclaim pond as an E-cell until the tailings facility is fully drained.

This approach acknowledges the initially higher drainage rates and the need to prevent release from the system, while effectively eliminating inventory at maximum drainage rates from the TSF. Also, since recirculation and evaporation at the supernatant pool will result in additional infiltration into the TSF, the supernatant pool evaporation system will be eliminated first in preference for downstream active evaporation within the reclaim pond. Finally, active management will be phased out by improving the TSF cover and eliminating residual drain down to a level that can be handled by passive systems. The passive systems may then be partially reduced in size over time as flows reach steady state and decrease to zero.

Long-term effluent discharge will be managed pursuant to the requirements of ODEQ (OAR 340-043-130). This will include the construction of an E-Cell or another ODEQ-approved method. The amount of the annual long-term discharge will be used to establish the number of acres of the reclaim pond that will be needed to provide evaporation of drain down fluids during Phase IV of PFS. The costs for converting the existing reclaim pond into an E-Cell and constructing the new E-Cell will be established in the RCE (Appendix J). Assumptions and bond costs will be included in the RCE.

4.7.1.4 Recontouring, Seeding, and Planting

The TSF will be recontoured to an average final slope configuration not steeper than 2.5H:1V on the dam face to provide for long-term mass stability. As discussed above, the surface of the impounded tailings will be covered, and the cover will slope to a drainage system to shed water off the relatively flat surface. The toe of the recontoured slopes will end inside and at the edge of the lined facility such that the subsequently placed cover material will direct surface runoff off the lined area of the TSF. The dam face will also include slope breaks horizontally along contour approximately every 100 vertical feet. Slope breaks will be small flat benches up to 20 feet wide and blended into the slopes. The toe and crest of the facility will also be rounded to blend into the adjacent slopes. Minimizing the total continuous slope length with benches and rounding the toe and crests will help to limit erosion until vegetation is established.

4.7.1.5 Reclaim Pond Closure

When no longer needed for solution management, the Reclaim Pond will be converted into an E-Cell until the tailings facility is fully drained. Under the RCE, assumptions have been made to convert the Reclaim Pond into an E-Cell since the cell is a double-lined facility with LCRS. As part of the design, the converted E-Cell will be covered with six inches of growth media and seeded. Once the underdrain flows cease, the sediments and precipitates in the cell will be sampled and tested. Depending on the results, the sediments and precipitates will either be buried in place or transported to an appropriate off-site disposal facility.

4.7.2 Milling and Refining Facility

The general concept for reclaiming the Project site is to remove all buildings and facilities that can be dismantled. Non-movable physical aspects such as the plant site itself will be contoured to match the original site topography and revegetated.

Removal of facilities and remediation of the site, including revegetation, will take approximately two years. Monitoring of site conditions will be undertaken on a quarterly and annual basis for the first five years with maintenance and remedial action taken on an as-required basis to ensure that the results of reclamation are sustainable.

The buildings and structures erected during the mining operation will be decommissioned and removed as part of the reclamation process. Buildings at the plant site will be dismantled during the first year of reclamation and sold or re-used elsewhere. These buildings will include:

- Administration building
- Laboratory
- Plant Workshop/Warehouse
- Mine Offices
- Truck Workshop/Warehouse
- Mill Building and Structures

The administration, laboratory, and mine office buildings will be modular structures that will break down into their component parts and can be hauled away and reused. The Plant and Truck Workshop/Warehouses are steel frame, fabric covered structures that can be similarly dismantled and reused elsewhere. The process facility is a steel frame non-enclosed structure containing process equipment, which will be removed before the frame is dismantled and removed.

The reclamation of the collection pond will be in accordance with the Water Pollution Control Facility (WPCF) permit as required by the ODEQ (Appendix L). Reclamation of lined ditches and other water management structures will be in accordance with the WPCF (Appendix L) and Stormwater Management Plan (Appendix Y).

Other structures to be remediated and removed include:

- Truck Wash Pad
- Crushing Area

The Truck Wash Pad is a concrete slab that will be broken up, have the rebar removed, and disposed of off site. The crushing area consists of a series of portable units mounted on chassis that can be towed away for use elsewhere.
Pipelines will be removed and disposed of off site:

- Tailings distribution pipeline
- Tailings reclaim water pipeline

All foundations remaining from decommissioned structures, made from inert materials such as concrete, will be broken up and covered with two feet of fill and growth media, which includes concrete slabs. Before burial all exposed rebar that has a potential to protrude through the completed backfill will be cut level with the remaining concrete.

