TINTINA RESOURCES
TSX.V:TAU | OTCQX:TINTF | www.tintinaresources.com

17 East Main Street
White Sulphur Springs, Montana
USA 59645
Tel: (406) 547-3466
Fax: (406) 547-3719
Web: www.tintinaresources.com
Email: info@tintinaresources.com

July 14, 2017

Bureau Chief
Hard Rock Mining Bureau
Montana Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901

Dear Sir,

Tintina Resources Inc., is pleased to submit our third revision, dated July 14, 2017, to its Mine Operating Permit application for our underground Black Butte Copper Project. We appreciate your departments continuing efforts in this review process.

We look forward to finalizing the Complete & Compliant process and continuing to work with the Department of Environmental Quality on permitting the Black Butte Copper Project.

Sincerely,

John Shanahan
President & CEO

Mine Operating Permit Application
Black Butte Copper Project, Meagher County, MT
Revision 3

Submitted by:

Tintina Montana, Inc.
Black Butte Copper Project
PO Box 431
White Sulphur Springs, MT 59645
406-547-3466

Submitted to:

Montana Department of Environmental Quality
Hard Rock Mining Bureau
P.O. Box 200901
Helena, Montana 59620-0901

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GLOSSARY OF TERMS

acre	a land measure based on the U.S. survey foot, one acre is approximately 43,560 square feet or 4,046.873 square meters.
adit	a horizontal entrance to an underground mine
amorphous	a mineral having no crystalline structure
anoxic	absence or reduced supply of oxygen
aquifer	a body of saturated alluvium or rock through which water can easily move
barite	$BaSO_4$, generally colorless barium sulfate mineral
binder	a substance used in construction that sets and hardens and can bind other materials together; any cementing material, either hydrated cement or a product of cement or lime and reactive siliceous materials. The kinds of cement and the curing conditions determine the general type of binder formed.
carbonate mineral	containing the carbonate ion (CO_3^{-2})
cement	a powdery substance made with calcined lime and clay. It is mixed with water to form mortar or mixed with sand, gravel, and water to make concrete
chalcopyrite	($CuFeS_2$) a copper sulfide mineral
Connective Linear Network	a MODFLOW programming modeling module developed to simulate discrete high permeability features (such as tunnels) in a larger grid system
conglomerate	coarse grained sedimentary rock composed of rounded fragments within a matrix of finer grained material
contact water	water contacting potentially acid generating materials that will be transported in ditches or pipelines to the contact water pond prior to RO water treatment
Cretaceous	a period in geologic time occurring between 145 and 65 million years ago
CTF basin drain system	The drain system internal to the CTF basin that consists of the HDPE liner system, the sub-grade bedding layer above the HDPE liner system, and the drainage layer above the sub-grade bedding layer. The drainage layer is a minimum 3.3 ft. (1,000 mm) thick consisting of uncompacted free-draining pre-production waste rock. The basin drain system is integrated with the water reclaim (wet well) sump to promote flow to the sump.
CTF seepage collection system	collects water that has seeped through the upper geomembrane of the liner system and directs it to a smaller sump (seepage collection sump that is located in between the geomembranes), pumps inside this sump, pump water to the CTF crest and discharges it back into the CTF to be collected by the CTF water reclaim system.
CFT water reclaim system	collects water from inside the CTF basin drain system in a (wet well) sump, and pumps that water to the PWP via a discharge pipe.

cut-off grade	level of mineral in an ore below which is not economically feasible to mine
Darcy's Law	an empirically derived equation that describes the flow of water through a porous medium
debris flow	rapid movement of soil and weathered debris above a bedrock surface
decline	a downward-sloping underground tunnel for access to ore-bearing mine workings
drift	horizontal or gently dipping underground mine tunnel that is cut parallel to or in the mineralized zone
ephemeral drainage	a gulch or coulee that contains flowing water only part of the year or only during "wet" years; sometimes referred to as an intermittent drainage
exploration license	a license issued by the Montana Department of Environmental Quality that authorizes the licensee to explore for minerals
fault	a planar fracture or discontinuity in a volume of rock across which there has been significant displacement along the fractures as a result of earth movement
fly-ash	the finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gases as defined by *ASTM C618 "Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete";* Fly-ash can be used as a supplementary cementaceous additive to cement.
formation	a grouping of rock strata that have comparable lithology, facies or other properties and can be correlated across wide distances between outcrops and exposures of rock strata
foot wall	the body of rock lying below a fault plane
foundation drain system	The CTF and PWP foundation drain systems comprise an interconnected dendritic system of pipes, embedded in granodioritic drainage gravel, sourced from either the CTF or PWP excavation footprints that is designed to collect and funnel the predicted groundwater flows from beneath the HDPE liners to a downgradient foundation drain collection pond.
gossan	iron-rich residual deposit, formed as the remnant of intense surface oxidation of sulfides and the leaching of sulfur and metals
hanging wall	the body of rock lying above a fault plane
hectare	a unit of surface, or land, measure equal 10,000 square meters: equivalent to 2.471 acres
Herth and Arndts	an empirically derived equation that describes groundwater linear steady state flow
hydrothermal vent	a fissure in the planet's surface from which geothermally heated water issues, common near volcanically or tectonically active places

hydraulic conductivity	a property of soil or rock that describes the ease with which water can move thorough pore spaces or fractures, abbreviated as *K*
hydrophytic	plant-life that thrives in wet conditions; used as an indicator of wetlands
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry, a type of analytical technique which is capable of detecting some metals and some non-metals at very low concentrations.
indicated resource	economic mineral occurrences where an estimate of contained metal, grade, tonnage, shape and / or other physical characteristics have been made based on sampling from outcrops, trenches, pits or drill holes
igneous	rocks that have cooled and crystallized from magma (previously molten rock)
igneous intrusion	rocks that were previously melted, then squeezed into and between (intruded) older rocks before crystallizing
laminations	fine layers or laminae that occur in sedimentary rocks
Laramide Orogeny	a period of mountain building events in western North America responsible for the creation of the Rocky Mountains beginning approximately 70-80 million years ago and ending 35 to 55 million years ago
LECO	a brand of carbon/sulfur combustion furnace equipped with infrared detection used for measurement of sulfur concentration in rock, soil, and organic materials over a wide concentration range
lithic scatters	archaeological sites that consist solely of flaked stone artifacts
lithology or lithologies	the physical character of a rock, generally determined megascopically or with the aid of a low power magnifier
lithotypes	rock defined on the basis of certain selected physical characteristics
massive	thick units of homogeneous (alike; consistent) material
measured resource	indicated resources that have gone through further sampling such that a competent person, usually a geologist, has declared the resource to be an acceptable estimate of the grade, tonnage, shape, densities, and / or physical characteristics at high degrees of confidence
middle Proterozoic	geological era from 1600 to 1000 million years ago
mil	one/thousandth of an inch
mineralization	the formation of ore bodies or lodes of important economic minerals
mining claim	a parcel of land that the claimant has asserted a right of possession
MODFLOW	USGS 3-D finite difference groundwater modeling software
net acid generating	refers to the potential of tailings or waste rock to generate acid
net acid generation testing	refers to a type of analysis that determined the balance between the acid producing and acid consuming components of tailings or waste rock

NI-43-101	National Instrument 43-101 is a national instrument for the Standards of Disclosure for Mineral Projects within Canada.
normal fault	a fault where the hanging wall has moved downward relative to the footwall
NP:AP ratio	balance between the acid consumption potential (neutralization potential or NP) and the acid production potential (acid potential or AP) of a rock
ore	naturally occurring rock that contains minerals that can be extracted at a profit
oxidation	alteration of a rock by the addition or in the presence of oxygen
oxide	mineral group that contains oxygen
paralithic	weathered bedrock
Peak Ground Acceleration	a measure of the maximum ground acceleration predicted or occurring during earthquake shaking at a specific location. As such, PGA is most commonly used as a primary design basis in engineering applications (dams, buildings, etc.). It is not a measure of the total energy (magnitude, or size) of an earthquake.
Portland cement	a brand of cement; for the Black Butte Copper project, a binder in paste backfill where structural strength is required of the backfill and where resistance to liquefaction and liquid separation is necessary
Pozzolans	a broad class of siliceous or siliceous and aluminous materials which, in themselves, possess little or no cementitious value but which will, in finely divided form and in the presence of water, react chemically with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties
potentiometric surface	a map that contours the distribution of groundwater elevations data and indicates the direction of groundwater flow
pyrite	ferrous sulfide (FeS_2): an iron sulfide mineral
qualified person	a "qualified person" is an individual who is an engineer or geoscientist with at least five years of experience in mineral exploration, relevant experience to the subject matter, and a member in good standing of a professional association.
quartzite	a hard, non-foliated metamorphic rock which was originally pure quartz sandstone
raise	vertical mine workings usually constructed from the bottom up
RO permeate	the portion of reverse osmosis feed water that passes through the RO membranes or filters and represents the purified or dilute water fraction
RO reject	the portion of the reverse osmosis feed water that will not pass through the RO membranes or filters and represents the impure, concentrated or contaminated water side, often called a brine because it contains salt concentrations

silicification	alteration process of petrification where rocks become saturated with silica
sedimentary rock	rocks formed from fragments of other rock (sediment) that are weathered, transported, deposited, and lithified
shale	laminated sediment comprised principally of clay-sized particles
slag	a non-metallic binder product, consisting of silicates and alumino-silicates of calcium, magnesium and other bases, developed in a molten condition simultaneously with iron in a blast furnace; when rapidly cooled it forms a glassy granular material that is ground and used as a supplementary cementaceous material additive to cement where as an additive it provides good engineering performance at reduced costs and has significant improved resistance to sulfate attack over cement.
slag cement	a hydraulic cement formed when finely ground granulated blast furnace slag is mixed with cement
specific conductance	an electrical measure of the amount of dissolved conductive substances in water
stratigraphically	relating to study of the distribution and spatial association of rock layers and layering
stratigraphy	the branch of geology focused on the study of the distribution and spatial association of rock layers and layering
subaqueous	occurring, appearing, deposited, or formed underwater
subsidence	settling or collapse of the ground surface
sulfide	mineral group that contains reduced sulfur (S^{-2})
TCLP	Toxicity Characteristic Leaching Procedure, a soil sample extraction method for chemical analysis to simulate leaching through a material for hazardous contaminants
tailings	the uneconomic material left over from the process of separating the valuable fraction from the uneconomic fraction of an ore
TDS	Total Dissolved Solids, a measure of the amount of dissolved solids in water
thrust fault	a low angle reverse fault dipping 45° or less
ton	an imperial unit of measure defined to be 2,000 pounds
tonne	metric unit defined as being a metric ton equal to a mass of 1,000 kg
transmissivity	a measure of how much water can be transmitted through an aquifer which is dependent on aquifer thickness and hydraulic conductivity
turbidite	a turbid or soft sediment density flow deposit
turbidity	a measure of water clarity or how much material is suspended in the water
unconformity	the contact between sedimentary rocks that are significantly different in age, or between sedimentary rocks and older, eroded igneous or

	metamorphic rocks. Unconformities represent gaps in the geologic record; periods of time that are not represented by any rocks
vent biota	specialized microorganisms adapted to thrive on and around deep sea volcanic vents

ACRONYMS

AA	Assessment Area
AADT	Annual Average Daily Traffic
ABA	Acid-Base Accounting
ANFO	Ammonium Nitrate / Fuel Oil
AP	Acid Potential
ARM	Administrative Rules of the State of Montana
AST	Above-ground Storage Tank
ASTM	American Society for Testing and Materials
ATI	Assemblage Tolerance Indices (aquatics)
ATR	Automatic Traffic Recorder
BACI	Before, After, Control and Impact (aquatics sampling protocol)
BHP	Broken Hill Proprietary Company Limited
BMP	Best Management Practices
CAI	Cominco American Inc.
CLN	Connective Linear Network
CP	Cemented Paste
CPT	Cone Penetration Test
CTF	Cemented Tailings Facility
CWP	Contact Water Pond
DEQ	Department of Environmental Quality
DNRC	Department of Natural Resources and Conservation
DOT	Department of Transportation
EA	Environmental Assessment
EDGM	Earthquake Design Ground Motion
EIS	Environmental Impact Statement
EMAEC	Estimated Maximum Allowable Effluent Concentration
EOR	Engineer of Record

EPM	equivalent porous media
FA	fly-ash
FAA	Federal Aviation Administration
FAR	Functional at Risk (aquatic)
FEMA	Federal Emergency Management Administration
FMEA	Failure Modes Effects Analysis
FWP	Fish, Wildlife and Parks
G&A	General & Administrative
GMS	Groundwater Modeling System
GWIC	Groundwater Information Center
HDPE	High Density Polyethylene
HBI	Hilsenhoff's Biotic Index
IBI	Integrated Biotic Indices (aquatic)
ICOLD	International Commission on Large Dams
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
IDF	Inflow Design Flood
LAD	Land Application Disposal (system)
LCZ	Lower Copper Zone
LHD	Load haul dump
LOM	Life of Mine
LSI	Langelier Saturation Index
LSZ	Lower Sulfide Zone
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MCE	Maximum Credible Earthquake
MDE	Maximum Design Earthquake
MDEQ	Montana Department of Environmental Quality (used for formal references only)
MDT	Montana Department of Transportation
MEPA	Montana Environmental Policy Act
MMRA	Metal Mines Reclamation Act
MODFLOW	Modular Three-Dimensional Finite-Difference Groundwater Flow Model
MOP	Mine Operating Permit

MPDES	Montana Pollution Discharge Elimination System
MRL	Montana Rail Link
MSHA	Mine Safety and Health Administration
MSL	Montana State Library
NAG	Net Acid-Generating
NCWR	Non-Contact Water Reservoir
NHS	National Highway System
NNP	Net Neutralization Potential
NP	Neutralization Potential
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
OHWM	ordinary high water mark (wetlands and streams)
O/E	Observed / Expected (model, aquatic)
PAG	Potentially Acid-Generating
PEA	Preliminary Economic Assessment
PET	Potential Evapotranspiration
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
POC	Parameter of Concern
PMP	Probable Maximum Precipitation (event)
PWP	Process Water Pond
RO	Reverse Osmosis
SAG	Semi-Autogenous Grinding
SAP	Sampling and Analysis Plan
SC	Specific Conductance
SCM	Supplementary Cementaceous Materials
SDS	Safety Data Sheet
SHPO	State Historic Preservation Office
SOC	Species of Concern
SPCC	Spill Prevention Control and Countermeasures Plan
SPT	Standard Penetration Testing
SWPPP	Storm Water Pollution Prevention Plan

TCLP	Toxicity Characteristic Leaching Procedure
TDI	Teply's Diatom Index (aquatic)
TDS	Total Dissolved Solids (water)
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOMS	Tailings Operations, Monitoring, and Surveillance (Manual)
TSS	Total Suspended Solids
UCS	Uniaxial Compressive Strength
UCZ	Upper Copper Zone
UIG	Underground Infiltration Gallery
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USGS or USG	U.S. Geological Survey
USZ	Upper Sulfide Zone
VSEP	Vibratory Shear Enhanced Processing
WEPE	Western Pearlshell mussel
WIM	Weight-in-motion (transportation)
WLE	Water Level Elevation
WRS	Waste Rock Storage (pad)
WTP	Water Treatment Plant
WOTUS	Waters of the U.S.

ABBREVIATIONS

Ag	Silver
Al	Aluminum
amsl	above mean sea level
As	Arsenic
ATV	all-terrain vehicle
AUM	animal unit months
Ba	Barium
BACI	Before, After, Control and Impact (aquatics sampling protocol)
Be	Beryllium

BCF	bio-concentration factor
bgs	below ground surface
BTV	background threshold value
Ca	Calcium
Cd	Cadmium
cfs	cubic feet per second (rate of flow)
Cr	Chromium
cm^3	cubic centimeters
Co	Cobalt
Cu	Copper
cu ft.	cubic feet
cu yds.	cubic yards
dB	decibels, units of noise measurements
dBA	A-weighted decibel noise level, in frequency range of normal human hearing
dBC	C-weighted decibel noise levels, frequency range of “rumbles”, large fans and blasting noise
DO	dissolved oxygen
EL	Elevation
FA	fly-ash
Fe	Iron
ft.	feet
g	grams
gpd	gallons per day
gpm	gallons per minute (rate of flow)
g/t.	grams per tonne
H:V	horizontal to vertical slope ratio
ha	hectares
Hg	Mercury
HP	horse-power
in.	inch
K	Potassium
K	hydraulic conductivity
km	kilometers

kph	kilometers per hour
kW	kilowatt
L_{dn}	a day-night average noise level
L_{eq}	A-weighted equivalent noise level, in the range of human hearing
L_{max}	maximum instantaneous noise level
L_{90}	90^{th} percentile-exceeded noise level
lbs.	pounds
Lpd	liters per day
Lpm	liters per minute
Lps	liters per second
m	meters
M	million
m^3	cubic meters
Ma	Millions of years before present (as a point in time)
Mg	Magnesium
mg/L	milligram per liter; approximately equal to parts per million (ppm)
mmhos/cm	micro mhos per centimeter (measurement of electrical conductivity)
Mn	Manganese
Mo	Molybdenum
MPa	Megapascal
mph	miles per hour
µg/L	micrograms per liter; approximately equal to parts per billion (ppb)
N	Nitrogen
NO_3	Nitrate
Na	Sodium
Ni	Nickel
NP	neutralization potential
oz.	ounce
Pb	Lead
PC	Portland cement
PLS	Pure Live Seed
ppb	parts per billion; approximately equal to micrograms per liter (µg/L)

ppm	parts per million; approximately equal to milligrams per liter (mg/L)
Sb	Antimony
SC	specific conductance
s.d.	standard deviation
Se	Selenium
$SO_4^{=}$	Sulfate
sq.	square
s.u.	standard units (of pH)
Sr	Strontium
TBD	To Be Determined
TDS	total dissolved solids
Tl	Thallium
TSS	total suspended solids
U	Uranium
UG	underground
VP	viewpoint
Zn	Zinc

This Mine Operating Permit (MOP) Application has been reviewed and approved by Jerry Zieg, Vice President of Exploration for Tintina Resources Inc., who is a qualified person for the purposes of National Instrument 43-101 *Standards of Disclosure for Mineral Projects* (NI 43-101). However, readers are cautioned that this application was prepared for submission to the Montana Department of Environmental Quality Permitting and Compliance Division – Hard Rock Program for review and approval under the Montana *Metal Mine Reclamation Act*. It is not a "technical report" under NI 43-101 and may not be compliant with NI 43-101.

1 INTRODUCTION AND PROJECT OVERVIEW

Tintina herein submits this revised Mine Operating Permit Application (MOP) (Revision 3) to the Montana Department of Environmental Quality (DEQ) Air, Energy & Mining Division – Hard Rock Mining Bureau for review and approval under the Montana Metal Mine Reclamation Act. This document was first submitted to the DEQ on December 15, 2015. The DEQ commented on this original document on March 10, 2016 and Tintina revised the document and responded to DEQ's comments on Revision 1 of the MOP on September 13, 2016. DEQ provided comments on Revision 1 of the MOP on December 15, 2016 and Tintina revised the document and responded to DEQ's comments in Revision 2 of the MOP on May 8, 2017. DEQ provided comments on Revision 2 of the MOP on June 8, 2017 and Tintina revised the document and addresses DEQ's most recent round of comments in this Revision 3 of the MOP dated July 14, 2017. Specific responses to the most recent round of DEQ comments can be found in a separate table located in the last section (Section 9) of this MOP application (Revision 3).

Tintina Montana, Inc. (Tintina) a wholly owned subsidiary of Tintina Resources, Inc., proposes to develop and operate a new underground mine and mill at its Black Butte Copper Project (Project) located 15 miles (24 km) north of White Sulphur Springs in Meagher County, Montana (Figure 1.1). The proposed mine permit area is located in Sections 24, 25, and 36 in Township 12N, Range 6E, and in Sections 19, 29, 30, 31, and 32 in Township 12N, Range 7E (Figure 1.2). The Project will produce and ship copper concentrate mined from both the upper and lower zones of the Johnny Lee copper deposit. All operations will occur within a Mine Permit boundary encompassing 1,888 acres (763.9 ha) of privately owned ranch land under lease to Tintina (Figure 1.2). Total surface disturbance required for construction and operation of all mine related facilities and access roads (Figure 1.3) comprises 295.9 acres (119.7 ha) (Table 3-2).