Concrete that may be contaminated through exposure to process reagents will be excavated and disposed of in the TSF.

Soils under and adjacent to the fuel storage areas would be tested for contamination. The results will be submitted to the ODEQ as part of a Final Closure Activities Report, which will summarize closure activities and status.

Chemicals will be disposed of at an approved solid waste management facility. All chemical reagents (including NaCN), petroleum products, solvents, and other hazardous or toxic materials in the mill, not salvaged, will be removed from the site and either reused or disposed of according to federal and state regulations. All salvageable equipment, instrumentation, and unused petroleum products and solid wastes from the mill operation will be used or recycled. Non-hazardous solid wastes will be disposed of at an off-site landfill designed to handle the waste material.

4.7.3 Underground Mine

At the permanent cessation of all mining activities, any adit openings to the surface will be permanently sealed by the placement of concrete and rock plugs, or steel bulkheads. The vent raise will be sealed by the placement of a concrete plug, covered with at least one foot of fill and growth medium, and revegetated.

Removal of underground facilities and equipment will consist of the following steps:

- Underground piping, pumps, tanks and pumping equipment will be removed and salvaged, or disposed of in an approved solid waste disposal facility.
- Piping that cannot be salvaged for reuse will be dismantled as required for backfill placement and left underground.
- Fans, motors, pumps, compressors, power supply, electrical distribution equipment, ventilation curtains and ducts, and other equipment will be removed, as practicable, and salvaged for use at another facility or disposed of in an approved solid waste disposal facility.
- Non-reactive equipment (e.g., HDPE pipe) may be left underground.
- Remaining fuel, lubricants and explosives will be removed from the underground workings and transported to other sites or disposed of according to federal and state standards and regulations.

All salvageable equipment, instrumentation, and unused petroleum products and chemicals and solid wastes from the underground mine will be used or recycled. Examples include piping, pumps, diesel, lubricating fluids, etc. Used and waste petroleum products and chemicals will be disposed of at a Class I landfill. Non-hazardous solid wastes would be disposed of at an off-site landfill. Water pipelines from the underground workings will be removed and hauled off site.

4.7.4 Road and Yard Features

All Project roads and yard features, including parking areas, will be gravel base and not be paved with asphalt. Roads without a defined post-mining use will be reclaimed concurrently as they are no longer needed for access. Where the original topography exceeds 3H:1V, the road cut will be filled with the road bed material to blend with existing topography and to ensure no steeper than 3H:1V slopes except where cut banks are located generally in bedrock.

Roads and safety berms will be recontoured or regraded to approximate the original contour. Where the road is located on fill, the side slopes will be rounded and regraded to 2.5H:1V. Finished slopes will be relatively similar to the surrounding topography. Compacted road surfaces will be ripped, covered with growth media from the safety berms or road fill, and re-vegetated.

Some access roads will be needed to access monitoring points. As monitoring is completed and the facility is considered to be closed, the access road will be reclaimed, as determined by the BLM and DOGAMI. However, access to the private land portion of the Project Area will remain after reclamation.

4.7.5 Measures to Minimize Sediment Loading to Surface Waters

Runoff from the TSF area and other slopes will occur following precipitation events; however, regraded slope angles, revegetation (including growth media placement) and BMPs will be used to limit erosion and reduce sediment in runoff. Silt fences, sediment traps, or other BMPs will be used to prevent migration of eroded material until reclaimed slopes and exposed surfaces have demonstrated erosional stability.

Long-term drainage structures installed for the main access will include properly installed ditches, water-bars, cross drains, and design flow culverts, as needed.

Details on the management of stormwater are in accordance with the Stormwater Management Plan (Appendix Y).

4.7.6 Disposition of Buildings and Ancillary Facilities

During final mine closure, buildings and structures will likely be dismantled and materials will be salvaged or removed to an authorized landfill. Concrete foundations and slabs will be broken using a track-hoe mounted hydraulic hammer or similar methods and buried in place under approximately three feet of material in such a manner to prevent ponding and to allow vegetation growth. After demolition and salvage operations are complete, the disturbed areas will be covered with approximately 12 inches of growth media and revegetated.

All reagents and explosives will be removed or appropriately disposed of. Any surface pipelines will be removed and salvaged or disposed. Underground pipeline ends will be capped and left in place. Unneeded utility poles will be cut off at ground level and removed.

All mining equipment, trailers, supplies, the cement silo, and other mine site infrastructure will also be removed from the site.

4.8 Facilities Not Subject to Reclamation

As determined by the BLM, roads on public lands suitable for public access or which continue to provide public access consistent with pre-mining conditions will not be reclaimed at mine closure. Narrow access roads may remain on large haul roads after they have been re-contoured and seeded.

4.9 Post Reclamation Monitoring and Maintenance

Post reclamation monitoring and maintenance will include the following:

- Following mine closure, berm and sign maintenance, site inspections, and any other necessary monitoring for the period of reclamation responsibility will be conducted. Monitoring of revegetation success will be conducted annually until the revegetation standards have been met and will include noxious weed monitoring and abatement as necessary.
- Calico will monitor the TSF drainage flow and chemistry. Mitigation will be developed if necessary.
- Post-mining groundwater quality will be monitored according to the requirements established by the ODEQ upon approval of the Chemical Mining Permit the goal of demonstrating the site poses no potential to degrade waters of the state through the successful implementation of the detailed Final Plan for Permanent Closure. The Reclamation Cost Estimate will contain costs for five years of groundwater monitoring.
- Revegetation monitoring will be conducted for a minimum of five years following implementation of revegetation activities or until revegetation success has been achieved. Revegetation monitoring will occur based on seasonal growth patterns, precipitation, and weather conditions.
- Noxious weed monitoring and control, as described in Appendix H, will be implemented for a five-year period following closure.

Surface erosion would be visually monitored on a weekly basis by Calico during storm events, or periods of high runoff; the frequency may be more often depending on weather conditions. Erosion control BMPs would be implemented as needed. Examples include diversion ditches to prevent run-on to the mine site and culverts to carry water across access roadways.

Security measures implemented at the mine site during operations would be installed during reclamation, including gating and warning signs. At closure, additional safety measures would be employed by Calico as necessary to secure the abandoned mining operations.

Revegetation monitoring of the reclaimed facilities would be conducted at both the mine and mill sites for at least three years following final reclamation. The monitoring would involve photo-documentation and be conducted during the "peak green" spring season. This program would be coordinated with the BLM and DOGAMI. Reclaimed areas not meeting regulatory standards would be evaluated, and corrective actions implemented. These measures could include, if necessary, additional soil amendments, reseeding, and installation of erosion control measures. This obligation would cease when the reclamation goals and requirements have been achieved, and upon release of all related reclamation bond(s).

Once all the final reclamation is completed, yearly post-reclamation maintenance would involve remedial dirt work and reseeding, if required. Yearly visits to the site would be conducted to monitor the success of revegetation for a three-year period, or until attainment of revegetation standards.

4.10 Drill Hole Plugging and Water Well Abandonment

Mineral exploration and development drill holes, monitoring, and production wells subject to OWRD regulations will be abandoned in accordance with applicable rules and regulations (OAR 690-220-0005 through 690-220-0140). Drill holes will be sealed to prevent cross contamination between aquifers and the required shallow seal will be placed to prevent contamination by surface access.

Monitoring wells around the TSF will be maintained until Calico is released of this requirement by the ODEQ. These wells will then be plugged and abandoned according to the requirements of the State Engineer.

As outlined under OAR 690-220-0005, any water well to be temporarily removed from service, temporarily abandoned due to a recess in construction, or temporarily abandoned before commencing service, shall be capped with a watertight seal, watertight welded steel cap, or threaded cap. If temporary abandonment is to be 90 days or less in duration, the temporary steel cap may be welded to the well casing with a minimum of four separate welds, evenly spaced, each at least 3/16 of an inch in length. Access ports and airlines, as described in OAR 690-210-0280, shall be maintained during the temporary abandonment. During the temporary abandonment, the well must be maintained to the standards prescribed in OAR 690-215.