The proposed operation will mine a total of approximately 15.3 million tons (13.9 million tonnes (Mt)) of combined copper-enriched rock and waste rock. This includes 14.5 million tons (13.2 Mt) of copper-enriched rock with an average grade of 3.04% copper, and 0.8 million tons (0.7 Mt) of waste rock. Mining will occur at a rate of approximately 1.3 million tons/year (1.2 Mt/year) or 3,640 tons (3,300 tonnes) of copper-enriched rock per day, over a mine life of approximately 19-years (including two years of construction and pre-production mining, 13 years of active production mining, and four years of reclamation and closure). The mining company will directly employ approximately 240 workers, with an additional 24 contract miners working at the site during the first four years of mining. It will require a maximum of approximately 144 sub-contracted employees during the initial 30 to 36 months of support facility construction.

All rock will be brought to surface through a single mine portal (Figure 1.3) along a decline (tunnel) with additional lower ramp access to both the upper and lower Johnny Lee zones (Figures 3.2 and 3.3). The mine portal lies approximately 128 feet (39 m) above the regional groundwater table. Four ventilation raises constructed to surface will also be collared above the regional groundwater table. One of these ventilation raises will be constructed as a secondary emergency escape way (see Section 3.6.4). Therefore, all surface access to the mine will be located well above the groundwater table to eliminate the possibility of water discharge from any of the mine workings operationally or after closure.

Mining will use a drift and fill method. Approximately 45% of the mill tailings will be mixed with cement and binder to form a paste, and used to backfill production workings during the sequential mining of drifts. This paste backfill method allows maximum extraction of copper-enriched rock without the need to leave pillars for structural support. The backfill also eliminates the risk of subsidence to surface, and minimizes groundwater contact with mineralized rock both during operations and after closure. The use of paste backfilling and the drift and fill mining method minimizes the surface area of the underground mineral deposit exposed (to a few percent) to circulating air and moving groundwater at any given time during the mine life.

Although much of the waste rock that will be trucked to surface will be non-acid generating, as a safeguard, all waste rock will be assumed to contain sulfide minerals and will be treated as potentially acid-generating (PAG). A temporary waste rock storage (WRS) facility, lined with high-density polyethylene (HDPE) geotextile, will be constructed between the portal and the mill. The WRS pad will receive all of the waste rock generated until construction of the cemented tailings facility (CTF) is completed (Figure 1.3). The construction of the CTF will use crushed and screened excavated granodiorite and/or alternatively *excavated Ynl Ex* and/or preproduction waste rock for use as a protective layer over the uppermost of its double HDPE liners. Pre-production waste rock from the WRS pad will be placed over this upper protective layer during construction to make the drainage layer within the CTF basin drain system. All future waste rock will be placed into the CTF along with the mill tailings. The temporary WRS pad will be completely reclaimed in year three. No mined waste rock will be left exposed on the surface after closure of the CTF. The CTF will be dewatered (if any is present), sealed with a cover of HDPE geotextile, and reclaimed in closure. A separate stockpile on a smaller lined pad will be constructed off of the northwest corner of the portal pad (Figure 1.3) near the end of the construction period to contain a reserve of copper-enriched rock for mill feed.

Dewatering of underground mine workings will provide all water required for mining and milling (approximately 210 gallons per minute (gpm) or 795 liters per minute (Lpm) or 0.47 cubic feet per second (cfs)). This consumptive use of water will be offset by water rights acquired under lease agreements with landowners. Excess water pumped from the mine will be treated to non-degradation standards and will be released through upland underground infiltration galleries to shallow bedrock, or into an infiltration gallery located in the Sheep Creek alluvial aquifer system. The water treatment system will consist of a double pass reverse osmosis system, with a nominal treatment rate of 500 gpm (1,893 Lpm), and a total treatment rate, with back-up RO unit of 750 gpm (2,839 Lpm). A permitted public water supply well will provide potable water.

Milling (Figure 1.3) will use a grinding/flotation process and will produce approximately 440 tons (400 tonnes) per day of copper-rich concentrate. Concentrate will be shipped by truck in closed shipping containers to a regional railhead facility in Montana. Railhead shipping locations currently being considered include those at Raynesford, Belt, Livingston, Townsend, and Harlowton. The company's final decision will be based on economic considerations at the time of shipping. The use of shipping containers eliminates the need for surface stockpiles and multiple handling stages during transport.

A process water pond (PWP), double lined with HDPE geotextile, with an underlying foundation drain and pond, will store water needed for milling. Water will be recycled between the process water pond and the mill during operations. A paste plant in the mill complex will mix fine-grained tailings from the milling process with cement for deposition both underground and in the cemented tailings facility. The plant will mix approximately 45% of the tailings with approximately 4% cement and other binders to be used as paste backfill in the underground mine workings.

The other 55% of the tailings will be mixed with 0.5 to 2% cement and other binders, which will be pumped to the cemented tailings facility where it will set up to form a non-flowable mass. The use of cemented tailings inhibits dust formation and provides added strength. The small amount of free water that collects in the CTF from cemented tailings seepage will be pumped to the PWP for reuse in the mill. Water not needed in the mill during mining operations, will be pumped directly from the PWP to the reverse osmosis (RO) water treatment facility for treatment and then released to the underground infiltration galleries.

The CTF, PWP, and brine pond cell of the CWP will use bottom liner systems comprised of a high-flow geonet-layer sandwiched between two layers of 100 mil (60 mil for the brine pond) HDPE geotextile liner. The geonet layer acts as a drain layer between the two liners. Both the CTF and the PWP facilities will incorporate foundation drains beneath the liners to remove groundwater (CTF) or vadose zone water (PWP) from beneath the facilities. This water is collected in foundation drain ponds that are either pumped back to the PWP for storage and reuse in the mill or alternatively pumped back directly to the RO water treatment plant (WTP). The CTF seepage collection system collects water that has seeped through the upper geomembrane of the CTF liner system and directs it to a smaller sump (seepage collection sump that is located in between the geomembranes), pumps inside this sump pump water to the CTF crest and discharges it back into the CTF to be collected by the CTF water reclaim system. The CFT water reclaim system collects water from inside the CTF basin drain system in a separate (wet well) sump, and pumps that water to the PWP via a discharge pipe.

The CTF and the PWP are by definition, based on their storage capacities, high hazard dams and as such are designed to contain the Maximum Probable Flood event (approximately 33 inches (84 cm) of precipitation and snowmelt in a single storm event) and to withstand the Maximum Credible Earthquake (MCE) and/or the 1 in 10,000 year earthquake event. In addition to its own storm water influx, the PWP will also have capacity to store excess storm water from the cemented tailings facility in a 1 in 500 year storm event while operationally remaining less than half full. Storm water excesses from the Contact Water Pond (CWP), PWP and the CTF are designed to quickly transfer through the water treatment system and into the underground infiltration gallery (UIG). Construction of the CTF and PWP will be overseen by three professional engineers in accordance with the Montana Metal Mines Reclamation Act (MMRA), as revised by MCA 82-4-378. A Tailings Operations, Monitoring and Surveillance (TOMS) Manual has been prepared separately for the following waste and water management systems: PWP, NCWR, and CTF that outlines regular monitoring, inspection, and reporting requirements as well as emergency response measures in the event of an upset of operating conditions as required by State law.

To reduce the risks to human health and the environment, Tintina has aggressively sought out and implemented a number of process variations and modifications to facility siting and construction. These were formulated using a Failure Modes and Effects Analysis, and resulted in the development of a number of mitigation measures. Process variations employed include using cemented paste tailings (both underground and at the cemented tailings facility), sealed shipping containers, underground grouting, and lined ditches and/or HDPE pipe for transport of contact water. Facility siting modifications used include locating mine openings above the water table, locating all facilities to reduce impacts to wetlands (<0.85 acres, 0.34 ha), and relocation of the decline to minimize the amount of sulfide-bearing rock brought to surface. Facility construction changes include foundation drains, double HDPE-lined foundations with a geonet layer between, an internal basin drain system at the CTF, designs to accommodate very large precipitation and earthquake events (and even more freeboard), and the use of foundation factors of safety well in excess of what is needed to avoid risk of a facility geotechnical failure. In addition, tailings will be transported in pipelines containing secondary containment for environmental protection, and Best Management Practices (BMPs) will be used to route storm water around the facilities to discharge points and sediment collection basins.

Tintina must obtain a groundwater appropriation permit for groundwater beneficially used in the milling process before using any groundwater. Since the Project is located in a closed basin, a mitigation plan will be prepared and submitted to the Department of Natural Resources and Conservation (DNRC) to offset potential adverse effects due to the consumptive use portion of the groundwater right. Tintina is in the process of developing a groundwater appropriation permit and corresponding draft mitigation plan. Tintina has designed an unlined Non-Contact Water Reservoir (NCWR) (Figure 1.3) as the preferred option for storing water used for mitigation by its subsequent release back to shallow groundwater by infiltration or discharge to the alluvial aquifer. Water stored in the NCWR will also be used to offset potential impacts to wetlands, if any are observed. This reservoir would be filled using water rights during the irrigation period of the year to off-set consumptive use during the non-irrigation months of the year. However, DNRC will determine how much depletion actually needs to be mitigated and therefore, the ultimate size of the NCWR to be constructed. Tintina has assumed a maximum size for purposes of determining surface disturbance and design characteristics for the mine operating permit application.

The project site currently has fifteen (15) surface water monitoring sites and nineteen (19) groundwater monitoring monitoring wells. Ongoing geochemical, weather, aquatic, and water resource monitoring will continue during construction and production. Tintina proposes an additional three (3) surface water sites, eight (8) new water quality monitor wells, water quality sampling of seven (7) existing pumping wells, and four (4) new wetland piezometers be installed during the permitting process. An additional ten (10) new monitoring wells and twenty-four (24) new piezometers are recommended for installation during construction. An additional 4 monitoring wells will be installed during closure (2 surface wells located downgradient of the underground workings and 2 within the underground mine workings). Tintina commits to the installation of all new proposed monitoring wells and piezometers (Table 6-1) during the specified time periods assuming they are approved and required by either DEQ as part of the MOP Application approval or the MPDES permitting process. Air quality, noise and aquatic monitoring will be conducted from construction, during operations and through mine closure as required by regulatory agencies.

The closure and reclamation plan has been carefully designed to insure that the site is returned to all pre-mining beneficial uses. The primary objective of these activities is to assure the physical and chemical stability of all facilities, and that water quality and quantity guidelines and regulations are maintained. No waste rock or tailings will be left exposed on surface after CTF closure is complete. Mine closure and reclamation will remove, treat, and dispose of all water from the tailings facility (if any is present), and from the process water pond, and CWP until the facilities are empty and can be reclaimed. Water treated during closure will meet non-degradation criteria, and will be discharged to an underground infiltration gallery system or to the alluvial aquifer for as long as the water treatment plant (WTP) is operational.

Closure work will involve progressive reclamation and revegetation of the embankments and any other disturbed surfaces. Closure and reclamation will focus on removal of surface infrastructure and exposed liner systems, and covering exposed tailings. Reclamation plans include removal of all buildings and their foundations and surface facilities including the portal pad, copper mineralized stockpile pad, PWP, CWP, mill site, and reservoir (NCWR). Plans also include recontouring, subsoil and soil replacement, and revegetating all the sites with an approved seed mix. Reclamation will include: 1) covering the CTF with a welded HDPE geotextile cover so that the CTF tailings are completely encapsulated; 2) covering the encapsulated CTF with fill, subsoil, and topsoil (at a slope or shape designed to preclude standing water); and 3) regrading and revegetation of the site. This report presents detailed conceptual cut and fill materials balance tables that indicates there is sufficient excess materials available from the facility excavations to fully reclaim and close the facilities either concurrently during operations or in closure at the end of the mine life, meeting or exceeding State and Federal guidelines.

Tintina plans to use the on-site WTP during construction, operations and early closure. In addition, Tintina will leave the pumps in the cemented tailings facility in early closure during monitoring. Water produced from the CTF in early closure (if any) will go directly to the WTP. This will continue into closure while water quality and flow are monitored, with gradually decreased monitoring until sufficient data are available to evidence that final closure objectives have been met. Closure objectives are expected to be attained by treatment within two years after mining and milling is completed and once facility closure activities have been sufficiently implemented. The actual water treatment phase of closure is estimated to take between seven (7) and 12.6 months to complete and will require the installation of 14 hydraulic barriers in the underground mine to control water flow and allow for efficient treatment of water. Treatment would not be required in perpetuity. Facilities can meet all water quality standards and non-degradation criteria in regional groundwater post-closure and in discharge to the infiltration galleries during construction, operations, and closure.

1.1 Project Location

The Project site is located about 15 miles (24 km) north of White Sulphur Springs (population 925), in Meagher County, Montana (Figure 1.1). The proposed mine permit area is located in Sections 24, 25 and 36 in Township 12N, Range 6E, and in Sections 19, 29, 30, 31, and 32 in Township 12N, Range 7E (Figure 1.2), The project is accessed from US 89, an all-weather State-maintained highway, by traveling west along 1.5 miles (2.4 km) of well-maintained gravel county road (Figure 1.2). Figure 1.1 is a general project location map, and Figure 1.2 presents a larger scale Site Vicinity Map showing the Mine Permit Area and deposits. Figure 1.3 is a site facility map. The coordinate system used throughout this application document is the Universal Transverse Mercator (UTM) Zone 12 North (N), and the datum is the 1983 North American Datum (NAD83), i.e., coordinates are relative to UTM Z12N NAD83.

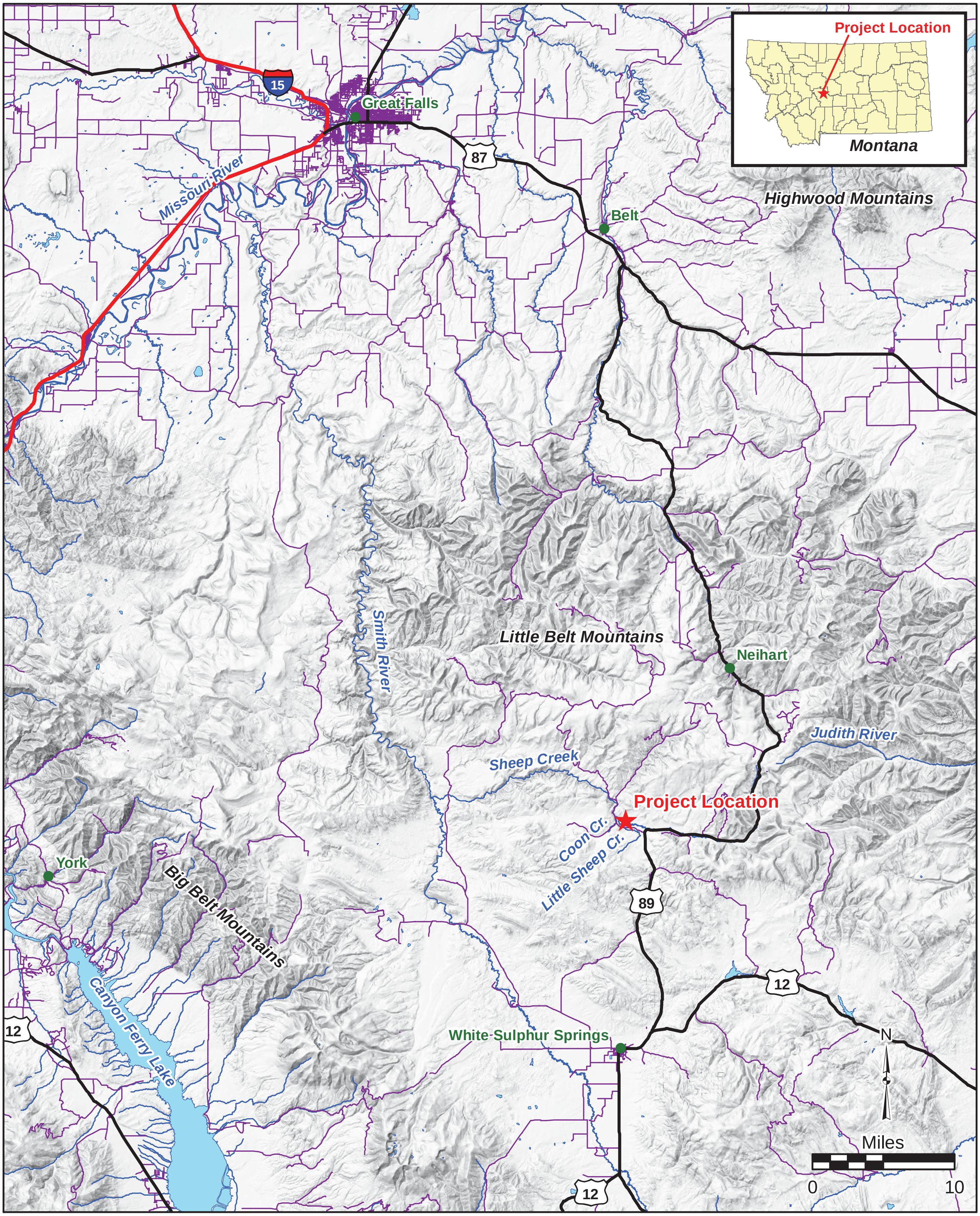
1.2 Brief Project History

Mineral exploration in the Project area began with limited small scale underground development for copper mineralization in 1894 (Weed, 1899). In the early 1900s, focus switched to development of iron resources in locally extensive gossans (Goodspeed, 1945; Roby, 1950). R & S Mining Company began production of small quantities of iron ore from Iron Butte, west of the Project area, in 1972. CRH Old Castle is the current operator of this iron mine, which operates on a seasonal basis.

Homestake Mining Company carried out the first modern exploration work for non-ferrous metals on the property in 1973 and 1974. Cominco American Inc. (CAI) resumed exploration in the district in 1976 and joint ventured (JV) the property with Broken Hill Proprietary Company Limited (BHP) in 1985. The Cominco/BHP JV drilled the discovery hole for the “Johnny Lee” deposit beside Johnny Lee’s (a former homesteader and miner) long abandoned root cellar. BHP operated the joint venture through early 1988, after which time operatorship reverted back to CAI. After reclaiming all exploration disturbances, CAI dropped the leases in the mid-1990s. The CAI and the CAI/BHP joint venture completed approximately 66 exploration core holes in the current lease areas (Resource Modeling Inc., 2010).

Tintina acquired the rights to mine the property in May of 2010, and has conducted surface exploration activities at the Project site under Exploration License No. 00710 issued by DEQ since September 2010. Section 1.5 below contains descriptions of these exploration activities. Tintina has, through extensive core drilling, established ‘Inferred’, ‘Indicated and ‘Measured’ resources, described further below in the Mineral Resources section (Section 1.4.6).

On November 7, 2012, Tintina submitted an application to amend its exploration license to gain underground access to the mineral deposit by constructing an exploration decline into the upper Johnny Lee zone. DEQ conducted an Environmental Assessment (EA) of Tintina's application to amend its exploration license under the Montana Environmental Policy Act (MEPA). The environmental review culminated in the January 2014 issuance of the Final Mitigated EA and approval by DEQ to proceed with construction of the exploration decline. However, Tintina decided not to construct the decline and to proceed directly to submission of an Application for a MOP (this document) for consideration by DEQ.