Any water supply well that is to be permanently abandoned shall be completely filled in such a manner that vertical movement of water within the well bore, including vertical movement of water within the annular space surrounding the well casing, is effectively and permanently prevented, per OAR 690-220-0030. If a dry or non-producing water supply well is to be permanently abandoned, it shall be abandoned in accordance with these standards. All permanent water supply well abandonments shall be performed by a licensed Water Supply Well Constructor.

The abandonment procedure shall be recorded on a form provided by or previously approved in writing by the Department. The form shall include, as a minimum, all the requirements as listed in OAR 690-205-0210, plus a description of the method of abandonment; well identification information, including owner information; and confirmation that the well identification tag shall be destroyed and will not be reused.

4.11 Reclamation Cost Estimate

The Consolidated Permit describes the maximum development that is likely to occur at the site based on current knowledge of geologic and other site conditions. The ultimate development will occur over a five-year period.

The proposed disturbance acreage for the Project is provided in Table 54. Acreage for ancillary facilities allows for bonding of a complete infill footprint with a resulting overstatement in RCE because sections within the footprint will likely remain undisturbed throughout the life of the Project. Disturbance has been provided for excess ancillary facilities, process facilities, waste rock storage areas, piping, and open pit. The RCE will be submitted at a later date for the purposes of review and approval of the reclamation permit.

Calico plans to use a phased bonding approach and will work out suitable milestone events with respect to Project development with the BLM and the ODEQ. Calico will provide a reclamation surety in accordance with regulations at 43 CFR 3809.522, 3809.553, and at Oregon Revised Statutes (ORS) 517.810. Calico will update the surety to reflect the actual disturbance and whatever additional disturbance is planned for the subsequent period. Any changes to equipment, consumable, and manpower costs will also be incorporated during the updates.

5 ALTERNATIVES ANALYSIS

5.1 Proposed Mining Operation Impact Analysis

Table 90 summarizes potential impacts to all listed resources from the proposed Project, as well as a comparison to the impacts associated with the action alternatives.