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Prepared by Tetra Tech, Inc. 2015

TINTINA RESOURCES

Legend

- Project Location
- City
- Interstate
- U.S. Route
- Local Road
- Stream
- Lake

Figure 1.1

Project Location

Black Butte Copper Project

Meagher County, Montana

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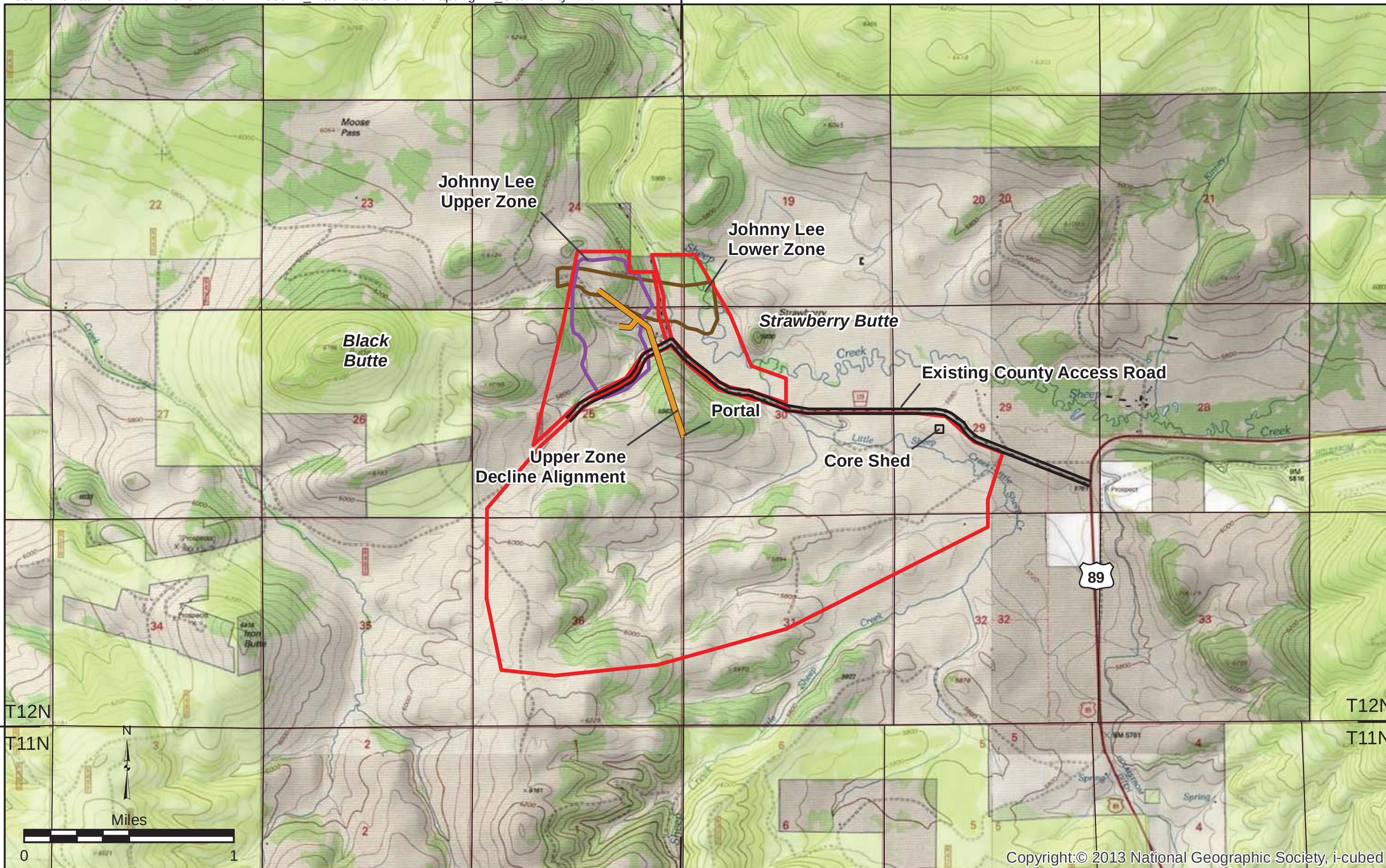

Prepared by Tetra Tech, Inc. 2016

Legend

- Decline Alignment
- Existing Road
- Mine Permit Boundary
- Lower Zone
- Upper Zone
- US Forest Service

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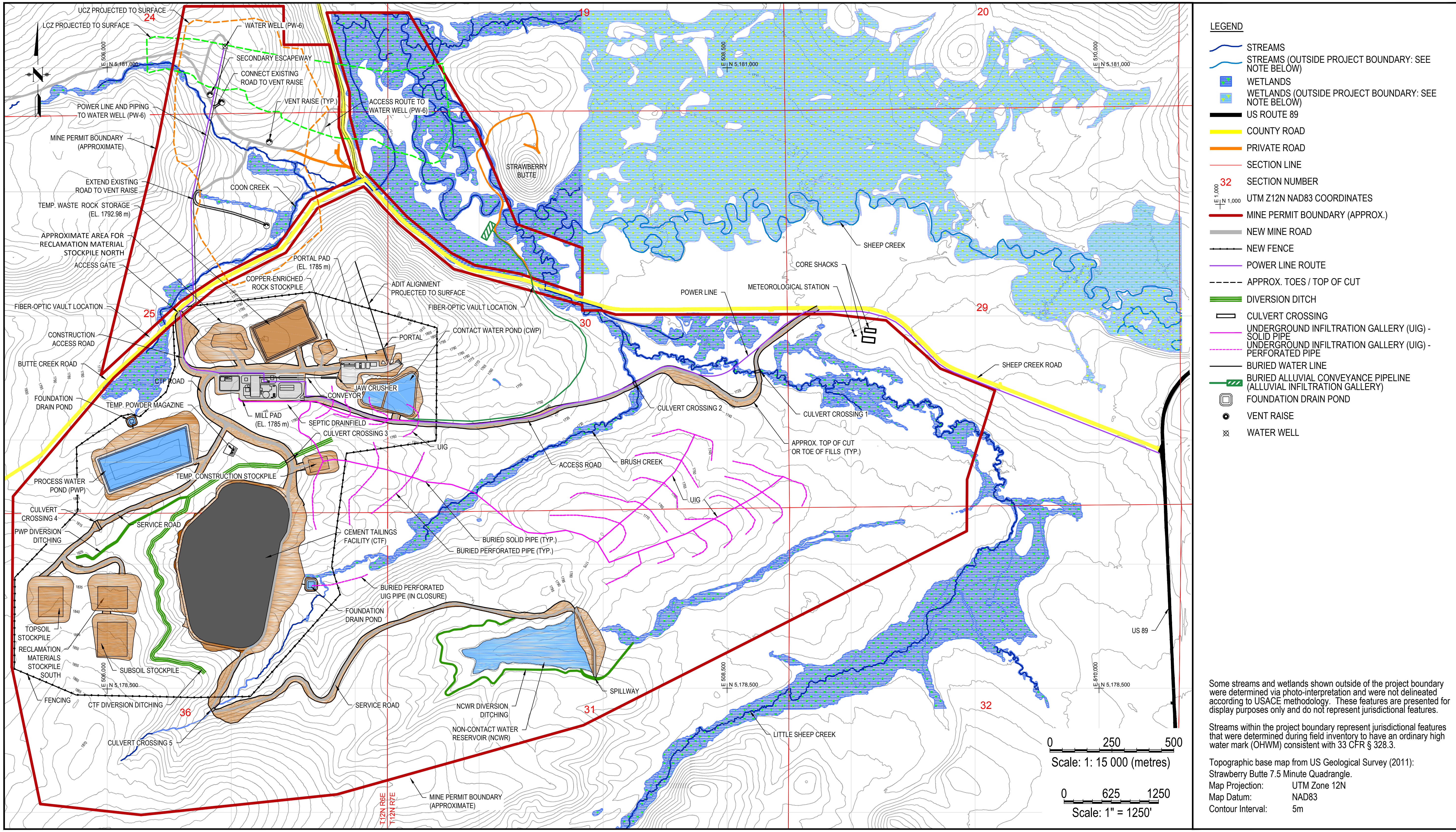
Figure 1.2

Site Vicinity Map with Mine Permit Boundary

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana



Prepared by Tetra Tech Inc. (Revised July 2017)

FIGURE 1.3

Facilities Site Plan

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana

TINTINA RESOURCES

1.3 Land Status

All activities proposed in the Operating Permit Application and all surface disturbances will occur on privately owned ranch land (Figure 1.2 shows private land shaded in a light grey overlay, as well a plan map of the upper and lower Johnny Lee deposits). Tintina has entered into agreements with surface, mineral, and water rights owners on 7,684.28 acres (3,110 ha) of private lands, and also controls 525 mining claims contiguous with the fee simple (leased) lands (Figure 1.4). Figure 1.4 also shows the proposed mine permit boundary and the location of the Johnny Lee deposit.

Tintina acquired its initial surface and mineral leases in May of 2010 on approximately 4,720 acres (1,908 ha) of ground in the Project area with the Bar Z Ranch (Figure 1.4). Later that year, the Holmstrom Ranch lease was acquired encompassing an additional 2,120 acres (858 ha). This lease has recently changed ownership and is now called the Short and Davis Lease (Figure 1.4). In 2011, Tintina acquired a mining and surface lease for a 2,970-acre (1,202 ha) property contiguous with the Bar Z Ranch called the Buckingham, Johnson, and Bodell lease (Figure 1.4).

Tintina's leases include land located in sections 23, 24, 25, 26, 27, 28, 30, 32, 33, 34, 35, and 36, Township 12 North, Range 6 East; sections 19, 29, 30, 31, and 32, Township 12 North, Range 7 East; sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14, Township 11 North, Range 6 East; and sections 5, 6, 7, 8, and 18, Township 11 North, Range 7 East, and sections 1 and 12 in Township 11 North, Range 5 East (Figure 1.4).

Tintina has established its legal right to explore for and develop mineral resources in the Mine Permit Area by virtue of its mineral rights lease agreement with mineral right owners. Table 1-1 lists names and addresses of all surface rights owners not only within the proposed Mine Permit Area but also within a 0.5-mile (0.8 km) distance around the Permit Boundary along with all mineral rights owners within the permit area. As Figure 1.4 and Table 1-1 indicate, all of the surface rights within the permit area are held by only two owners: Bar Z Ranch, Inc. and Arthur and Joy Short. As discussed above, Tintina secured surface-use and mining lease agreements for those lands in 2010. In addition, Tintina was able to secure surface-use and mining lease agreements with all surface rights owners within 0.5 miles around the permit boundary except Castle Mountain Ranch and Tim and Cheryl McGuire (Table 1-1). Tintina also secured mining leases with all mineral rights owners within the mine permit area (Table 1-1). There is no federally–owned land within the proposed Mine Permit Boundary Area, although there are federally-owned lands within 0.5 miles of the permit boundary (light green shaded areas on Figure 1.2).

Table 1-1. Surface and Mineral Rights Ownership and Right to Mine Sources

Owner	Address	Legal Right to Mine
Surface rights within a 0.5-mile radius of the permit area		
Bar Z Ranch, Inc.	122 Birch Creek Road, White Sulphur Springs, MT, 59645	Secured by surface use agreement
Steve Buckingham	859 Montana Highway 30, White Sulphur Springs, MT 59645	Secured by surface and mining lease
Castle Mountain Ranch	65 Castle Mountain Estate, White Sulphur Springs, MT 59645	Not applicable - property outside of permit area and not under lease
Tim and Sheryl McGuire	256 Ramspeck Lane, White Sulphur Springs, MT 59645	Not applicable - property outside of permit area and not under lease
David Hanson	P.O. Box 92, Willow Creek, MT 59760	Secured by surface use agreement
Arthur and Joy Short	P.O. Box 206, White Sulphur Springs, MT 59645	Secured by surface and mining lease
U.S. Forest Service	204 W Folsom Street, White Sulphur Springs, MT 59645	Secured by Tintina-owned mining claims
Surface rights within the permit area		
Bar Z Ranch, Inc.	122 Birch Creek Road, White Sulphur Springs, MT, 59645	Secured by surface use agreement
Arthur and Joy Short	P.O. Box 206, White Sulphur Springs, MT 59645	Secured by surface and mining lease
Mineral rights within the permit area		
Don Davis (joint owner with Tom Davis)	810 Montana Avenue, Deer Lodge, MT 59772	Secured by mining lease
Tom Davis (joint owner with Don Davis)	Address not available, refer to Don Davis' address	Secured by mining lease
Donna Dupea	303 Birch Creek Road, White Sulphur Springs, MT 59645	Secured by mining lease
John Hanson	122 Birch Creek Road, White Sulphur Springs, MT 59645	Secured by mining lease
Robert Hanson	3718 U.S. Highway 12, White Sulphur Springs, MT 59645	Secured by mining lease
Steve Buckingham (joint owner with Johnson and Bodell)	859 Montana Highway 30, White Sulphur Springs, MT 59645	Secured by surface and mining lease
Kathy Johnston (joint owner with Buckingham and Bodell)	684 Smith River Road, White Sulphur Springs, MT 59645	Secured by surface and mining lease
Marilyn Bodell (Joint owner with Buckingham and Johnston)	P.O. Box 402, White Sulphur Springs, MT 59645	Secured by surface and mining lease
Arthur and Joy Short	P.O. Box 206, White Sulphur Springs, MT 59645	Secured by surface and mining lease

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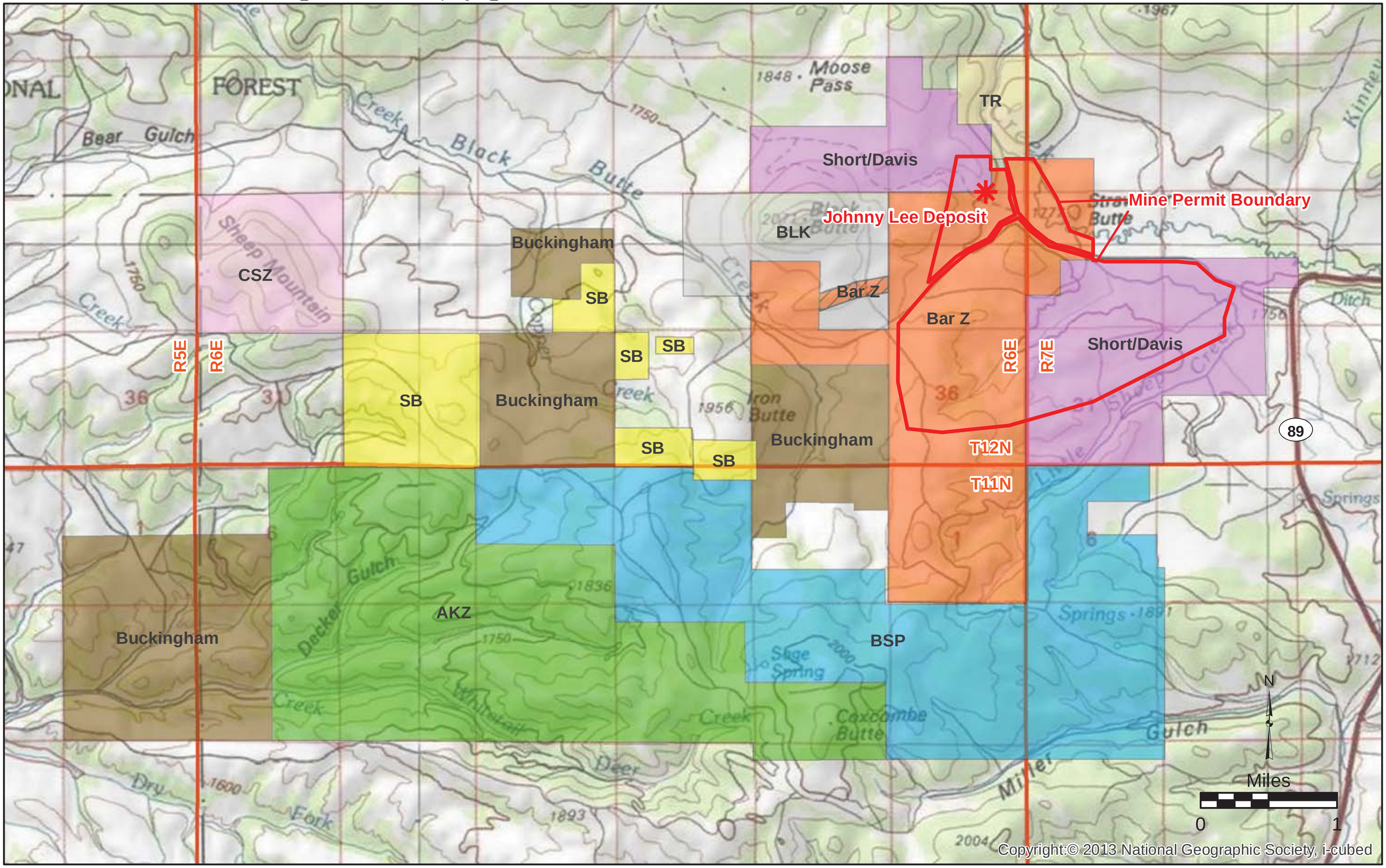


Prepared by Tetra Tech, Inc. 2016

Legend

- BSP Claims (USFS S & M)
- SB Claims (USFS S & M)
- AKZ Claims (USFS S & M)
- CSZ Claims (USFS S & M)
- BLK Claims (USFS S & M)
- TR Claims (USFS S & M)
- Bar Z Ranch (S) Hanson, Hanson, Dupea (M)
- Bar Z Ranch (S)
- Short/Davis (S & M)
- Buckingham (S) Johnson, Buckingham, Bodell (M)

TINTINA RESOURCES

Figure 1.4

Tintina Land Position Map

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana

1.4 Geology

Resource Modeling, Inc. (Resource Modeling, Inc, 2010) summarized the geologic setting, deposit types, and mineralization in the Project area. The following subsections contain a modified summary, with the addition of more recent information. Figure 1.5 shows a geologic map of the Project area, Figure 1.6 includes a stratigraphic section, and Figure 1.7 shows a geologic cross-section through the Project area. Topography in the project area is from the USGS website: viewer.nationalmap.gov; 2011 Strawberry Butte 7.5 Minute Quadrangle.

1.4.1 Regional Geologic Setting

The copper deposits of the Project area occur in middle Proterozoic (~1.4 billion years old) sedimentary rocks of the Belt Supergroup (Zieg and Leitch, 1993). During subsidence and filling of the Belt sedimentary basin, a deep water calcareous shale facies (Newland Formation) was deposited in the Helena embayment (a trough-like seaway which extended eastward into the craton through central Montana) (Godlewski and Zieg, 1984). The northern depositional boundary of the deeper water sediments of the Helena embayment lay along the present day southern flank of the Little Belt Mountains, north of White Sulphur Springs, Montana (Figure 1.1). During the Cretaceous Laramide orogeny (approximately 65 million years ago), renewed thrust faulting along the ancestral northern margin of the Helena embayment formed the Volcano Valley fault (*VVF*) (Winston, 1986). Tertiary igneous rocks intrude Paleozoic rocks and Belt Supergroup rocks in the region; Tertiary sedimentary rocks have also been identified. The Black Butte copper deposits lay along the northern margin of the Helena embayment, and along the reactivated Volcano Valley fault zone (Figure 1.5).

1.4.2 Local Geologic Setting

The Newland Formation shale hosts the Black Butte copper deposits (Figure 1.6). It's evenly laminated shale formed from deposition of microturbidites (small-scale turbidity or density flow deposits) in a sub-wave base depositional setting. Debris flow conglomerates occur in the sedimentary section (Resource Modeling, Inc., 2010) and record larger mass wasting events from a shallow water shelf in the Newland Formation along the northern margin of the embayment. Alluvial deposits lie beneath the stream channels and along the axis of larger drainages. They rest on the thick sequence of dolomitic and silicic shales of the Proterozoic Newland Formation (Figure 1.6) that dip gently to the southeast. The above-described prominent east-west-trending, southerly dipping low-angle Volcano Valley Fault (*VVF*) forms a northern boundary to Newland Formation exposures within the Project area (Figure 1.5). Paleozoic (Middle Cambrian) Flathead sandstone (Figure 1.6) outcrops at the surface on the north side of the *VVF.* It lies unconformably over Proterozoic Newland Formation, Chamberlain Formation shales, Neihart Formation quartzite, and Precambrian crystalline basement rock (Figure 1.7).

A separate northeast verging segment of the *VVF* called the Black Butte Fault (*BBF*) lies south of the Johnny Lee copper deposit (Figure 1.5). The area between the *BBF* and the *VVF* contains all of the known copper resources within the Project area. Tertiary igneous rocks intrude the lower part of the Newland Formation mostly south of the *BBF* but have not been identified in the deposit areas.

In June of 2017, a field mapping and technical study of the project area was undertaken by the Whitehall Geogroup, Inc. (2017, and Appendix W) to determine if there is evidence of Quaternary faulting activity in the general area of the cement tailings facility at the proposed Black Butte Copper Project site. Previous workers have mapped faults in this area that offset Mesoproterozoic to earliest Eocene rocks, but the youngest documented activity on these faults occurred during the late Cretaceous and early Eocene.

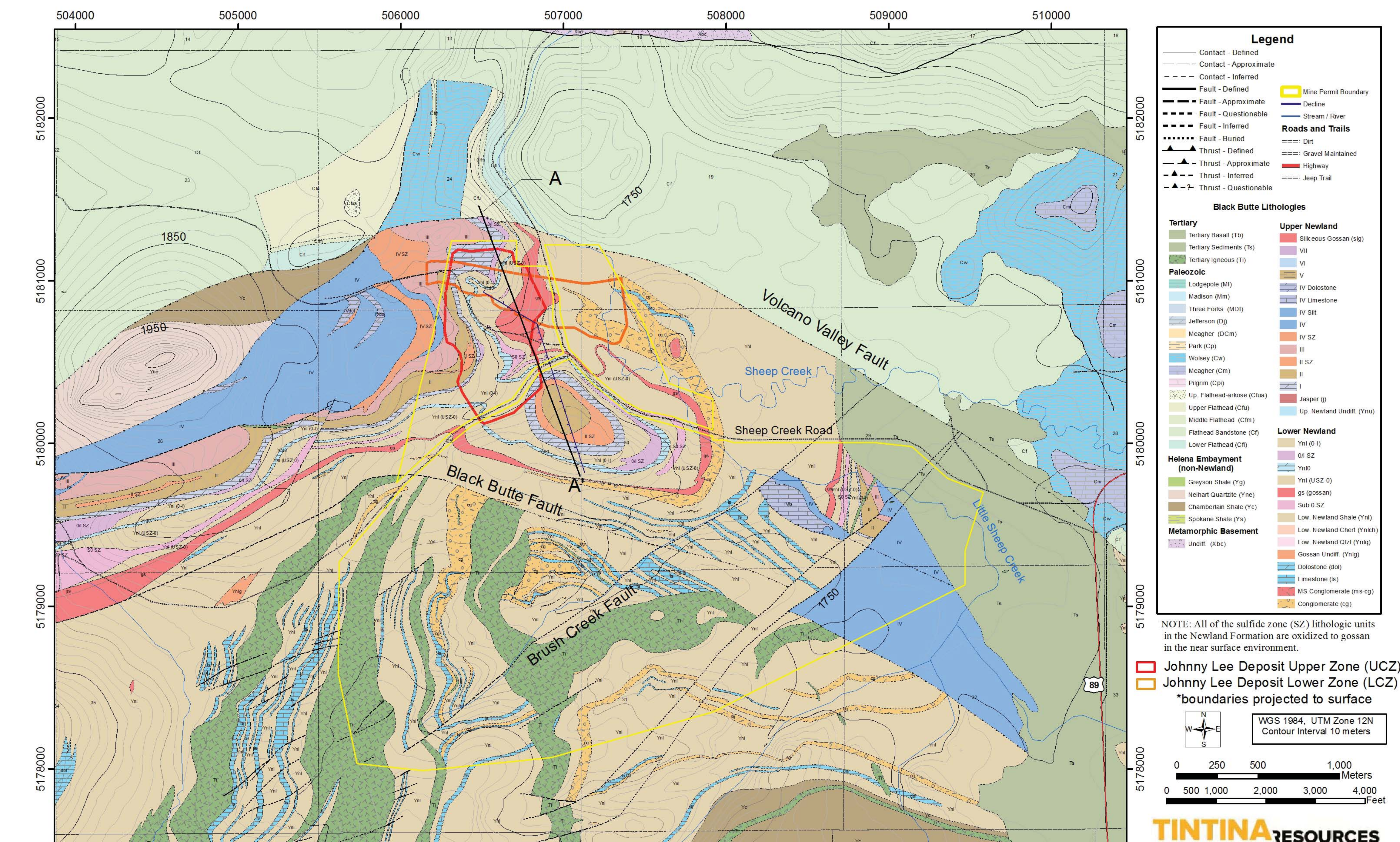
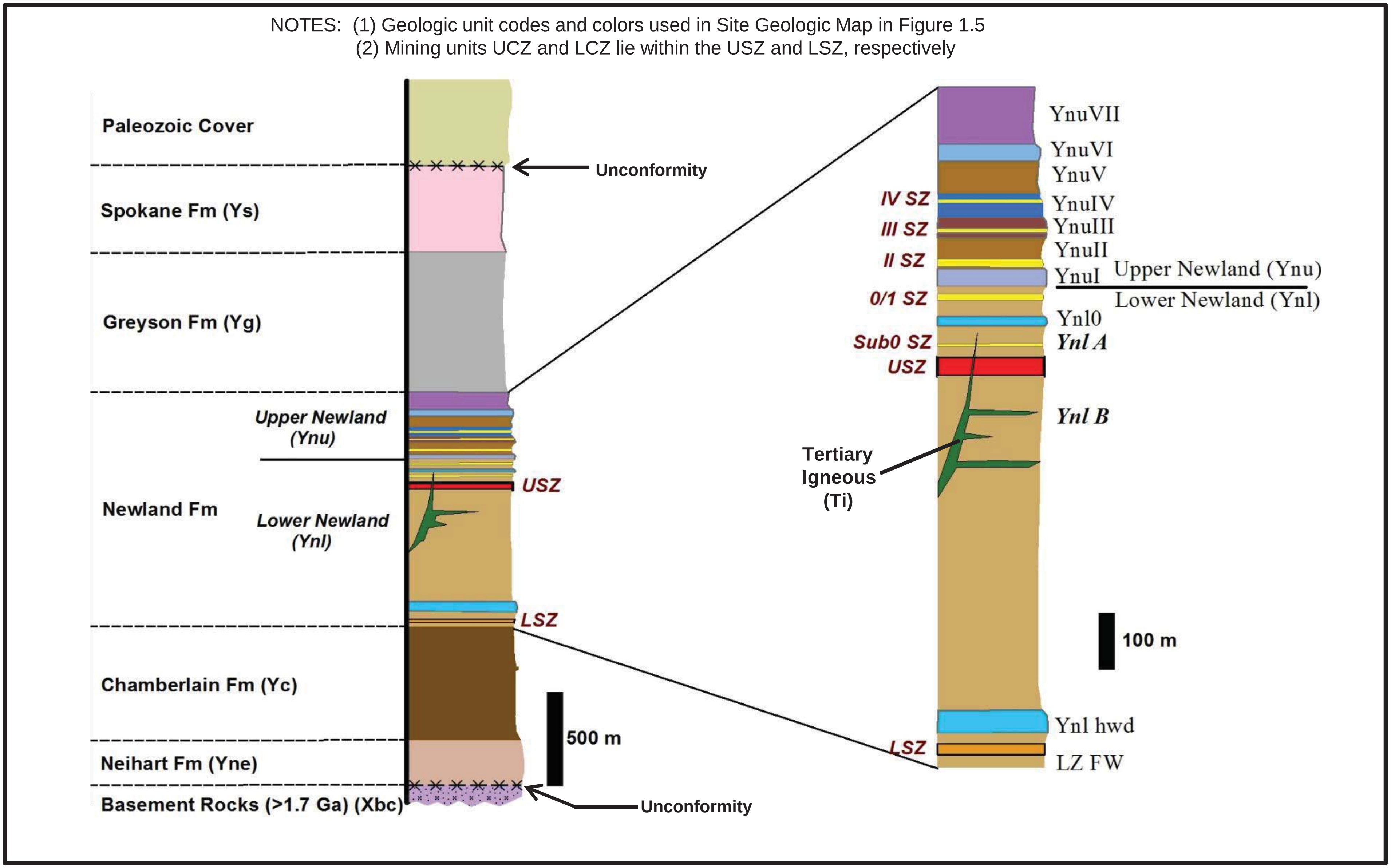


Figure 1.5
Site Geologic Map Showing Copper-Rich Deposits
Black Butte Copper Project, Meagher County, MT



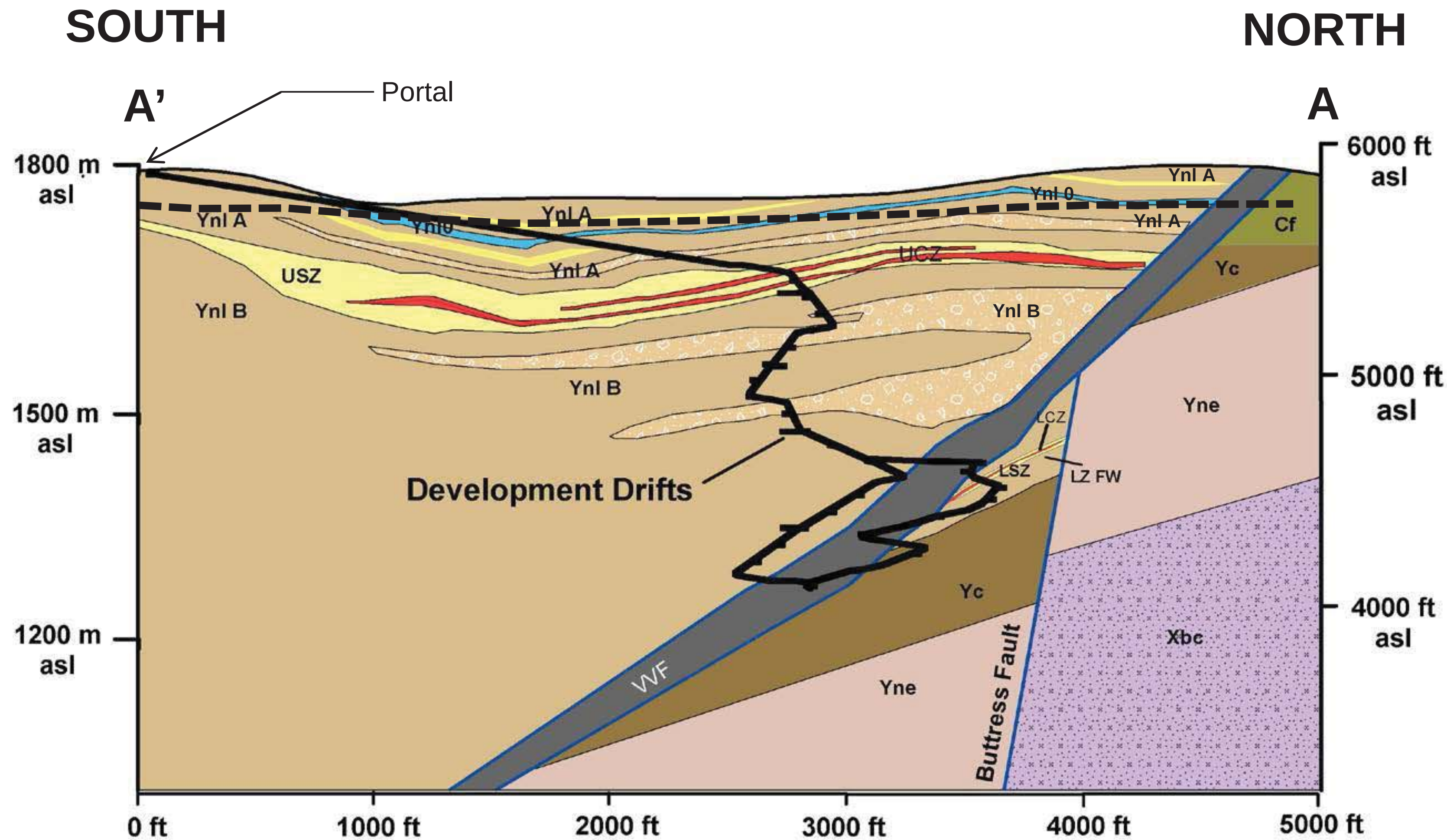
Prepared by: Tintina Resources (2016)

TINTINA RESOURCES

Abbreviations: Fm = Formation; FW = footwall; hwd = hanging wall dolomite; SZ = Sulfide Zone
LZ FW = Lower Zone Footwall

Other geologic units not listed on this stratigraphic section but that are included in Figure 1.5 site geologic map include: Ts (Tertiary sediments) and Paleozoic cover units (Cw = Wolsey Formation; Cf = Flathead sandstone; cg = conglomerate interbeds in Ynu and Ynl; and ls = limestone interbeds in the Ynu and Ynl. The Ynl unit is divided into the Ynl A and the Ynl B subunits relative to the location above or below the USZ, respectively.

Figure 1.6
Stratigraphic Section
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana



Notes: (1) See Figures 1.5 and 1.6 for lithology descriptions
(2) See Figure 1.5 for location of cross-section line A-A'

VVF = Volcano Valley Fault LZ FW = Lower Zone Footwall

Top of groundwater table surface as of November 2016

Prepared by: Tintina and Hydrometrics (2017)

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Figure 1.7

Generalized Geologic Cross-Section A-A' with Ore Deposits and Ramp Access

Mine Operating Permit Application

Meagher County, Montana

Geologic mapping done by others and in this study indicates that there is no evidence of these older faults or any new faults being active during the Quaternary period. This conclusion is supported by geologic field evidence of Cenozoic deposits which demonstrates that these deposits are not disrupted by faulting. It is also supported by LiDAR data from which a hill shade-image was generated. Northeast-trending features can be seen on the hill-shade image, but these features do not offset mapped Quaternary deposits (the Quaternary Period began about 2.6 million years ago). Additionally, no other fault-like features crossing the Cenozoic units (the Cenozoic Era began about 66 million years ago) were identified on the hill-shade image.

The Johnny Lee copper deposit consists of two stratabound lenses of mineralization, an upper copper zone (*UCZ*) and lower copper zone (*LCZ*), each contained within the Upper and Lower Sulfide Zones (*USZ and LSZ* respectively) of the lower part of the Newland Formation (Figure 1.6 and Figure 1.7). The *UCZ* lies at a depth of approximately 90 to 625 feet (30 to 190 m) below ground surface (bgs) and occurs within shale and dolostone of the upper part of the lower Newland. The southward dipping *VVF* cuts through the entire Newland Formation. A thin slab of the lower part of the Newland Formation lies below the *VVF* and contains the *LCZ,* which is at a depth of approximately 985 to 1,640 feet (300 to 500 m) below ground surface (Figure 1.7). The *LCZ* and enclosing lower part of the Newland Formation shale lie on the Chamberlain Formation.

The Buttress Fault carries both the Chamberlain and Newland Formation shales on its south side downward against Precambrian crystalline basement rocks (gneiss) and Neihart Formation quartzite on its north side (Figure 1.7). The Volcano Valley Fault truncates the Buttress Fault, and Cambrian sedimentary rocks (including the Flathead sandstone and the Wolsey Formation) cover it to the north such that it has no surface expression (Figure 1.5). The Buttress fault likely has a Proterozoic age.

The Newland Formation may be separated into upper (*Ynu*) and lower (*Ynl*) subunits (Figure 1.6) in the immediate deposit areas (north of the Black Butte Fault). In addition, the lower Newland has been further informally separated into *Ynl A* and *Ynl B* subunits (Figure 1.6) relative to their location above and below the Upper Sulfide Zone, respectively. The *Ynl A* and *Ynl B* units are largely used in this MOP application and its associated baseline studies to define portions of the geologic section based on geochemical subunits (see Section 2.4.2 and Table 2-20) and hydro-stratigraphic subunits (see Section 4.1.2 and Figure 4.4). The use of these units is a matter of convenience for topical studies, designed to be used only in the vicinity of the Johnny Lee deposit zones, and is not intended to have any larger regional scale geologic significance.

1.4.3 Deposit Type

Geologists classify the Black Butte copper deposit as a sediment-hosted deposit. Bedded pyrite shows higher concentrations in several discrete, semi-continuous, and laterally extensive stratigraphic horizons or sulfide zones (Figure 1.6) that locally contain copper enrichments. The sulfide zones exposed in the near-surface environment as shown in Figure 1.5 are typically altered to gossan (as a result of intense oxidation and leaching of former sulfide minerals) consisting of iron-oxide rich (i.e. goethite) and/or quartz minerals.

1.4.4 Mineralization

Bedded pyrite horizons within dolomitic shale of the Lower Newland Formation host tabular sheets of copper mineralization. Exploration drilling has outlined two separate lenses containing copper resources which are called the Johnny Lee Upper Copper Zone (*UCZ*) and the Johnny Lee Lower Copper Zone

(*LCZ*). Below are descriptions of both the copper zones and the more widespread host sulfide halo, i.e., the Upper Sulfide Zone (*USZ*) and the Lower Sulfide Zone (*LSZ*).

1.4.4.1 Johnny Lee Upper Sulfide Zone

The Johnny Lee Upper Sulfide Zone (*USZ*) consists of a lens of fine-grained bedded pyrite (FeS_2) as thick as 285 feet (87 m), and containing two or three chalcopyrite-bearing ($CuFeS_2$) horizons all capped by a barite ($BaSO_4$)-rich pyritic stratigraphy. Himes and Petersen (1990) describe microscopic textures and various sulfide minerals (primarily from copper-enriched horizons) and Graham and others (2012) and White and others (2013) have completed more recent work. Pyrite occurs as laminations and beds of very fine-grained pyrite, as micro-crystals, and spheroidal aggregates (1 to 25 microns in diameter). Pyrite and rarely marcasite (FeS_2) aggregates contain rims, patches, and sometimes interior cores of chalcopyrite and tennantite ($Cu_3(As,Sb)S_8$) and in many cases amorphous Cu, Co, Ni, and As-rich material. Chalcopyrite occurs as coarser grained veinlets and clots, in parallel bedded layers and bands, in quartz veinlets, and in barite veins and masses.

While local silicification occurs within the *USZ*, most of the copper mineralization occurs within unsilicified bedded pyrite. The *USZ* zone reaches its greatest thicknesses in the south central portion of the Johnny Lee deposit. Strontium-rich minerals celestine ($SrSO_4$) and strontianite ($SrCO_3$) occur in some places toward the base of the *USZ* and below the copper-enriched horizons. Barite concentrations cap the copper zone, and include a sulfide-free shale horizon called the 'barite marker horizon'.

1.4.4.2 Johnny Lee Lower Sulfide Zone

The Johnny Lee *LSZ* lies in the footwall (below) the southward-dipping *VVF* (Figure 1.6). Johnny Lee *LSZ* mineralization consists of pyrite and rare marcasite, with high concentrations of chalcopyrite and local occurrences of siegenite ($(Ni,Co)_3S_4$) and cobaltite (CoAsS). The Johnny Lee Lower Sulfide Zone contains no identifiable barite or strontium-rich minerals. Coarse-grained dolomite alteration is abundant on the margins and above the pyritic zone. Silicification overprints much of the Cu-mineralized area, as well. A silicified debris flow conglomerate underlies the *LSZ* with disseminated chalcopyrite, and chalcopyrite also occurs in quartz veinlets. Most sulfide textures show replacement of both preexisting dolomite alteration and of earlier generations of sulfide mineralization. Some pyrite is bedded, even at the base of the *LSZ.*

The Volcano Valley Fault dips more steeply south than the underlying *LSZ* and truncates the zone (Figure 1.7) to form its south boundary. The Buttress Fault truncates the *LSZ* on the north. Because of fault truncations on its north and south, the *LSZ* retains little evidence of its presumably broader scale mineralogical zoning patterns.

1.4.5 Copper Deposit Geometry

The Johnny Lee Upper Copper Zone *(UCZ)* comprises 78% of the total tonnage of the Johnny Lee deposit copper resource. The *UCZ* measures 3,280 feet (1,000 m) in a north-south direction and approximately 2,165 feet (660 m) in an east-west direction (Figure 1.6), and ranges in depth from 90 to 590 feet (30 to 180 m) from the surface. The *UCZ* is a flat, tabular deposit that ranges in thickness from 10 to 85 feet (3 to 26 m). The deposit varies in dip from 0° to 20° to the west. In some areas the mineralized zone consists of a single lens. In other areas it consists of two sub-parallel lenses separated by 6 to 53 feet (1.8 to 16 m) of lower grade material.

The Lower Copper Zone (*LCZ*) comprises 22% of the total tonnage of the Johnny Lee copper resource. It measures approximately 3,300 feet (1,005 m) from west to east, and ranges from 160 to 660 feet (49 to 201 m) from north to south (Figure 1.6). The *LSZ* dip varies from 20° to 37° to the south and ranges in depth from 985 to 1,640 feet (300 to 500 m) from surface. The mineralized zones range in thickness from 8 to 57 feet (2.5 to 17.3 m).

1.4.6 Mineral Resources

Figure 1.6 and cross-section Figure 1.7 illustrate the location of both the Upper and Lower Copper Zones of the Johnny Lee Deposit. Resource Modeling, Inc. (in Tetra Tech, 2013a) recently recalculated mineral resources (February 2013) using 2010 through 2012 drill data including drill hole logs, geologic correlations, and assays to create a block model of the deposit zones.