Table 90. Proposed Project and Alternatives Impact Analyses

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Air Quality Resources	An emissions inventory conducted for the proposed Project indicated that the following criteria pollutants had potential annual emissions below the Significant Emission Rates (SERs) as defined in OAR 340-200-0020: $PM_{2.5}$; CO; NO_x; SO_2; Volatile Organic Compound (VOC); and lead. The potential annual emissions for PM_{10} were above the SER; therefore, the PM_{10} emissions were modeled. The total concentration of the modeled emissions for PM_{10} 24-hour were 43.6 $\mu g/m^3$, compared to the National Ambient Air Quality Standards (NAAQS) of 150 $\mu g/m^3$.	Under this alternative, criteria pollutant emissions would significantly increase from the construction of the open pit, blasting activities in an open pit area, increased hauling and dumping, and increased equipment travel and operations.	Under this alternative, there would be more ore left in the tailings, so the daily processing needs would be much greater than the proposed Project. Therefore, the criteria pollutant emissions and specifically fugitive dust emissions would be greater than the proposed Project.
Aquatic Resources	There were no sites observed during field surveys that contained aquatic resources. There is no site with aquatic resources habitat within the Permit Area; therefore, impacts to aquatic resources are not anticipated from the proposed Project.	Impacts under this alternative would be the same as the proposed Project.	Impacts under this alternative would be the same as the proposed Project.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Areas of Critical Environmental Concern (ACECs)/Research Natural Areas (RNAs)	There are no ACECs or ACECs/RNAs in the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.
Cultural Resources	The proposed Project would potentially impact two cultural sites recommended as eligible for listing on the NRHP and one unevaluated site that requires further testing within the Mine and Process Area, and five unevaluated sites in the Access Road Area that require further testing in areas proposed to be widened or realigned.	Depending on the location of the open pit under this alternative, one additional unevaluated cultural site that requires further testing may be impacted,	Depending on the location of the heap leach facility under this alternative, one additional unevaluated cultural site that requires further testing may be impacted,
Environmental Justice	There are minority, low-income, and tribal populations in and near the Permit Area. Impacts from the proposed Project are currently unknown, but outreach would continue to be conducted throughout the permitting process. Dewatering needs for the underground mine may result in concerns from Tribal nations in the area.	Dewatering needs associated with this alternative would be greater than the proposed Project. Potential Tribal concerns may be increased from the increased dewatering needs.	Impacts under this alternative are anticipated to be the same as the proposed Project.
Geochemistry	The results of the Grassy Mountain geochemical characterization program indicate that the majority of the waste rock and unprocessed ore material will generate acid and leach metals under long-term weathering conditions. The exceptions to this include the sinter material that shows a low potential for acid generation. This can be attributed to	Impacts under this alternative are anticipated to be proportionally greater than the impacts associated with the proposed Project. This is due to the greater tonnage of materials mined under the open pit mining method.	Impacts under this alternative are anticipated to be the same as the proposed Project.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
	the lower sulfide sulfur content associated with this material type.		
Geology and Soils	There are 17 soil types identified in the Permit Area. Activities in the Mine and Process Area would impact up to 265 total acres of soils, consisting of the following nine soil types: Farmell-Rock outcrop complex, 8 to 30 percent slopes; Farmell-Chardoton very cobbly soil, 15 to 30 percent slopes; Farmell-Chardoton very cobbly soil, 4 to 15 percent slopes; Farmell-Chardoton extremely stony soil, 4 to 15 percent slopes; Farmell-Chardoton soil, 8 to 15 percent slopes; Ruckles very stony loam, 8 to 30 percent slopes; Soil A extremely gravelly sandy loam, 15 to 30 percent slopes; Xeric Torriorthents, 8 to 30 percent slopes; and Soil B very gravelly sandy loam, 8 to 30 percent slopes. Surface disturbance would increase the potential for wind and water erosion; however, the high rock fragment content in the soils reduces the potential for sheet erosion by water. Geologic hazards (i.e., seismicity/earthquake hazards, slope failures/landslide areas, volcanic eruptions) have low probability in the area. The proposed Project would extract approximately three mtons of ore and 0.2 mtons of waste rock.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would primarily impact up to 471 acres more of the nine soil types in the Mine and Process Area. Under this alternative, approximately 30 mtons of ore and 49 mtons of waste rock would be extracted.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the nine soil types in the Mine and Process Area.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Grazing Management	The proposed Project would impact approximately 265 acres of the following grazing allotments: Dry Creek (10411) and Nyssa (10403).	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would impact up to 471 acres more of the Nyssa Grazing Allotment.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the Nyssa Grazing Allotment.
Groundwater	Production well pumping was modeled simultaneously with the transient model dewatering pumping to predict drawdown effects on the aquifer system for a ten-year period. After ten years of pumping, the model predicts a little over two feet of drawdown at Lowe Spring and zero drawdown at Poison Spring. After ten years of pumping, when the wells cease pumping, the area of impact would continue to migrate outward due to the slow equilibration of the cone of depression. After approximately 27 years of recovery, the model predicts a residual drawdown of over 20 feet near the production wells, approximately ten feet of drawdown at Lowe Spring, and less than 0.5 feet of drawdown at Poison Spring. The maximum drawdown in the production wells is 212 feet after ten years.	This alternative would have a greater level of groundwater impacts as compared to the proposed Project, since more mine dewatering would be required to dewater the open pit, as well as longer production water needs to process the additional tons of ore. In addition, once mining ceases, a pit lake would likely develop in the bottom of the open pit.	This alternative would have approximately the same level of groundwater impacts as the proposed Project.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Land Use	Part of the Access Road Area is designated Exclusive Farm Use; the remainder of the Access Road Area and Mine and Process Area are designated Exclusive Range Use (ERU). Mining operations are permitted conditional uses of ERU-designated lands under Oregon Revised Statutes 215.283 and 215.296. The Malheur County Planning Commission approved the Conditional Use Permit and issued a Land Use Compatibility Statement on May 23, 2019. The existing land uses in the Permit Area are primarily wildlife habitat and mineral exploration. The areas proposed for disturbance would be recontoured and reseeded, returning the land to pre-Project conditions.	Impacts under this alternative would be the same as the proposed Project.	Impacts under this alternative would be the same as the proposed Project.
Noise	Noise generating sources associated with the proposed Project include blasting of the underground mine, the crushing and screening plant, the processing plant, and equipment and vehicles.	Under this alternative, noise levels and the duration of noise from blasting the open pit would be increased. There would also be more noise associated with the larger numbers of haul trucks needed to haul the larger amounts of ore mined from the open pit.	Noise generated under this alternative would be less than the proposed Project, as there would be no mill and tailings facility associated with this alternative.
Oregon Natural Heritage Areas (ONHAs)	There are no ONHAs in the Permit Area; the closest ONHA is approximately 16 miles from the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Outstanding Natural Areas (ONAs)	There are no ONAs in the Permit Area; the closest ONA is approximately 77 miles southwest of the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.
Recreation	The proposed Project would temporarily reduce opportunities for dispersed recreationists, in the Recreation Opportunity Spectrum (ROS) classification of "Semi-primitive Motorized," of pleasure driving, hiking, scenery viewing, rockhounding, and ATV use. The Access Road would be widened in some areas, providing better access for larger vehicles accessing the Twin Springs Campground to the southwest of the Mine and Process Area.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would impact up to 471 acres more of the "Semi-primitive Motorized" ROS classification and reduce opportunities for dispersed recreationists.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to dispersed recreation opportunities and the "Semi-primitive Motorized" ROS classification.
Socioeconomics	The proposed Project would employ approximately 100 people. Calico would implement a local hire preference policy thereby resulting in beneficial impacts to the surrounding communities.	Under this alternative, a larger workforce would be required to handle the increased amount of ore needing to be processed. In addition, more construction workers, equipment operators, and miners would be needed. Although there could be increased beneficial economic impacts to the local communities, there could also be increased impacts to traffic, noise, air quality, wildlife, visual resources, and dispersed recreation.	Under this alternative, a larger workforce would be required to handle the increased amount of ore needing to be processed through a heap leach. In addition, more construction workers, equipment operators, and miners would be needed. Although there could be increased beneficial economic impacts to the local communities, there could also be increased impacts to traffic, noise, air quality, wildlife, visual resources, and dispersed recreation.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Surface Water	Surface water features in the Permit Area consist of ephemeral or intermittent drainages. Storm water would be managed through diversion channels and ditches constructed around the surface facilities and waste rock storage areas, which would change the surface drainage patterns.	Impacts to surface drainage patterns would be similar under this alternative; however, due to the large surface size of the open pit, several additional diversion channels would need to be constructed.	Impacts to surface drainage patterns would be similar under this alternative.
Terrestrial Vegetation	The proposed Project would impact up to 265 acres of the following vegetation communities: Wyoming Big Sagebrush/Crested Wheatgrass; Crested Wheatgrass Seeding; Bluebunch Wheatgrass/Cheatgrass/Annual; Wyoming Big Sagebrush/Bluebunch Wheatgrass; and Burned Yellow Rabbitbrush/Bluebunch Wheatgrass.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would primarily impact up to 471 additional acres of the Wyoming Big Sagebrush/Bluebunch Wheatgrass vegetation community.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the Wyoming Big Sagebrush/Bluebunch Wheatgrass vegetation community.
Transportation	The proposed Project would result in increased vehicle travel on the Main Access Road from mining equipment and support vehicles. In addition, approximately 100 workers would be employed at the mine, resulting in increased personal vehicle travel along the Main Access Road; however, a daily bus shuttle service from Vale to the mine site is anticipated to be provided, reducing the number of personal vehicles traveling on the road.	Under this alternative, approximately ten times more ore would be mined from the open pit than from the underground mine. This would result in the need for additional mining equipment and employees, resulting in more equipment and vehicles using the Main Access Road. However, this alternative would also operate a daily bus service from Vale.	Under this alternative, a larger workforce would be required to handle the increased amount of ore needing to be processed through a heap leach. In addition, more construction workers, equipment operators, and miners would be needed. This would result in the need for additional mining equipment and employees, resulting in more equipment and vehicles using the Main Access Road. However, this alternative would also operate a daily bus service from Vale.