Table 1-2 presents the Measured and Indicated copper resources of the Johnny Lee deposit upper and lower zones. A measured bulk density value of 3.99 g/cm^3 (8.03 cubic ft./ton), a cutoff grade of 1.6% copper, a copper price of US$2.75 per pound ($6.05 per kg), and an estimated copper metallurgical recovery of 81% was used for the UCZ. A measured bulk density of 3.49 g/cm^3 (9.18 cubic ft./ton), a cut-off grade of 1.5% copper, a copper price of U.S. $2.75 per pound ($0.45 per kg), and an estimated copper recovery of 84% was used for the *LCZ*.

Table 1-2. Measured and Indicated Copper Resources of the Johnny Lee Deposit

	Copper Cutoff (%)	Tonnes/ (Tons) (000)	Copper (%)	Copper Lbs. (M)	Cobalt (%)	Cobalt Lbs. (M)	Silver g/t.	Silver oz. (000)
UCZ Measured	1.6	2,659 (2,931)	2.99	175	0.118	6.9	16.3	1,393
UCZ Indicated	1.6	6,520 (7,188)	2.77	398	0.125	18.0	15.5	3,249
LCZ Indicated	1.5	2,387 (2,631)	6.40	337	0.033	1.7	4.5	345
Avg. or Total	**1.6**	**11,566 (12,749)**	**3.57**	**910**	**0.100**	**26.6**	**13.4**	**4,987**

Note: Resource data from Updated NI 43-101 Technical Report and PEA (Tetra Tech, 2013a)

1.5 Work Completed to Date under Exploration License

Tintina acquired the property in May of 2010 and has conducted surface exploration activities at the Project site under Exploration License No. 00710 since that time. The Project is currently approved and bonded for surface disturbances related to drilling various types of borings and test pit excavations for mineral exploration, groundwater monitoring, and for hydrologic, geotechnical, metallurgical, and soil testing.

Tintina has used surface drilling methods to complete a total of 205 core holes (including metallurgical and geotechnical test holes) to define the mineral resources and estimate the feasibility of mining and milling the copper deposits. Several rounds of ongoing exploration drilling have been approved over time by DEQ following the submittal of a “Notice of Resumption of Exploration Activities” by Tintina. Tintina has hydraulically plugged 193 of these holes in accordance with ARM 17.24.106 to prevent aquifer cross contamination. Twelve drill holes remain open for use as water level observation wells for hydrologic testing and characterization of aquifers.

Between 2011 and 2013, Tintina drilled a total of twelve (12) groundwater monitoring wells, including eight paired wells with one completion in surficial material and an adjacent well completed in bedrock. Ten pumping wells were also drilled to determine groundwater levels, to collect geologic samples, and primarily to conduct pump tests to define bedrock unit aquifer characteristics. A licensed water well driller drilled and completed these wells in accordance with State regulations. In addition, Tintina installed 12 shallow piezometers in alluvial valley fill sediment or in wetlands to monitor seasonal changes in water levels, and to test for draw down properties during pump testing of nearby bedrock wells. The Water Resources Baseline section (Section 2.2) presents a map showing locations of environmental test wells and piezometers (Figure 2.3), and a table listing sampling frequency (Table 2-7). In 2014 and 2015, Tintina completed 21 relatively shallow geotechnical drill holes and excavated 39 test pits to evaluate foundation materials underlying proposed and alternate facility locations (Figure 3.13). Other excavations include a number of small soil test pits for soil sampling and infiltration testing. In March 2016 Tintina completed four additional monitoring wells inside the proposed CTF footprint to collect additional groundwater data.

Surface disturbances related to exploration, environmental, and geotechnical drill holes, and access roads and drill pads to date have totaled 6.0 acres (2.4 ha), all of which have been reclaimed. The reclamation includes initial stockpiling of soil, recontouring of drill sumps, pads, and access roads, replacing stockpiled soil, and revegetation. All temporary disturbances have been recontoured and revegetated in accordance with State requirements, and seeded with a seed mixture approved by DEQ. All funds posted for reclamation bonding since the initiation of the project remain in place with DEQ.

1.6 Regulatory Compliance

This Operating Permit Application has been designed to meet the requirements of the Montana Metal Mines Reclamation Act (Title 82, Chapter 4, Part 3, MCA) and the rules and regulations governing the act. Compliance with regulatory requirements is cross-referenced with components of this Operating Permit Application in Table 1-3.

Table 1-3. Permit Application Cross-Referenced with Regulatory Compliance

SECTION	RULES (ARM)/ACT (MCA) CITATION
1.0 INTRODUCTION	
1.1 Project Location	ARM 17.24.115(k)
1.2 Brief Project History	MCA 82-4-337(1)(a)
1.3 Land Status	MCA 82-4-335(5)(f) through (h)
1.4 Geology	ARM 17.24.116(3)(i)
2.0 EXISTING CONDITIONS/ ENVIROMENTAL BASELINE STUDIES	
2.1 Climate, Metrological Data & Air Quality	ARM 17.24.116(3)(a)
2.2 Water Resources	
2.3 Wetlands Resources	
2.4 Environmental Geochemistry	
2.5 Soil Resources	
2.6 Terrestrial Wildlife Resources	ARM 17.24.116(3)(a)
2.7 Aquatic Resources	
2.8 Vegetation Resources	MCA 82-4-335(5)(f) through(h)
2.9 Cultural Resources	
2.10 Socio-economic Resources	
2.11 Noise	
2.12 Transportation Resources	
2.13 Land Use	
3.0 OPERATING PLAN	
3.1 Introduction	ARM 17.24.116(3)
3.1.1 Mine Permit Boundary	ARM 17.24.116(3)(d) and (e)
3.1.2 List of Facilities with Surface Disturbance Acres	ARM 17.24.116(3)(d)

SECTION	RULES (ARM)/ACT (MCA) CITATION
3.2 Underground Mine Operations and Mining Methods	ARM 17.24.116(3)(f)
3.2.2 Tintina's Underground Mine Plan	
3.2.2.6 Mining Equipment	ARM 17.24.116(3)(j)
3.3 Mineral Production	
3.3.1 Processing Method	ARM 17.24.116(3)(g): ARM 17.24.116(3)(p)
3.3.2 Mining Operations and Schedule	
3.3.3 Mill Support Facilities	
3.4 Mine Site – General Construction	
3.4.1 Overview and Disturbance Acres	
3.4.2 Construction of Facilities	
3.5 Engineering Evaluations	
3.51 Geotechnical Foundation Evaluations	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.5.2 Design Standards	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, 82-4-342 and 82-3-378
3.5.3 Hazard Potential Classifications	
3.5.4 Seismicity	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.5.5 Stability Analysis	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, 82-4-342 and 82-4-378
3.5.6 Longevity of HDPE Geomembranes	
3.5.7 Seepage Analysis	
3.5.8 Tailings Characteristics	ARM 17.24.116(3)(d), MCA 82-4-335(5)(n)
3.5.9 Binder Sources, Cemented Tailings Paste Suitability, and Laboratory Test Results	
3.6 Infrastructure Support and Waste and Water Management Facilities	
3.6.1 Roads	ARM 17.24.116(3)(h) & (r), MCA 82-4-335(5)(i)
3.6.2 Power and Powerlines	
3.6.3 Portal Pad	
3.6.4 Ventilation Raises	
3.6.5 Temporary Waste Rock (WRS) & Operational Storage	ARM 17.24.116(3)(d), MCA 82-4-335(5)(n)
3.6.6 Process Water Pond (PWP)	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, and 82-4-342
3.6.7 Contact Water Pond (CWP)	
3.6.8 Cemented tailings Facility (CTF)	MCA 82-4-301, 82-4-303, 82-4-305, 82-4-335, 82-4-336, 82-4-337, 82-4-342 and 82-4-378; ARM 17.24 116(3)(g); SB-209: MCA 82-4 335(5)(l)
3.6.9 Non-Contact Water Reservoir (NCWR)	
3.6.10 Stockpiles	
3.6.11 Pipelines	
3.6.12 Equipment & Contract Manpower Required for Support Facility Construction	
3.6.13 Facility Siting Alternative Analysis	
3.7 Water Management	
3.7.1 Introduction	ARM 17.24.116(3)(k); MCA 82-4-336(5)
3.7.2 Water Supply	
3.7.3 Water Balance	

SECTION	RULES (ARM)/ACT (MCA) CITATION
3.7.4 Water Treatment	ARM 17.24.116(3)(b); ARM 17.24.115 (a-d) and (k)(iv) MCA 82-4-336(2)
3.7.5 Treated Water Disposition	
3.7.6 Storm Water	
3.7.7 Erosion Control & Best Management Practices (BMP)	
3.8 Other Operational Management Components	
3.8.1 Total Project Employment with Subcontractors	ARM 17.24.116(3)(q)
3.8.2 Projected Construction & Operational Traffic	
3.8.3 Waters of the US (WOTUS)	
3.8.4 Air Quality & Dust Control	ARM 17.8.308; 17.24.115(1)(h)
3.8.5 Visual Resource Assessment	
3.8.6 Operational Noise	ARM 17.24.116(3)(a): ARM 17.24.116(3)(s)
3.8.7 Fire Protection	ARM 17.24.116(3)(m): 17.24.116(3)(g)
3.8.8 Solid Waste Disposal	ARM 17.24.115(i); ARM 17.24.116(3)(c)
3.8.9 Sewage Treatment	ARM 17.24.116(3)(o)
3.8.10 Hazardous Materials Disposal (Includes Emergency Response Plan)	ERP: ARM 17.24.116(3)(n)
3.8.11 Site Security	
3.8.12 Lighting	
3.8.13 Cultural Resource Protection	ARM 17.24.116(3)(t)
4.0 MODELING STUDIES	
4.1 Hydrologic Conceptual Model	
4.2 Predictive Water Quality Modeling	
4.3 Post Closure Non-degradation Evaluation	ARM17.30.715
4.4 Closure Compliance with Non-degradation Criteria	ARM17.30.715
5.0 MITIGATIONS	
6.0 MONITORING	
6.2 Ongoing Baseline Monitoring	
6.3 Operational Monitoring	
6.3.1 Water Quality & Quantity Monitoring	ARM 17.24.116(3)(l), MCA 82-4-335(5)(m)
6.3.2 Facility Operational Monitoring	
6.3.3 Facility Geotechnical Monitoring	
6.3.4 Waste Rock Geochemistry Monitoring	
6.3.5 Air Quality Monitoring	ARM 17.8.308; 17.24.115(1)(h)
6.3.6 Wetlands Monitoring	
6.3.7 Aquatic Resource Monitoring	
6.3.8 Noise Monitoring	ARM 17.24.116(3)(s)
6.3.9 Reclamation Monitoring	
6.4 Post Operational Closure Monitoring	
6.4.1 Facility Closure Monitoring	ARM 17.24.115(1)(m)

SECTION	RULES (ARM)/ACT (MCA) CITATION
6.4.2 Water Quality Monitoring	ARM 17.24.115(1)(d),(e),(f),(n);17.24.116(3)(l); ARM 17.24.106
6.4.3 Reporting	
7.0 RECLAMATION & CLOSURE	ARM 17.24.116(5)
7.2 Disturbed Land Reclamation Compliance	MCA 82-4-336(2), (3), (4), (5), (6), (8), (9)(a), (10), (11)
7.3 Detailed Plan for Permanent Reclamation & Closure	ARM 17.24.150
7.3.1 Post Mining General Construction Measures	
7.3.2 Post Mining Building & Solid Waste Disposal	ARM 17.24.115(1)(i) & (m), MCA 82-4-303(15)(e); ARM 17.50.1405
7.3.3 Site-specific Facility Closure	ARM 17.24.115(1)(m); ARM 17.24.106
7.3.4 Soil Salvage Placement	
37.3.5 Revegetation	ARM 17.24.115(1)(c), (k)(iii) & (l) MCA 82-4-303(15)(c)
7.4 Reclamation Schedule	MCA 82-4-303(15)(i); 82-4-336(3)
7.5 Bond Release	MCA 82-4-338(1),
8.0 REFERENCES	
9.0 RESPONSES TO COMMENTS	

1.7 List of Other Major Requirements

Table 1-4 presents a list of other major permits required, plans that must be submitted, or acts requiring compliance or monitoring in order to obtain a Montana Mine Operating Permit. These permits, plans, and acts are listed in Table 1-4 by name, related resource, and regulatory or administrative agency.

Table 1-4. List of Permits Required, Plans Requiring Submission and Acts for Compliance.

Resource	Permit / Plan /Act	Agency
Mine Operating Permit	Exploration License	MT DEQ, Air, Energy & Mining Div., Hard Rock Mining Bur.
	Environmental Impact Statement – Record of Decision	MT DEQ, Air, Energy & Mining Div., Hard Rock Mining Bur.
	Hard Rock Mining Operating Permit	MT DEQ, Air, Energy & Mining Div., Hard Rock Mining Bur.
	Reclamation Bond	MT DEQ, Air, Energy & Mining Div., Hard Rock Mining Bur.
Water Quality	Montana Pollution Discharge Elimination System (MPDES) permit	MT DEQ, Water Quality Div., Water Protection Bur.
	Montana Groundwater Pollution Control System (MGWPCS) permit	MT DEQ, Water Quality Div., Water Protection Bur.
	Storm Water Pollution Prevention Plan (SWPPP)	MT DEQ, Water Quality Div., Water Protection Bur.
	Spill Prevention, Control and Countermeasures (SPCC) Plan	MT DEQ, Permitting & Compliance Div., Waste and Underground Tank Management Bur.
Water Rights / Quantity	Certificate of Water Rights / Groundwater Appropriations	MT Dept. Natural Resources and Conservation, Water Rights Bur.
Water - Other	Public Water Supply Permit	MT DEQ, Water Quality Div., Public Water and Subdivisions Bur.
	Sewage Disposal	Meagher County Health Department, Environmental Services
Wetlands / Waters of US	Clean Water Act Section 404 Permit	US Army Corps of Engineers (USACE)
	MT Streambed Preservation Act - 310 Permit	USACE; Meagher County Conservation District; MT Fish, Wildlife and Parks
	MT Streambed Preservation Act - 318 Permit	USACE; Meagher County Conservation District; MT Fish, Wildlife and Parks
Dam Safety	Dam Safety / Hazard Evaluation	MT Dept. Natural Resources and Conservation, Water Resources Division, Dam Safety Bur.
Tribal Communications		US Army Corps of Engineers
Air / Noise	Montana Air Quality Permit	MT DEQ; Air Quality Bureau
Employee Impact	Hard Rock Mining Impact Plan	MT Dept. of Commerce, Community Development Div., Hard Rock Mining Impact Board
Energy Transmission	Major Facility Siting Act (MFSA)	MT DEQ, Air, Energy & Mining Div., Energy Bur.
Road Use / Transportation	Highway Approach Permit	Montana Department of Transportation
Aquatics	Aquatics Monitoring Program	MT DEQ, Air, Energy & Mining Div., Hard Rock Mining Bur.; MT Fish, Wildlife and Parks
Cultural Resources	Historic Preservation Act	MT State Historical Preservation Office (SHPO)
Weed	Weed Plan	Meagher County Noxious Weed Management Program
Emergency Response	Emergency Response Plan	MT DEQ, Air, Energy & Mining Div., Hard Rock Mining Bur.

2 EXISTING CONDITIONS / ENVIRONMENTAL BASELINE STUDIES

Existing condition data describe and evaluate attributes of the environment at the Project site, while baseline studies involve conducting research and gathering/analyzing physical or chemical data associated with resources that might be affected by facility construction or mine operations. Collection of both types of information facilitates the evaluation of possible impacts, and provides a benchmark against which potential future changes could be measured. Evaluations typically compare existing condition physical and chemical data with State standards, regulations and / or guidelines.

An initial consultation between DEQ and Tintina identified the types of baseline assessments, information, and data quality anticipated to be necessary to evaluate this application. This section of the MOP Application summarizes resources selected for baseline study. Table 2-1 lists the baseline assessments or study citing the location of the summary sections in this MOP Application document and the location of detailed technical reports providing supporting information on the resources that are included as appendices to this MOP Application.

Table 2-1. Reference Sections for Environmental / Baseline Studies

Baseline Resource	Summary Section This Report	Detailed Technical Report as Appendix
Geology	1.4	W
Climate, Meteorology and Air Quality	2.1	A-1
Meteorology Monitoring Data	2.1.2	A-3
Air Quality	2.1.6	---
Water Resources	2.2	B
Water Resources Monitoring Data	---	B-A
Water Resources Quality Statistics	---	B-B
Hydrologic Modeling	4.0	M
Wetland Resources	2.3	---
Wetland Delineation Report	2.3.1 and 2.3.2	C-1
Wetland Functionality Report	2.3.7	C-2
Environmental Geochemistry	2.4	D and D-1
Geochemical Modeling	4.2	N
Soil Resources	2.5	E
Terrestrial Wildlife Resources	2.6	F
Aquatic Resources	2.7	G
Vegetation Resources	2.8	H
Weed Plan	2.8.4	O
Cultural Resources	2.9	I
Socio-Economic Resources	2.10	---
Noise	2.11	J
Transportation Resources	2.12	---
Visual Resources	3.8.5	---
Land Use	2.13	---

Tintina initiated collection of data characterizing the existing site conditions and site-specific environmental baseline studies by as early as 2010. Tintina will continue to collect data through ongoing baseline investigations during the permitting phase, and will monitor conditions throughout operations and into closure as mandated by DEQ (described in Section 2.2.4). For most studies, Tintina's leased property boundary usually forms the study area boundary, but select resources required larger study areas. Section 1.3 above describes the boundary of the leased property which includes approximately 7,684 acres (3,109 ha) (Figure 1.4).

2.1 Climate, Metrological Data and Air Quality

2.1.1 Climate

The Project area occurs in a cold, semi-arid or steppe climate (Köppen- Gieger climate classification, http://www.eoearth.org/view/article/162263/; Finlayson and McMahon, 2007).These, cold, semi-arid climates are located in temperate zones and are typically found in continental interiors, some distance from large bodies of water and locally can include areas of high elevation. These climate zones typically have hot summers and cold winters, usually see snowfall during the winter, and at higher latitudes tend to have dry winters and wetter summers. They are often subject to major temperature swings between day and night, sometimes by as much as 36°F (approximately 20ºC) or more. This climate zone tends to support short or scrubby vegetation, usually dominated by either grasses or shrubs but locally in upland portions of the Project area, forest communities of Douglas-fir and lodge pole pine occur where thin soils cover near-surface bedrock.

2.1.2 Meteorological Data Collection

In April, 2012, Tintina established an ambient meteorological monitoring station (Tintina Station) at an elevation of 5,699 feet (1,737 m) just west of the core shed (Figure 1.2 and Figure 2.1) to measure wind speed, wind direction, standard deviation of wind direction, temperature at 30 feet and 6 feet (9 and 1.8 m), delta temperature (calculated difference in temperature between 30 and 6 foot (9 and 1.8 m) stations), solar radiation, barometric pressure, and precipitation. On June 23, 2015, Tintina installed an evaporation pan measuring device. The monitoring station has collected baseline meteorological data to provide information for this mine operating permit application, and is also used to support various ongoing environmental and water balance engineering studies. Bison Engineering, Inc., of Helena, MT operates the meteorological station. Tintina has received quarterly reports of daily data since the second quarter of 2012 and these are attached to this Operating Permit Application Appendix A (Bison Engineering, Inc., 2015).

2.1.3 Meteorological Data Analysis

The Tintina meteorological station (Figure 2.1) has collected 50 months' worth of data (through June of 2016). Months that had fewer than 20 days of recorded data were excluded from the summaries as shown in Table 2-2 below. The precipitation and temperature records have 27 and 30 monthly values respectively. The precipitation record for March 2013 contains a one-day event in which approximately 4 inches (102 mm) of precipitation was recorded. Analysis of this meteorological data (Knight Piésold, 2015a; Appendix A) generated long-term estimates of precipitation and evaporation for use in preparation of the site-wide water balance.

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Date: November 4 2015 Source: Knight Piesold (2015)

TINTINA RESOURCES

LEGEND:

CLIMATE STATION

NOTES:

1. BASE MAP: BING ONLINE.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 12N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:750,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

Figure 2.1
Regional Meteorological Stations
Black Butte Copper Project

Meagher County, Montana

Table 2-2. Tintina Weather Station Monthly Data

Precipitation (in.)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2012					2.48	3.46	1.77	0.47	0.16	1.81	1.10	0.28	-
2013	0.70	1.34	7.24	0.91	2.68					0.40	0.75	1.34	-
2014	1.61	0.16	3.11	1.86	0.83	5.67	1.22	3.23	1.46	0.75	0.51		-
2015	1.41	0.78	0.60	1.38	2.09	1.97	1.69	0.58	1.69	0.24	0.70	0.89	-
2016	1.33	0.25	0.78	1.55	2.66	1.33	1.74	1.15	2.64	2.31	0.17	0.29	-
Average	1.26	0.63	2.93	1.43	2.15	3.11	1.61	1.36	1.49	1.10	0.66	0.70	**18.42**
Temperature (ºF)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2012					42.0		62.4	59.2	49.6	34.7	28.4	17.6	-
2013	17.6	19.0	24.8	31.5	45.5	52.9	62.1		52.2	31.3	26.1	13.6	-
2014	18.0	8.2	25.0	33.4	44.6	48.2	60.4	56.8	47.7	41.2	21.2	20.3	-
2015	17.1	23.7	32.5	35.4	44.0	57.3	57.6	57.9	49.5	41.0	21.0	17.8	-
2016	19.2	25.0	29.3	39.0	44.1	55.8	58.6	56.7	46.6	39.6	32.4	10.0	-
Average	18.0	19.0	27.9	34.8	44.1	53.6	60.2	57.7	49.1	37.6	25.8	15.9	**37.0**
Evaporation (in.)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2015						2.01	3.78	6.59	3.94	2.05			**18.37**
2016						4.04	4.66	5.97	0.77	0.45	0.65		**16.54**
Average						3.03	4.22	6.28	2.36	1.25	0.65		**17.45**

Blank cells had fewer than 20 days of recorded data

To date, the measured records at Tintina station (Table 2-2) indicate a mean annual precipitation of 18.42 inches (468 mm) and a mean annual temperature of 37.0 F (2.8º C). Actual measured net evapotranspiration from Tintina's on-site meteorological station has averaged 17.45 inches (443 mm) from its June 23, 2015 (start-up) through November of 2016.

Early in 2015, Knight Piésold undertook as part of its effort to complete a water balance analysis for the Project, a meteorologic data study to generate long term estimates of precipitation and evaporation for the project area. As can be seen from Table 2-2 the Tintina weather station has a rather short period of record for recorded data (four years in 2015). Generating these long-term estimates are done by comparing records from nearby weather stations that have longer periods of record. In order to do that Knight Piésold had to use monthly temperature data with the Thornthwaite equation to estimate a mean annual potential evapotranspiration of 17.4 in. (441 mm), as shown in Table 2-3 (Knight Piésold, 2015). Potential evapotranspiration is considered to be generally equivalent to pond evaporation. These calculated values show remarkable agreement with actual measure pan evaporation data from the project site for 2015 and 2016 (Table 2-2).

Table 2-3. Tintina Station Potential Evapotranspiration (in.)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2012					2.07		4.8	4.1	2.5	0.5			**-**
2013				0	2.4	3.5	4.8		2.8	0			**-**
2014				0.4	2.3	2.9	4.6	3.8	2.2	1.3			
Average				0.2	2.2	3.2	4.7	3.9	2.5	0.8			**17. 4**

Calculated PET from Thornthwaite equation (uses daily temperature, length of day and a measure of heat index or mean annual temperature to calculate PET)

Blank cells = no data

Four regional climate stations were then investigated for comparison with the Tintina station. The locations of these stations are shown on Figure 2.1 and the mean annual meteorological values are summarized in Table 2-4 and Appendix A-2 (Knight Piésold, 2015a) presents the detailed analysis of this data (including pond evaporation estimates, and long-term temperature and precipitation data) and compares results among the four meteorological stations.

Table 2-4. Regional Meteorological Station Summary

Station	Elevation (amsl)	Period of Record	Mean Annual Precipitation (in.)	Mean Annual Temperature (^oF)	Mean Annual Pan Evap. (in.)
Bozeman	4,862	1892 - 2015	18.5	43.2	36.8
Millegan 14 SE	4,970	1984 - 2015	18.6	41.0	-
White Sulphur Spring	5,440	1949 - 1981	15.8	-	-
Neihart 8 NNW	5,230	1967 - 2013	21.3	41.7	-

Two synthetic series of monthly precipitation and temperature generated for the Project site (Tintina meteorological station, elevation 5,699 feet (1,737 m)) allow the best possible estimate of precipitation, temperature, and evaporation. For the period 1892 to 2015, a synthetic series includes data generated from the Bozeman station, and for the period 1984 to 2015 a synthetic series includes data from the Millegan station (Knight Piésold 2015a, Appendix A-2). Modelers often create synthetic (artificial, not measured) sets of data using statistical analysis of larger sets of data that compare favorably with smaller sets of data. This is done to generate a broader set of data within a variable system such as weather or climate. A good example is the extrapolation of weather data from a shorter period of time (record) to an extended period of record, so that the long term significance of extreme high or low frequency events can be evaluated. The calculated mean annual precipitation values for the Project site were 20.0 in. (508 mm) and 16.4 in. (417 mm), respectively. These are lower than the mean annual precipitation recorded at the Tintina station in 2012 to 2014. This is likely because the site-based weather station data represent a limited period of record that is not yet well suited for long-term predictions, hence regional data were incorporated into the overall hydro-meteorological analysis to assess variability. The Millegan station, located close to the Project site, indicated that the 2012–2014 period was wetter than the long-term average, whereas the Bozeman station indicated that the 2012–2014 period deviated less from the long-term average conditions. Because the Millegan station is located closer to the Project site, and is considered more representative of Project site weather patterns, this study adopted the long-term precipitation estimate based on the Tintina-Millegan comparison for water balance calculations. In addition, the Tintina-Millegan estimate yielded a more conservative result with respect to water supply availability used in the site-wide water balance. Statistical graphs of correlations for temperature and precipitation data between the Tintina-Bozeman and the Tintina-Millegan sites are included in Knight Piésold's report (Knight Piésold, 2015a).

The study generated three estimates of long-term mean annual pond evaporation for the Project site. The study based two estimates on temperature values and the Thornthwaite equation. Analysis using the Tintina-Bozeman temperature series yielded a mean annual potential evapotranspiration of 17.2 in. (437 mm); and analysis using the Tintina-Millegan temperature series yielded a mean annual potential evapotranspiration of 16.7 in. (424 mm) The third estimate, which was based on pan evaporation at the Bozeman station scaled to the Project site, yielded a mean annual pond evaporation value of 20.2 inches (513 mm). Given the level of uncertainty in the evaporation estimates, as with the precipitation, the study applied the most conservative approach to the water balance analyses, and used the highest evaporation estimate (20.2 in., 513 mm) for the Project site for modeling purposes. Tintina installed a pan evaporation measuring station at the project site in June 2015.

2.1.4 Meteorological Data Used for Engineering Analysis and Design

The values presented in Table 2-5 represent those considered most representative of the Project site when using the most restrictive approach, with respect to water availability. The values below represent an average annual water deficit of 3.8 inches (96 mm).

Table 2-5. Long-Term Project Precipitation and Pond Evaporation Data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual*
Precipitation (in.)	0.8	0.67	1.1	1.5	2.3	2.8	1.8	1.5	1.2	1.1	0.9	0.9	16.4
Precipitation (mm)	20	17	28	38	58	71	46	38	30	28	23	23	417
Pond Evaporation (in.)	0	0	0	1.9	3.0	3.3	4.4	3.9	2.4	1.4	0	0	20.2
Pond Evaporation (mm)	0	0	0	48	76	84	112	99	61	36	0	0	513

- Annual total values have been rounded.

The use of this cautious approach is justified based on the fact that the addition of water from underground mine dewatering will result in overall surplus water conditions on a project wide basis, regardless of the variation in hydro-meteorological conditions at the site. In addition, any surplus or deficit of water introduced by variations in precipitation or evaporation will be compensated for on a monthly basis, based on water right requirements either by sending surplus water to the water treatment plant and discharging the treated water in the underground infiltration gallery, or by directing mine dewatering outputs into the PWP. The required mitigation of consumptive use implemented under water rights as a part of normal operating procedures will compensate for variations in actual climatic fluctuations on a monthly basis.

2.1.5 Wet and Dry Return Periods for Project Site Precipitation

Table 2-6 presents the wet and dry annual precipitation values up to the 1:100 year return period. These values are calculated based on the mean annual precipitation, and the standard deviation of annual precipitation values, using the annual precipitation values from the Tintina-Millegan precipitation series (Knight Piésold, 2015a). The analysis assumes a normal distribution. The Tintina weather station will continue meteorological data collection to provide a longer period of record for comparison to the regional stations.

Table 2-6. Wet and Dry Return Period Project Precipitation

Return Period	Annual Precipitation (in. / mm)
1:100 year **wet** (mean + 2.326 s.d.)	24.6 / 625
1:50 year **wet** (mean + 2.054 s.d.)	23.6 / 599
1:20 year **wet** (mean + 1.645 s.d.)	22.1 / 561
1:10 year **wet** (mean + 1.282 s.d.)	20.9 / 531
Mean Annual Precipitation	**16.4 / 417**
1:10 year **dry** (mean - 1.282 s.d.)	11.9 / 302
1:20 year **dry** (mean - 1.645 s.d.)	10.6 / 269
1:50 year **dry** (mean - 2.054 s.d.)	9.2 / 234
1:100 year **dry** (mean - 2.326 s.d.)	8.2 / 208

NOTE: 1. The standard deviation was calculated to be 3.5 in. (89 mm)

2.1.6 Air Quality

Meagher County, in which the Project is located, is classified for air quality purposes as "Unclassifiable or Better Than National Standards" for all criteria pollutants (40 CFR 81.327 and DEQ website http://deq.mt.gov/AirQuality/Planning/AirNonattainment.mcpx). This classification indicates that DEQ has not monitored the area's air quality but that, based on the Department's experience, the area is presumed to meet the ambient air quality standards. Specifically, regarding the recently revised 8-hour ozone standard, EPA has published information indicating that all of Montana currently meets the new standard or is presumed to do so (EPA website: http://ozoneairqualitystandards.epa.gov/OAR_OAQPS/OzoneSliderApp/index.html#).

As noted above, DEQ has not measured ambient air pollutant concentrations in or near the Project area. The most representative data have been collected at the Sieben Flats monitoring station located approximately 50 miles west of the Project between Helena and Great Falls. This is a National Core (NCore) Multipollutant Network monitoring station that monitors background air quality on a regional scale as part of a national air quality trends network. The NCore site and the Project site are both rural locations that are quite similar, and this similarity supports the "Unclassifiable or Better Than National Standards" classification determination (Sieben Flats NCore data can be accessed at this EPA website: http://www3.epa.gov/airdata/ad_rep_mon.html).

There are no significant sources of air pollution in the vicinity of the Project area. The nearest significant source is the Graymont Indian Creek Lime Plant which is located approximately 46 air miles (74 km) southwest of the mine. White Sulphur Springs is approximately 15 miles south of the mine site and does not have any significant emitting sources. The nearest large population centers are the cities of Great Falls, Bozeman, and Helena, located at distances of approximately 50, 76 and 54 air miles, (80, 122 and 87 km) respectively, from the Project.

In addition, Tintina received an air quality permit from DEQ's Air Resources Management Bureau for its Amendment to Exploration License to Construct and Exploration Decline. This application concludes that recent emission air pollutant rates from the Project's exploration activities are quite low and are not expected to substantially degrade surrounding air quality. Potential emission rates for criteria pollutants, as reported in the exploration decline air quality permit (MAQP #4978-00) are all well below EPA thresholds for "significant emission rates." The air quality permit states on page 4 of the analysis section that "…the potential emissions expected from operating the facility (exploration decline) at its maximum throughput on a continuous basis would not violate ambient air quality standards."

Tintina will either modify its existing Air Quality Permit or submit an application for and acquire a new Montana Air Quality Permit under the Montana Clean Air Act prior to construction and mining activities at the site that specifies requirements for applicable state and federal air quality standards. The air quality permit application requires that the applicant demonstrate compliance with all applicable State and Federal regulations and ambient air quality standards. As part of that application, a list of equipment and specifications for all stationary emissions sources would be compiled for submittal to DEQ's Air Resources Management Bureau for review and final determination of permitting needs once specific pieces of equipment have been selected for the mining operation. The conditions of the Air Quality Permit will specify monitoring and reporting requirements in detail and may specifically require air quality monitoring for particulates.

2.2 Water Resources

2.2.1 Water Resources Study Area and Methods of Study

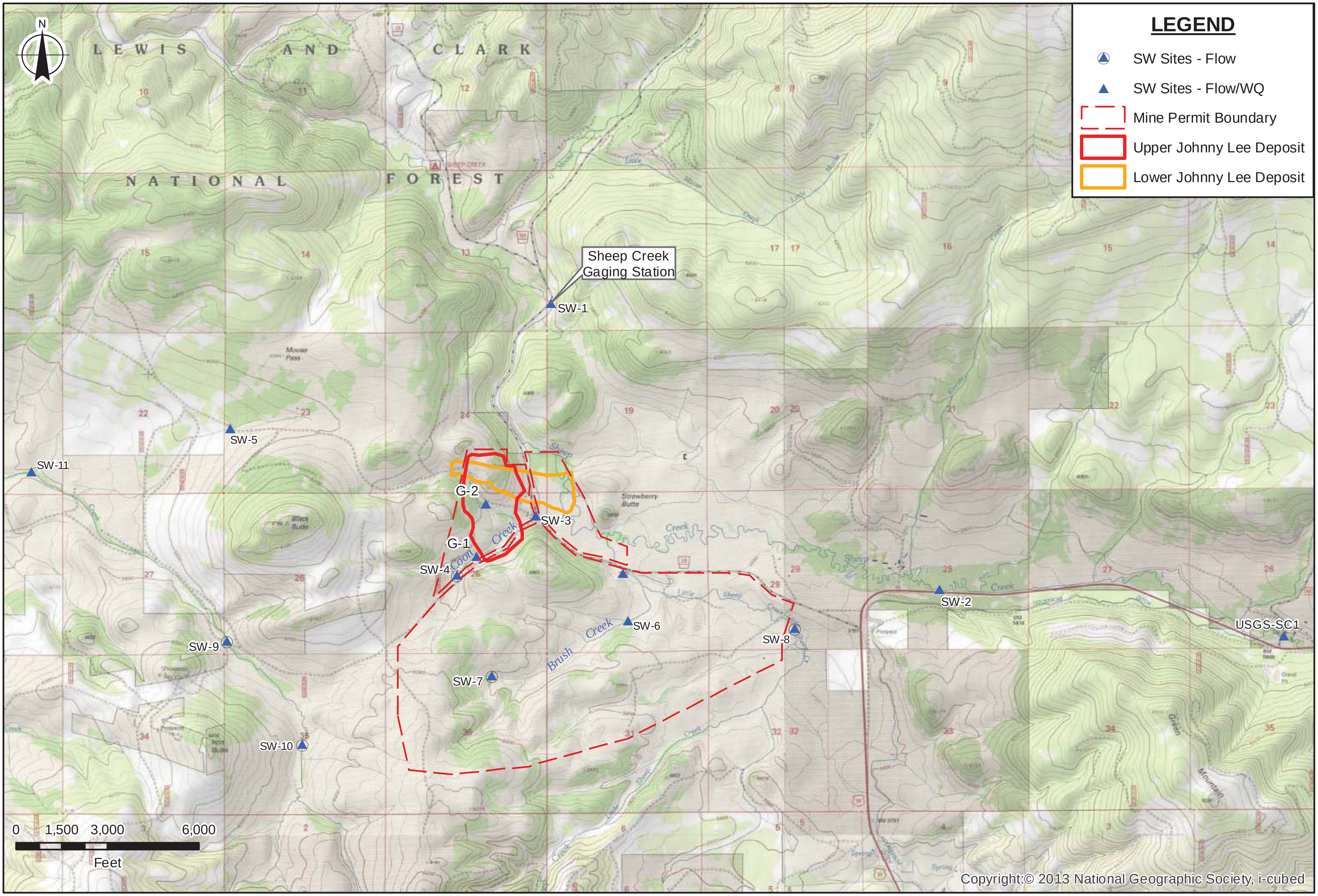
Tintina has conducted both water resource baseline monitoring and hydrologic investigations for the Project. They initiated the baseline monitoring program in May of 2011 and it includes measurement of flow, water levels, and water quality at surface water, groundwater, and spring and seep monitoring sites in the Project area (Hydrometrics, 2017a). The baseline monitoring program includes the following:

- Quarterly monitoring at 12 surface water sites. Beginning in 2013, Tintina monitored three of these sites located on Sheep Creek on a bi-weekly/weekly schedule during spring run-off and then monthly since 2014 (Figure 2.2). In 2016, a surface water site on Little Sheep Creek was added to the monthly monitoring program.
- Quarterly groundwater monitoring at 22 monitoring well sites and 22 additional test wells and piezometer sites (Figure 2.3). An additional 8 wetland piezometers were installed in 2017 (see Figure 6.2 and Map Sheet 1).
- Annual spring and seep monitoring which includes monitoring of flow and field parameters at 16 springs and water quality sampling and analysis at 11 sites (Figure 2.4). Tintina has monitored eight spring sites on a monthly schedule since 2016.

Field parameters are also monitored annually at 10 seep locations.

Figure 2.2 shows the location of surface water resource monitoring sites. Figure 2.3 shows the location of groundwater resource monitoring sites. Table 2-7 summarizes the type of baseline data available and period of record at each of the baseline monitoring sites.

In addition to baseline monitoring (Hydrometrics, 2017a), Tintina conducted a number of groundwater investigations to characterize the hydrostratigraphic units in the Project area (Hydrometrics, 2012a, 2013, and 2015a) and groundwater conditions in the vicinity of surface facilities (June 2016, and March 2017). Investigations have also examined groundwater/surface water interactions related to use of UIG areas (Hydrometrics, 2013), and have included two synoptic surveys on Sheep Creek between Little Sheep Creek and downgradient monitoring site SW-1 (Figure 2.2). Tintina is currently conducting an infiltration tracer study (Hydrometrics, 2017b). Synoptic surveys are summarized in Appendix B with survey sites shown on Figure 14 of Appendix B.