Resource	**Proposed Project**	**Open Pit Mine Alternative**	**Heap Leach Ore Processing Alternative**
Visual Resources	The proposed Project would create visual resource impacts to the existing visual environment with the addition of mine buildings, associated mining facilities, and equipment. There are existing man-made features in the area consisting of roads, fences, and a powerline, which disturb the rural feel of the surrounding undeveloped landscape. The mining features may be visible from several KOPs, and would alter the forms, lines, colors, and textures of the existing landscape. Most of the mining-related equipment would be underground, so would not be visible from the KOPs.	This alternative would create a very large open pit, which would result in a large alteration of the existing landscape in comparison to an underground portal. All the mining equipment would be on the surface or in the open pit, and potentially visible from the KOPs.	This alternative would create a heap leach pad with adjacent precious metal recovery plant. This would alter the characteristics of the existing visual environment by changing the forms, lines, colors, and textures of the existing landscape. The heap leach pad and plant could potentially be visible from the KOPs.
Wetlands	There were two wetlands identified in the Permit Area during field surveys. The proposed road design would avoid the wetland; therefore, no impacts to the wetlands are anticipated from the proposed Project.	Impacts under this alternative would be the same as the proposed Project.	Impacts under this alternative would be the same as the proposed Project.
Wild, Scenic or Recreational Rivers	There are no wild, scenic or recreational rivers in the Permit Area; the closest is located approximately 31 miles to the south of the southernmost tip of the Permit Area. There would be no impact to this resource from the proposed Project.	There would be no impact to this resource from this alternative.	There would be no impact to this resource from this alternative.