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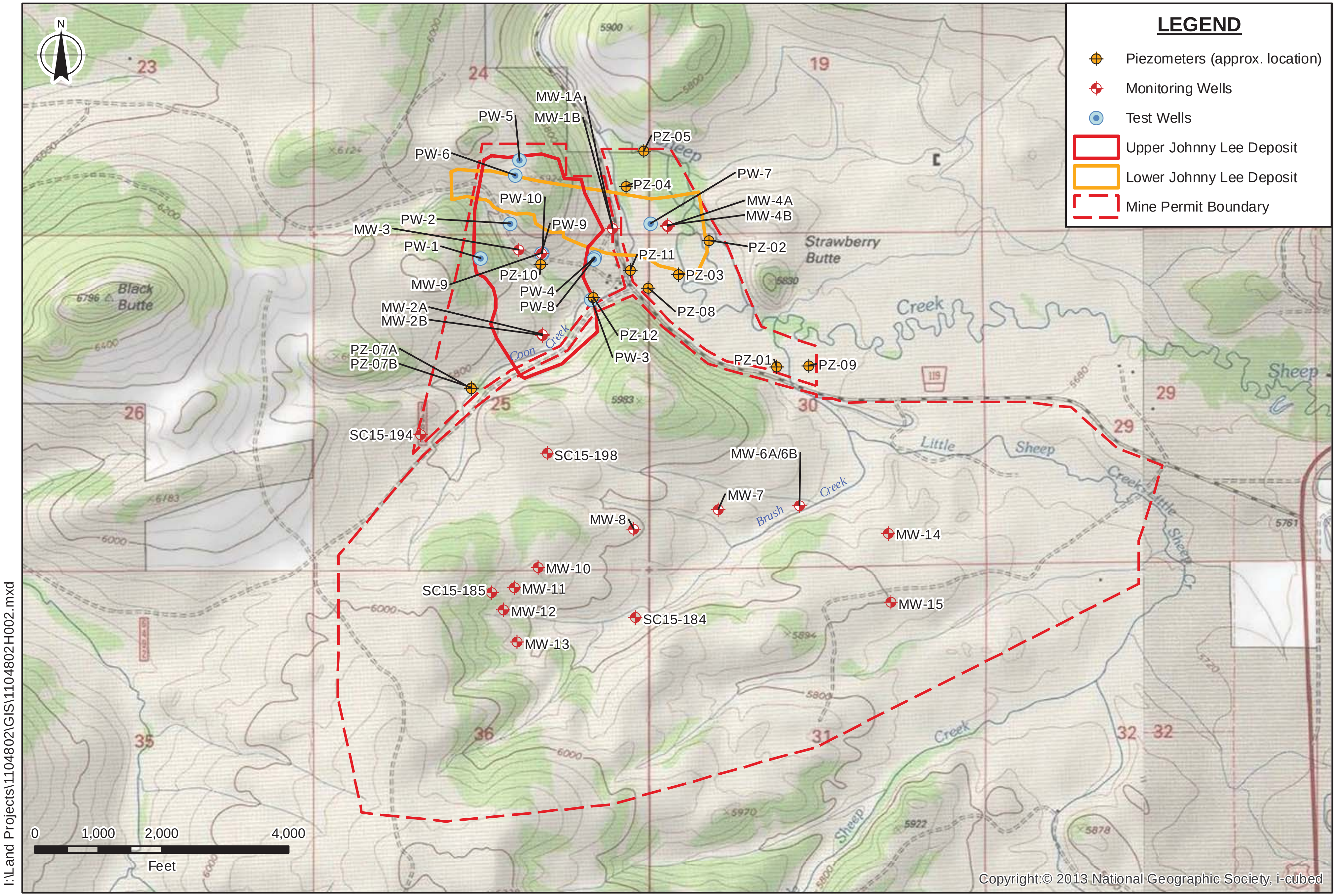
Date: June 2016, Source: Hydrometrics, Inc. (2016)

TINTINA RESOURCES

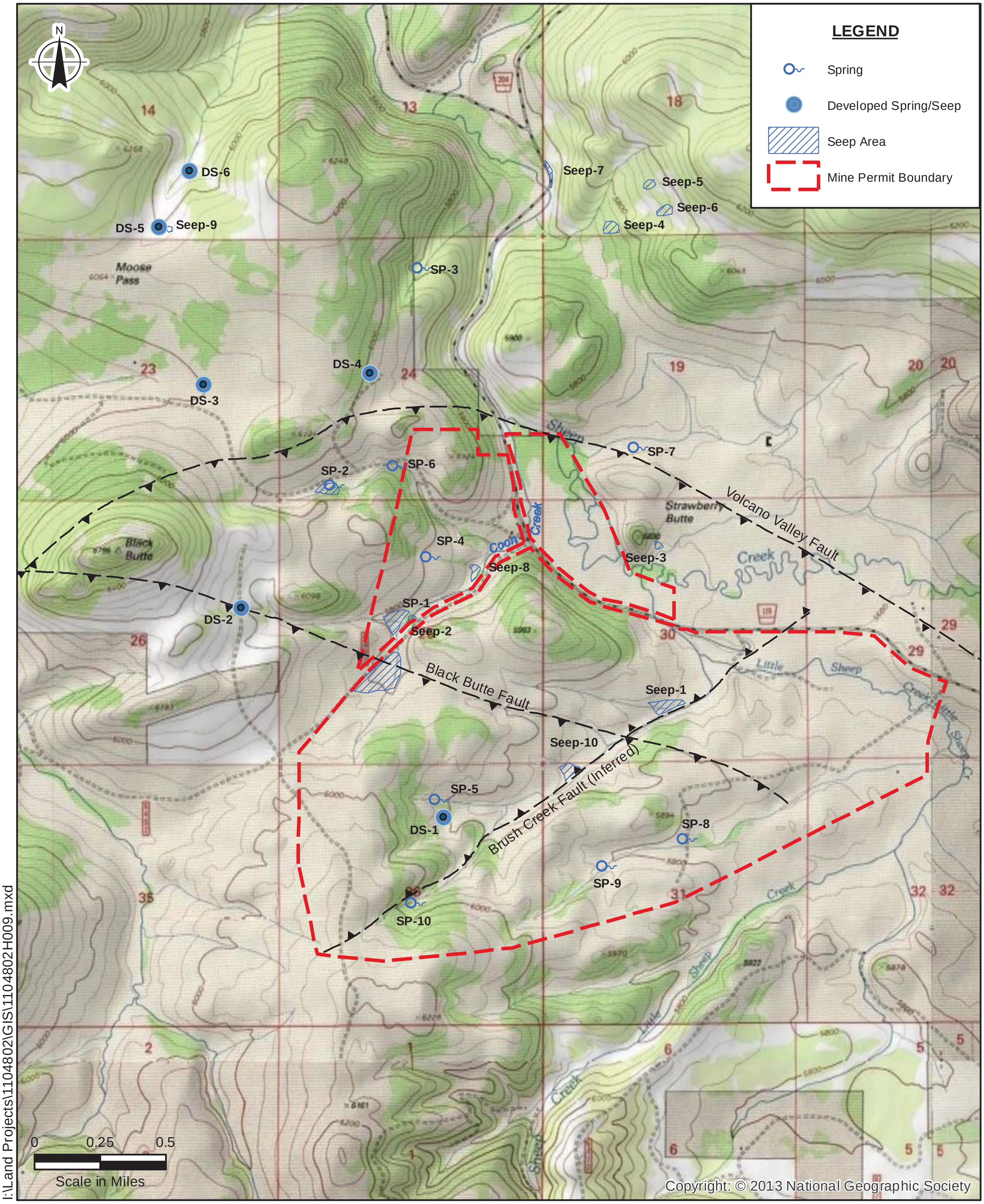
Figure 2.2
Surface Water Resource Monitoring Sites
Black Butte Copper Project
Meagher County, Montana



Date: February 2017, Source: Hydrometrics, Inc. (2017)

TINTINA RESOURCES

Figure 2.3
Groundwater Monitoring Sites
Black Butte Copper Project
Meagher County, Montana



Date: June 2016, Source: Hydrometrics, Inc. (2016)

TINTINA RESOURCES

Figure 2.4
Baseline Spring and Seep Sites
Black Butte Copper Project
Meagher County, Montana

Table 2-7. Water Sampling Summary for Baseline Monitoring Sites

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12 North							
Developed Springs								
DS-1	506,507	5,178,871	Monthly	2011-2016	X	X	X	
DS-2	505,263	5,180,151	Annual	2011-2016	X	X	--	
DS-3	505,038	5,181,521	Monthly	2011-2016	X	X	X	
DS-4	506,057	5,181,589	Monthly	2011-2016	X	X	X	
DS-5	504,761	5,182,485	Annual	2011-2016	X	X	--	
DS-6	504,950	5,182,828	Annual	2011-2016	X	X	--	
Seeps								
Seep-1	507,876	5,179,571	Annual	2011-2016	--	X	--	
Seep-2	506,311	5,180,089	Annual	2012-2016	--	X	--	
Seep-3	507,821	5,180,537	Annual	2012-2016	--	X	--	
Seep-4	507,531	5,182,486	Annual	2012-2016	--	X	--	
Seep-5	507,768	5,182,749	Annual	2011-2016	--	X	--	
Seep-6	507,853	5,182,587	Annual	2011-2016	--	X	--	
Seep-7	507,155	5,182,821	Annual	2011-2016	--	X	--	
Seep-8	506,701	5,180,382	Annual	2011-2016	--	X	--	
Seep-9	504,825	5,182,476	Annual	2011-2016	--	X	--	
Seep-10	507,270	5,179,165	Annual	2011-2016	--	X	--	
Springs								
SP-1	506,273	5,180,099	Annual	2011-2016	X	X	--	
SP-2	505,834	5,180,907	Annual	2011-2016	X	X	--	
SP-3	506,371	5,182,242	Monthly	2011-2016	X	X	X	
SP-4	506,425	5,180,469	Monthly	2011-2016	X	X	X	
SP-5	506,479	5,178,985	Monthly	2011-2016	X	X	X	
SP-6	506,220	5,181,028	Monthly	2011-2016	X	X	X	
SP-7	507,694	5,181,138	Monthly	2011-2016	X	X	X	

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12 North							
SP-8	507,996	5,178,745	Annual	2012-2016	X	X	--	
SP-9	507,502	5,178,578	Annual	2012-2016	X	X	--	
SP-10	506,335	5,178,351	Annual	2012-2016	X	X	--	
Surface Water Sites								
SW-1	507,148	5,182,710	Monthly	2011-2016	X	X	X	Hourly water level data since 2012; High flow bi-weekly/weekly Flow
SW-2	511,040	5,179,844	Monthly	2011-2016	X	X	X	High flow bi-weekly/weekly Flow
SW-3	506,996	5,180,581	Quarterly	2011-2015	X	X	X	
SW-4	506,308	5,180,114	Quarterly	2011-2016	X	X	--	
SW-5	503,914	5,181,465	Quarterly	2011-2016	X	X	X	Typically dry
SW-6	507,919	5,179,536	Quarterly	2011-2016	X	X	X	
SW-7	506,420	5,179,000	Quarterly	2011-2016	X	X	X	
SW-8	509,575	5,179,476	Quarterly	2011-2016	X	X	--	
SW-9	503,944	5,179,271	Quarterly	2011-2016	X	X	--	
SW-10	504,665	5,178,322	Quarterly	2011-2016	X	X	2015	Added Lab WQ for TMDL
SW-11	501,951	5,181,021	Quarterly	2011-2016	X	X	X	
SW-14	507,876	5,180,008	Monthly	2016	X	X	X	High flow bi-weekly/weekly Flow
USGS-SC1	514,509	5,179,419	Monthly	2014-2016	X	X	X	High flow bi-weekly/weekly Flow
G-1	506,405	5,180,178	Single Event	July 2011	X	X	2011	Data collected once only in July 2011
G-2	506,497	5,180,699	Single Event	July 2011	X	X	2011	Data collected once only in July 2011
Monitoring Wells								
MW-1A	506,935	5,180,842	Quarterly	2011-2016	X	X	X	
MW-1B	506,934	5,180,845	Quarterly	2011-2016	X	X	X	
MW-2A	506,598	5,180,332	Quarterly	2011-2016	X	X	X	
MW-2B	506,597	5,180,329	Quarterly	2011-2016	X	X	X	
MW-3	506,484	5,180,740	Quarterly	2011-2016	X	X	X	

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12 North							
MW-4A	507,201	5,180,855	Quarterly	2012-2016	X	X	X	
MW-4B	507,200	5,180,858	Quarterly	2012-2016	X	X	X	
MW-6A	507,809	5,179,493	Quarterly	2013-2016	X	X	X	
MW-6B	507,793	5,179,491	Quarterly	2013-2016	X	X	X	
MW-7	507,452	5,179,501	Quarterly	2013-2016	X	X	X	
MW-8	507,036	5,179,398	Quarterly	2013-2016	X	X	X	
MW-9	506,593	5,180,725	Quarterly	2014-2016	X	X	X	
MW-10	506,579	5,179,215	Quarterly	2016	X	X	X	
MW-11	506,465	5,179,117	Quarterly	2016	X	X	X	
MW-12	506,413	5,179,010	Quarterly	2016	X	X	X	
MW-13	506,478	5,178,856	Quarterly	2016	X	X	X	
MW-14	508,256	5,179,377	Quarterly	2016	X	X	X	
MW-15	508,291	5,179,071	Quarterly	2016	X	X	X	
SC15-184	507,047	5,178,973	Quarterly	2015-2016	X	X	X	First monitoring July 2015
SC15-185	506,355	5,179,094	Quarterly	2015-2016	X	X	X	First monitoring July 2015
SC15-194	506,014	5,179,855	Quarterly	2015-2016	X	X	X	First monitoring July 2015
SC15-198	506,621	5,179,855	Quarterly	2015-2016	X	X	X	First monitoring July 2015
Test Wells								
PW-1	506,301	5,180,698	Quarterly	2011-2016	X	One Time	One Time	Lab data from pumping test
PW-2	506,443	5,180,865	Quarterly	2011-2016	X	X	X	
PW-3	506,846	5,180,479	Quarterly	2012-2016	X	X	X	
PW-4	506,902	5,180,688	Quarterly	2012-2016	X	X	X	
PW-5	506,491	5,181,173	Quarterly	2013-2015	X	--	--	
PW-6	506,468	5,181,098	Quarterly	2012-2015	X	Twice	Twice	
PW-6N	506,468	5,181,098	Quarterly	2015-2016	X	One Time	One Time	Lab data from pumping test
PW-7	506,846	5,180,696	Quarterly	2013-2016	X	X	X	
PW-8	506,598	5,180,722	Quarterly	2014-2016	X	X	X	

Monitoring Site	Easting (meters)	Northing (meters)	Monitoring Frequency	Period of record	Flow or Water Level	Field Parameters	Lab Parameters	Comments
	UTM-WGS 1984 Zone 12 North							
PW-10	506,594	5,180,722	Quarterly	2014-2016	X	X	X	
Piezometers								
PZ-01	507,650	5,180,256	Quarterly	2012-2016	X	--	--	
PZ-02	507,401	5,180,779	Quarterly	2012-2016	X	--	--	
PZ-03	507,249	5,180,619	Quarterly	2012-2016	X	--	--	
PZ-04	506,992	5,181,111	Quarterly	2012-2016	X	--	--	
PZ-05	507,080	5,181,215	Quarterly	2012-2016	X	--	--	
PZ-07A	506,258	5,180,075	Quarterly	2014-2016	X	--	--	
PZ-07B	506,258	5,180,075	Quarterly	2014-2016	X	--	--	
PZ-08	507,090	5,180,574	Quarterly	2014-2016	X	--	--	
PZ-09	507,884	5,180,179	Quarterly	2014-2016	X	--	--	
PZ-10	506,589	5,180,672	Quarterly	2014-2016	X	--	--	PW-8 Aq Test temporary piezometers
PZ-11	507,021	5,180,643	Quarterly	2014-2016	X	--	--	PW-8 Aq Test temporary piezometers
PZ-12	506,844	5,180,514	Quarterly	2014-2016	X	--	--	PW-8 Aq Test temporary piezometers
BB WM1	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM2	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM3	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM4	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM5	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM6	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM7	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring
BB WM8	IP	IP	Quarterly	2017	X	--	--	includes wetland vegetation monitoring

TABLE NOTES:

- Added lab WQ for Total Maximum Dailey Load (TMDL) means - began water quality monitoring at the request of the TMDL program.
- The listed monitoring site coordinates in UTM-WGS 84 Zone 12 are very similar to NAD 83 UTM Zone 12N coordinates used throughout most of the MOP document.
- The coordinates for recently installed wetland piezometers BB WM1 through BB WM8 are incomplete as the surveys are all in progress (IP).

Water resource monitoring data collected from 2011 to July 2015 are summarized in the Baseline Water Resource Monitoring Report (Hydrometrics 2017a), which is included as Appendix B of this Permit Application. Subsequent hydrogeological investigations are summarized in individual reports. Water resource monitoring data collected from July 2015 through 2016 are presented in the digital water quality files in Appendix B-A (Hydrometrics 2017a); actual quarterly or annual reports were submitted to the DEQ including most recently water the quality data for the first quarter of 2017; however, the 2017 data has not been added to the geochemistry electronic data base (Appendix B-A) to date. The Project Electronic Database will be updated and provided to the EIS contractor and the DEQ upon request. Analytical data, well logs, and aquifer test analyses for the subsequent monitoring/investigations has been appended to Appendices B-A through B-D for ease of reference in this Permit Application. The additional hydrological investigation reports in this Permit Application include the following:

- Appendix B-1: Hydrological Assessment of Proposed Cemented Tailings Facility Report (Hydrometrics, 2016b), and;
- Appendix B-2: Eastern UIG Tracer Test Report (Hydrometrics, 2017b) that includes an Addendum Letter from Ozark Underground Laboratory dated July 11, 2017 that discusses fluorescein dye details.

The remainder of this section describes the hydrologic setting of the Project area and summarizes the results of baseline and other water resources monitoring programs conducted from 2011 through 2016.

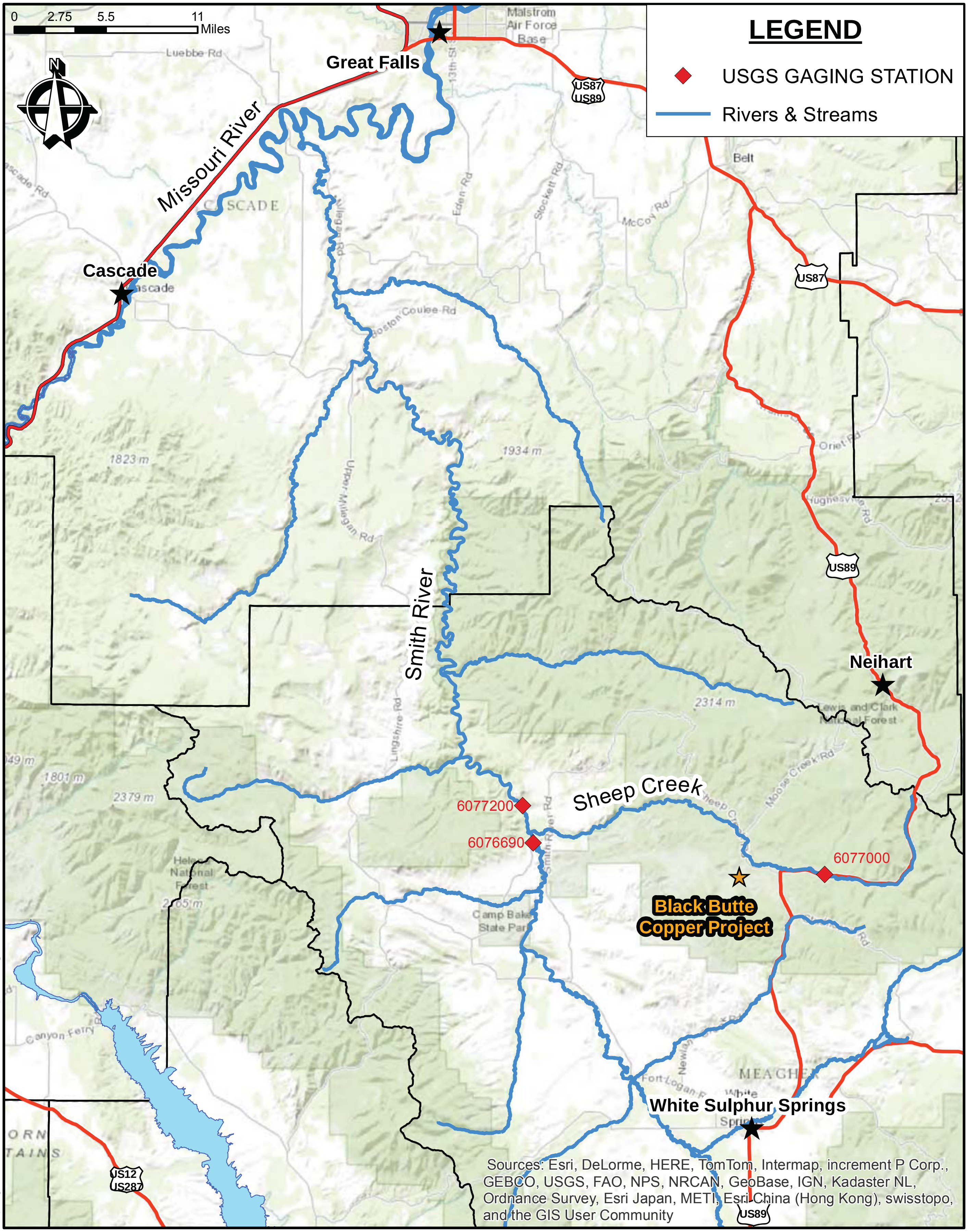
2.2.2 Surface Water

The Project area is in the upper portion of the Sheep Creek drainage, a tributary to the Smith River, which in turn is a tributary of the Missouri River (Figure 2.5). Sheep Creek is a fifth order stream draining a total of approximately 194 square miles (502 square km). Sheep Creek originates in the Little Belt Mountains at an elevation of approximately 7,400 feet (2,255 m) and discharges to the Smith River approximately 34 river miles (55 km) to the west at an elevation of 4,380 feet (1,335 m). The Project area is located in the approximate upper third of the drainage approximately 19 river miles (30.5 km) above the confluence with the Smith River. Sheep Creek is a high quality stream that flows in a meandering channel through a broad alluvial valley upstream of the Project site but enters a constricted bedrock canyon just downstream. It is used principally for stock water and fishing (Resource Modeling, Inc, 2010).