Resource	Proposed Project	Open Pit Mine Alternative	Heap Leach Ore Processing Alternative
Wildlife Resources	The proposed Project would potentially impact the following wildlife habitat types: Exotic Annual Grassland; Perennial Grassland; and Sagebrush Shrub-steppe. The Mine and Process Area is primarily within the Sagebrush Shrub-steppe habitat, with small portions of developed roads. The proposed Project could also potentially impact the habitat of several avian species including greater sage-grouse, and bats.	This alternative would add up to 471 acres of additional disturbance from the open pit, waste rock storage area, and tailings facility, and would primarily impact up to 471 additional acres of the Sagebrush Shrub-steppe habitat type and increase the loss of foraging habitat for several wildlife species. The open pit mine would also potentially create nesting habitat for specific avian species such as golden eagles.	This alterative would reduce the total acres of disturbance by approximately 61 acres. This would reduce the impacts to the Sagebrush Shrub-steppe habitat type.

5.2 Alternatives Analyzed

There are no alternatives that will avoid or minimize environmental impacts. The proposed mine design and operations include design features that result in the smallest disturbance footprint for the proposed activities.

5.2.1 Open Pit Mine

Under this alternative, the Project would be developed as outlined in the Proposed Action, except the mineral resource would be mined by a surface mining method, rather than by an underground method. The open pit resource would total approximately 30 million tons of ore and 49 million tons of waste rock. The open pit alternative is anticipated to be up to approximately 75 acres in size. The waste rock storage area would need to be placed near the open pit and would be anticipated to cover up to approximately 200 acres, depending on the location and design. The tailings facility that would contain the 30 million tons of processed ore would be anticipated to be up to approximately 300 acres, depending on the location and the height of the tailings dam.

5.2.2 Heap Leach Ore Processing

Under this alternative, the Project would be developed as outlined in the Proposed Action, except the ore would be processed by a heap leach method rather than a milling method. Under this alternative the mill and tailings facility would not be built. Instead, a heap leach pad would contain and process the ore. In addition, a precious metal recovery plant would be built adjacent to the leach pad. The leach pad and plant would be anticipated to cover up to approximately 40 acres, depending on the pad design.

5.3 Alternatives Eliminated from Detailed Consideration

5.3.1 Mining in Another Location

The location of the proposed underground mine is strictly dictated by the location of the identified ore deposit; therefore, no location alternatives for the underground mine would be possible.

5.3.2 Alternate Tailing Storage Location

Under this alternative, the Project would be developed as outlined in the Proposed Action, except an alternate tailings location would be used for the disposal of the process ore. As part of the design development for the Project, Golder, the engineering firm that designed the proposed tailings facility, assessed several alternate sites (Appendix C). Based on that assessment, the proposed site was determined to be the most technically viable location. There might be other locations more distant from the mining and processing operation; however, any other such location would result in a larger project footprint over a larger permit area.

Six alternative TSF storage options were evaluated as part of the TSF design process. These included:

- Option 1 – TSF located east of the proposed underground portal (included in the 2015 Profitability Economic Assessment [PEA])
- Option 2 – TSF located northwest of the underground portal
- Option 3 – TSF located southwest of the underground portal (Included in the 2015 PEA)
- Option 4 – TSF located south and further west of the underground portal in a separate ephemeral drainage than the other options (included in the 2015 PEA)
- Option 5 – TSF located on Bishop's property about 3 miles southwest of the underground portal
- Option 6 – Filtered or paste tailings storage options

Each of these options were evaluated at a conceptual level by Golder and included in a trade-off study letter presented as Appendices C and W.

To adequately compare each option, technical and environmental/social criteria were used. Based on this review, Option 2 was identified as the most preferable TSF option. Option 2 was then advanced through pre-feasibility and the construction-level design presented in Appendix C.

5.3.3 Alternative Tailing Disposal

Under this alternative, the Project would be developed as outlined in the Proposed Action, except an alternate tailings disposal method would be used for the disposal of the process ore. The Proposed Action would pump the tailings into a pipeline for the subaerial deposition of the tailings. The alternatives to this method would be to pump the tailings into a pipeline for subaqueous deposition, or to mechanically dewater the tailings and then haul the tailings to the disposal site. Subaqueous deposition requires that the impoundment area behind the tailings dam be filled with solution. This would result in a higher water consumption during operation and a longer closure period as the tailings are dewatered through consolidation. The mechanical dewatering of the tailings would require a significant capital investment that would make the project uneconomical.

5.3.4 Alternative Water Supply

Under this alternative, water for the Project would be obtained through a municipal water supply system from the City of Vale. This alternative would not be physically feasible, as the pipeline system would need to be approximately 22 miles long. In addition, the adequacy of the City of Vale water supply to meet the Project's needs has not been determined.

5.3.5 Alternative Power Supply

Under this alternative, the Project would be developed as outlined in the Proposed Action, except there would be on-site power generation using generators instead of power obtained from a powerline. This alternative would result in the need for three 60 hertz (Hz) diesel-powered generators and one backup 60 Hz diesel-powered generator to supply power to the processing plant, and one 60 Hz diesel-powered generator and one 60 Hz backup diesel-powered generator to supply power to the underground mine. To accommodate the power demand generated by the underground mine and processing plant, the generators would operate at a maximum of 24 hours per day, or 8,640 hours per year, with the backup generators running approximately 500 hours per year. These generators would accommodate the power demands of the Project, but would result in substantial additional air quality emissions, specifically from nitrogen oxide and carbon monoxide, as well as additional traffic associated with the fuel deliveries (Appendix W).

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Appendix A: Oversize Figures

Appendix B: Baseline Studies and Work Plans (uploaded to sharesite)

EM STRATEGIES

Appendix C: Tailings Design Report

Appendix D: Mill Design Report

Appendix E: Emergency Response Plan

Appendix F: Cyanide Management Plan

Appendix G: Monitoring Plan

Appendix H: Noxious Weed Monitoring and Control Plan

Appendix I: Wildlife Mitigation Plan

Appendix J: Reclamation Cost Estimate

EM STRATEGIES

Appendix K: Interim Management Plan

Appendix L: ODEQ Water Pollution Control Facility Application and Division 43 Permit Application

Appendix M: ODEQ Class I Air Quality Operating Permit Application

EM STRATEGIES

Appendix N: OWRD Dam Permit Application

Appendix O: ODEQ Storm Water Permit Application

Appendix P: OWRD Water Rights

Appendix Q: Monitoring Well Work Proposal

Appendix R: Malheur County Land Use Compatibility Statement (LUCS)

Appendix S: Portal Design Report

Appendix T: Ecological Risk Assessment

Appendix U: Inadvertent Discovery Plan

Appendix V: Aggregate Application

EM STRATEGIES

Appendix W: Alternatives Support Documents

Appendix X: Mining Claim Information

Appendix Y: Stormwater Management Plan

EM STRATEGIES

Appendix Z: Petroleum Contaminated Soil Management Plan

Appendix AA: Quality Assurance Plan

Golder Associates Inc.
Construction Quality Assurance Plan
Tailings Storage Facility and Waste Rock Dump

Golder Associates Inc.
Technical Specifications
Tailings Storage Facility and Waste Rock Dump

Ausenco
Grassy Mountain Project
Project Quality Plan – Processing

EM STRATEGIES

Appendix AB: Hazardous Material Reporting

EM STRATEGIES

Appendix AC: Road Design Report

Appendix AD: Well Field Design Report

EM STRATEGIES

Appendix AE: Water and Wastewater Facilities Preliminary Engineering Design