Primary tributaries to Sheep Creek in the immediate Project area include Little Sheep Creek, Brush Creek and Coon Creek (Figure 2.6). To the west of the project area is Black Butte Creek, also a tributary to Sheep Creek. Black Butte Creek flows to the northwest and joins Sheep Creek approximately 7 miles (11 km) to the west-northwest of the Project area. There is a small unnamed tributary that joins Sheep Creek on the north side of Strawberry Butte that collects water from springs on the north flank of the Sheep Creek Valley. Another small unnamed tributary flows westward from the northern side of Black Butte (the geographic feature) into Black Butte Creek. Flow in these tributary drainages is only perennial on their lower reaches and ephemeral upstream. Moose Creek, one mile north of the mine permit boundary, is the first of several tributaries to Sheep Creek that lie to the north and downstream of the project site (Figure 2.6).

The United States Geological Survey (USGS) historically operated a gaging station on Sheep Creek (USGS 06077000) that was located approximately 4 miles (6.4 km) upstream of the Project area (Figure 2.5 and Figure 2.6). This site provided stream flow data for Sheep Creek from 1941 through 1978 and the USGS reports average monthly flows ranging from approximately 9 cfs to 115 cfs (254 to 3,256 Lps; 0.5 to 3.26 m^3/sec). The nearest active USGS gaging stations (USGS 06076690 and 06077200) are located on the Smith River near Fort Logan above the confluence with Sheep Creek and just below the confluence with Sheep Creek and Eagle Creek (Figure 2.6). The upstream gaging station (06076690) provided continuous data from October 1977 to the end of September 1996 and intermittent data since then. The downstream gaging station (06077200) has run continuously since October 1, 1996. Flows on the Smith River at the upstream gaging site range from 18 to 3,200 cfs (510 to 90,613 Lps; 0.5 to 90 m^3/sec) and at the downstream gaging site from 30 to 3,800 cfs (0.85 to 107.6 m^3/sec). The percentage of flow from Sheep Creek is unknown as there are additional tributary drainages between the two USGS gaging stations.

The Holmstrom Ditch is a significant man-made hydrologic feature effecting flows in Sheep Creek. It has diverted Sheep Creek water for irrigation use into the Newlan Creek drainage since 1935. The diversion point for the ditch is just downstream of the former USGS-SC1 gaging station (Figure 2.6). While the local ranchers continue to use the ditch for seasonal irrigation diversions, the Newlan Creek Water District also uses the ditch as a source of water for the Newlan Reservoir.



K:\project\11048\Baseline WRM Report\Fig1 Location Map.mxd

Date: November 3, 2015 Source: Hydrometrics (2015)

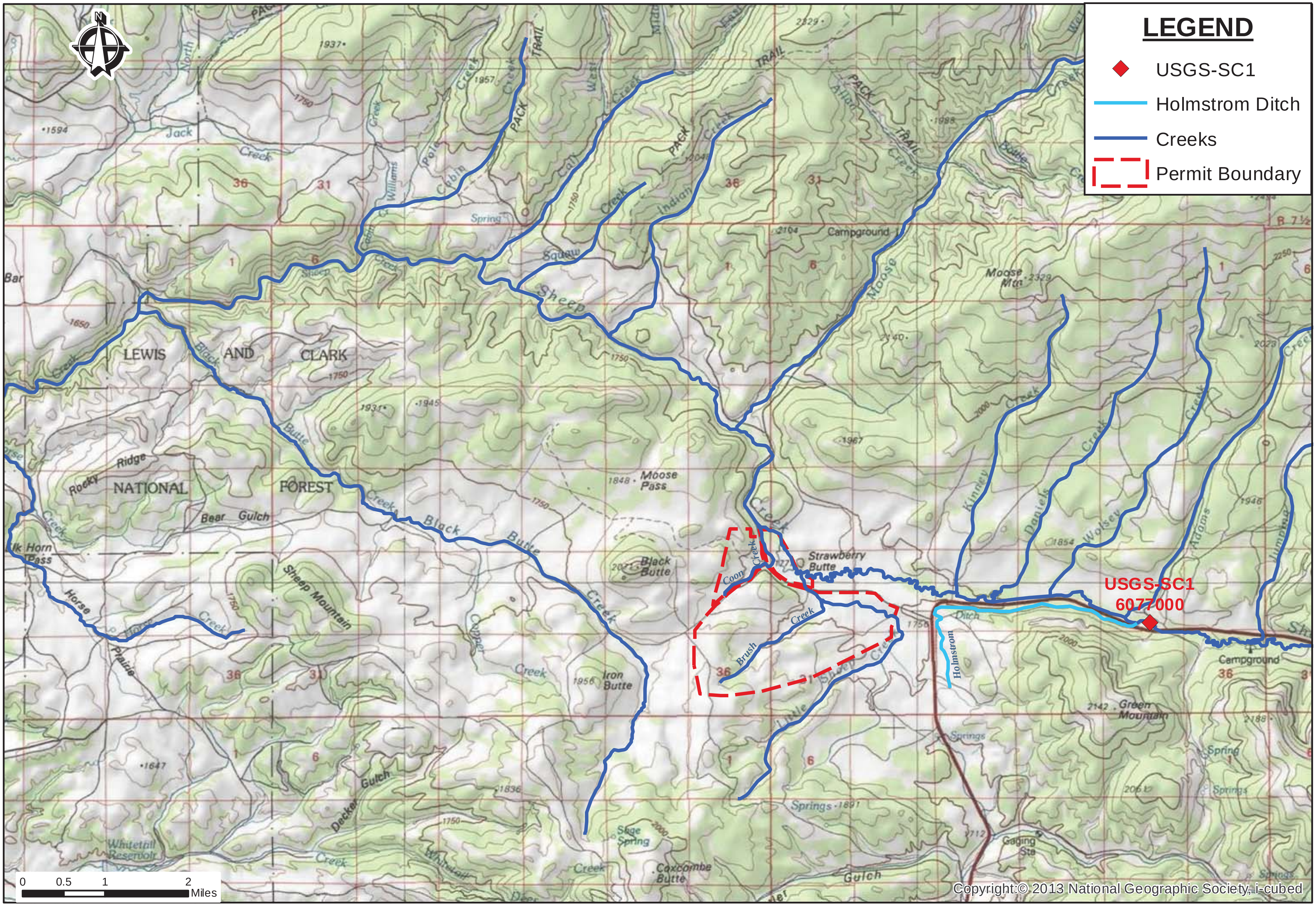
TINTINA RESOURCES

Figure 2.5

Plan Map of Sheep Creek, Smith River, and Missouri River

Black Butte Copper Project

Meagher County, Montana



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Date: June 2016, Source: Hydrometrics, Inc. (2016)

TINTINA RESOURCES

Figure 2.6
Major Creeks and Tributaries
Black Butte Copper Project
Meagher County, Montana

2.2.3 Groundwater

Quaternary alluvial deposits that occupy the axes of the major drainages, colluvium deposits (highly weathered shallow bedrock that flank these drainages), and the underlying more competent bedrock formations all contain groundwater in the project area. Primarily low permeability dolomitic and silicic shales and argillaceous dolomites of the Newland Formation form the bedrock of the Project area. A review of available information in the Groundwater Information Center (GWIC) database (Montana Bureau of Mines and Geology; MBMG, 2011) indicates wells completed in bedrock in the project area are generally low yielding with reported yields of 4 to 50 gpm (median 12 gpm). The GWIC database bedrock wells within the area are generally completed at depths greater than 100 feet below ground surface. One well was completed at less than 100 feet; the range of depth of all wells is 52 - 500 feet, and the median depth is 191 feet). There is limited historical information on the hydrogeology of the Project area. Some previous exploration drilling (Resource Modeling, Inc, 2010) in the deeper bedrock units underlying the Sheep Creek Valley encountered artesian flow. Artesian flows were noted in some core holes that were collared in the Sheep Creek Valley and penetrated through the *VVF* into the *LCZ*. These artesian flows were only observed in open holes after many weeks/months. Flow rates from these core holes were very low, and when they were observed the holes were plugged at depth to seal off the groundwater in the *LCZ*.

In more recent exploration drilling (conducted since 2010), artesian flows were not observed in any holes drilled in the Sheep Creek Valley immediately after drill hole completion. However, those drill holes that were not plugged within a few weeks of completion commonly exhibited artesian conditions. The low flow rate and long delay before artesian flows were observed provides additional evidence that the *LCZ* is a very low permeable unit and the *VVF* inhibits vertical flow from the *LCZ* to the surface. Although there is a large pressure head in the *LCZ*, the data from PW-7 and observations from boreholes suggest there is very little flow.

2.2.4 Water Resources Baseline Monitoring

Tintina has conducted surface water and groundwater monitoring to establish baseline stream flows, groundwater potentiometric elevations, and water quality in the Project area. This work has included analyses of surface water and groundwater quality samples for physical parameters, common ions, and nutrients, as well as a comprehensive suite of trace metals (Table 2-8). In addition to the laboratory analysis, hardness was calculated based on the concentration of calcium and magnesium. During some monitoring events bicarbonate and carbonate concentrations were reported by the laboratory; the calculated hardness and bicarbonate results are included in the water quality databases (Appendix A).

Table 2-8. Parameter, Methods, and Detection Limits for Baseline Water Monitoring

Parameter	Analytical Method[1]	Project-Required Surface Water Detection Limit	Project-Required Groundwater Detection Limit
Physical Parameters			
TDS	SM 2540C	4 mg/L	10 mg/L
TSS	SM 2540C	4 mg/L	10 mg/L
Common Ions			
Alkalinity	SM 2320B	4 mg/L	4 mg/L
Sulfate	300.0	1 mg/L	1 mg/L
Chloride	300.0/SM 4500CL-B	1 mg/L	1 mg/L
Fluoride	A4500-F C	0.1 mg/L	0.1 mg/L
Calcium	215.1/200.7	1 mg/L	1 mg/L
Magnesium	242.1/200.7	1 mg/L	1 mg/L
Sodium	273.1/200.7	1 mg/L	1 mg/L

Parameter	Analytical Method(1)	Project-Required Surface Water Detection Limit	Project-Required Groundwater Detection Limit
Potassium	258.1/200.7	1 mg/L	1 mg/L
Nutrients			
Nitrate+Nitrite as N	353.2	0.003 mg/L	0.1 mg/L
Total Persulfate Nitrogen	A 4500-N-C	0.04 mg/L	--
Total Phosphorus	E365.1	0.003 mg/L	--
Trace Constituents (SW - Total Recoverable except Aluminum Dissolved], GW - Dissolved)(2)			
Aluminum (Al)	200.7/200.8	0.009 mg/L	0.009 mg/L
Antimony (Sb)	200.7/200.8	0.0005 mg/L	0.0005 mg/L
Arsenic (As)	200.8/SM 3114B	0.001 mg/L	0.001 mg/L
Barium (Ba)	200.7/200.8	0.003 mg/L	0.003 mg/L
Beryllium (Be)	200.7/200.8	0.0008 mg/L	0.0008 mg/L
Cadmium (Cd)	200.7/200.8	0.00003 mg/L	0.00003 mg/L
Chromium (Cr)	200.7/200.8	0.01 mg/L	0.01 mg/L
Cobalt (Co)	200.7/200.8	0.01 mg/L	0.01 mg/L
Copper (Cu)	200.7/200.8	0.002 mg/L	0.002 mg/L
Iron (Fe)	200.7/200.8	0.02 mg/L	0.02 mg/L
Lead (Pb)	200.7/200.8	0.0003 mg/L	0.0003 mg/L
Manganese (Mn)	200.7/200.8	0.005 mg/L	0.005 mg/L
Mercury (Hg)	245.2/245.1/200.8/SM 3112B	0.000005 mg/L	0.000005 mg/L
Molybdenum (Mo)	200.7/200.8	0.002 mg/L	0.002 mg/L
Nickel (Ni)	200.7/200.8	0.001 mg/L	0.001 mg/L
Selenium (Se)	200.7/200.8/SM 3114B	0.0002 mg/L	0.0002 mg/L
Silver (Ag)	200.7/200.8	0.02 mg/L	0.02 mg/L
Strontium (Sr)	200.7/200.8	0.0002 mg/L	0.0002 mg/L
Thallium (Tl)	200.7/200.8	0.0002 mg/L	0.0002 mg/L
Uranium (U)	200.7/200.8	0.008 mg/L	0.008 mg/L
Zinc (Zn)	200.7/200.8	0.002 mg/L	0.002 mg/L
Field Parameters			
Stream Flow	HF-SOP-37/-44/-46	NA	NA
Water Temperature	HF-SOP-20	0.1 °C	0.1 °C
Dissolved Oxygen (DO)	HF-SOP-22	0.1 mg/L	0.1 mg/L
pH	HF-SOP-20	0.1 s.u.3	0.1 s.u.
Specific Conductance (SC)	HF-SOP-79	1 µmhos/cm	1 µmhos/cm

(1) Analytical methods are from *Standard Methods for the Examination of Water and Wastewa*ter (SM) or EPA's *Methods for Chemical Analysis of Water and Waste* (1983).
(2) Samples to be analyzed for dissolved constituents will be field-filtered through a 0.45 µm filter.
(3) s.u. = standard units

2.2.4.1 Surface Water Monitoring

Tintina established eleven surface water stations as baseline monitoring sites (Figure 2.2) and began monitoring at these sites in May 2011 with subsequent quarterly monitoring events scheduled in the months of August, November, March, and May of each year. Monitoring includes flow, stage, and field parameters (temperature, pH, and specific conductance (SC)) at all of these sites and collection of water quality samples at six of the sites (Table 2-7) during quarterly monitoring. In July 2011, surface water samples were collected from two sites (G-1 and G-2) downgradient of where gossan outcropped in the streambed to evaluate if exposed gossan affected surface water quality. This was a one-time monitoring event and these sites are not included as part of the long-term baseline monitoring program. Beginning in 2014, Tintina began monthly sampling of sites on the main stem of Sheep Creek. An additional site (SW-14) was established on Little Sheep Creek in 2016 and added to the monthly monitoring program.

2.2.4.2 Stream Flow

Table 2-9 summarizes instantaneous flow measurements from monthly and quarterly monitoring results for each of the surface water monitoring sites. Instantaneous flows estimated for Sheep Creek at SW-1 during May / June have ranged from approximately 100 to more than 600 cfs (2.8 to 17.0 m^3/sec). Flow in Sheep Creek during late summer/fall ranges from 7 to 30 cfs (0.20 to 0.85 m^3/sec) at the upstream monitoring site SW-2 and 10 to 34 cfs (0.28 to 0.96 m^3/sec) at the downstream monitoring site SW-1. Individual measurements typically showed an increase in flow by 25% to 50% between SW-2 to SW-1. Stream flow declines rapidly in late June/early July averaging 10 cfs to 30 cfs (0.28 to 0.85 m^3/sec) by late summer and 10 to 15 cfs (0.28 to 0.42 m^3/sec) by late winter.

Tintina has installed a stilling well with a transducer at monitoring site SW-1 that allows collection of seasonal baseline stage and discharge monitoring in Sheep Creek. Data collected at this site shows flows in excess of 100 cfs (2.8 m^3/sec) in Sheep Creek from mid-May-through mid-June, with high flow estimates of 200 cfs to more than 800 cfs (5.66 to more than 22.65 m^3/sec).

In addition to the flow monitoring at baseline monitoring sites, Tintina has also measured stream flow on a monthly basis in Sheep Creek at the former upstream USGS-SC1 gaging site since May 2014 with concurrent measurements at SW-1 and SW-2 to allow correlation of the stream flows between the sites. Stream flow in Sheep Creek increases between the upstream USGS-SC1 site and downstream SW-1 by a factor of up to 2.5 during spring run-off, after which time the increased flow diminishes and flows at the two sites become nearly equal in late August when tributary inflows downstream of USGS-SC1 are diverted for irrigation. Downstream flows increase after the irrigation season ends and the flow measurements show an approximately 50% increase in stream flow between USGS-SC-1 and SW-1 in early spring.

Table 2-9. Summary of Stream Flow Monitoring Data

Monitoring Station	Stream	March	May/June	August/Nov
		Measured Stream Flow (cfs)		
SW-1	Sheep Creek	30-41	111-613	10-34
SW-2	Sheep Creek	Frozen	98-250	7-30
SW-3	Coon Creek	0.22	0.3-5	0.08-0.34
SW-4	Coon Creek	0.16	0.2-2	0.01-0.4
SW-6	Unnamed tributary to Black Butte Creek	0.04-0.26	0.5-4	0.17-0.33
SW-7	Unnamed tributary to Black Butte Creek	0-0.4	0-0.3	0.001-0.01
SW-8	Little Sheep Creek	1.7	1-9	0.2-1
SW-9	Black Butte Creek	0.3-1.8	2.3-12.7	0.3-0.8
SW-10	Black Butte Creek	Frozen	1.7-15.2	0.3-0.5
SW-11	Black Butte Creek	1.0-2.9	1.6-21.4	0.4-1.0
SW-14	Little Sheep Creek	1.6	7.6-11.8	0.8-1.1

The observed increase in stream flow between SW-2 and SW-1 is accounted for during high flow season by inflow from Little Sheep Creek; however, during steady state base flow periods the increase is not accounted for by Little Sheep Creek or other monitored tributaries and is likely attributable to inflow from groundwater and unmonitored springs and tributaries on inaccessible private property to the north of Sheep Creek.

2.2.4.3 Surface Water Quality

Appendix B (Hydrometrics, 2017a) of this Permit Application is a Baseline Water Resources Report and Appendix B-A of this Application provides electronic water quality data for each of the surface water monitoring sites. Appendix B-A of this Application (Hydrometrics, 2017a, on CD), contains water quality statistics for individual sites in the Baseline Report. Analytical results for surface water samples collected from within the Project area show neutral to slightly alkaline pH values (6.8 to 8.6), and low to moderate specific conductance (49 to 487 µmhos/cm). Calcium and bicarbonate dominate the major ion chemistry of waters. Hardness typically ranges from approximately 73 to 256 mg/L. Metals data show infrequent excursions above DEQ-7 (MDEQ, 2012a) water quality standards for selected metals (aluminum and iron) during high run-off events. Samples collected from gossan sites G-1 and G-2 were similar to the long-term water quality monitoring sites and therefore they were not added to the long-term baseline water resource monitoring program. The following constituents showed surface water standard exceedances:

- Total recoverable iron exceeded the chronic aquatic criteria of 1 mg/L during peak run-off periods at all sites except SW-6 and SW-11 (2011), SW-3 (2012), and SW-14 (2016).
- Dissolved aluminum concentrations often exceeded the chronic aquatic criteria of 0.087 mg/L during periods of high run-off in Sheep Creek (SW-1, SW-2, and USGS SC-1) and in Black Butte Creek (SW-11).
- Thallium exceeded the human health surface water standard of 0.00024 mg/L at SW-3 during three separate monitoring events in 2011.

Sheep Creek is included in DEQs 303(d) list of impaired streams for dissolved aluminum and *Escherichia coli*. The exceedances of dissolved aluminum occur during spring run-off near peak flow, when turbidity is high. Elevated dissolved aluminum values from highly turbid water are not unusual, and have been observed in many different geographic areas, during high flow events under what are “natural” conditions. Nonetheless, DEQ conducted a broad monitoring program in the Sheep Creek drainage for further data collection that could be used for development of a TMDL if deemed necessary. DEQ has not issued a completion schedule for establishing a TMDL.

2.2.4.4 Groundwater Monitoring

Section 1.4 of this Permit Application provides a description of the surficial and bedrock geology of the Project area. Monitoring wells and test wells are completed within shallow and deep stratigraphic units to define baseline water levels, groundwater flow directions and ground-water quality within the Project area. Well locations are shown on Figure 2.3 and well completion data is summarized in Table 2-10. A series of paired monitoring wells (MW-1A/1B, MW-2A/2B, MW-4A/4B, and MW-6A/6B; Figure 2.3) installed between 2011 and 2013 help document baseline conditions within the unconsolidated Quaternary / Tertiary clayey gravel deposits and in the underlying shallow bedrock groundwater system. Wells completed in alluvium and shallow unconsolidated overburden include MW-1A, MW-4A and MW-6A. Six monitoring wells were installed in 2016 to evaluated shallow groundwater in the vicinity of the CTF (MW-10 through MW-13) and groundwater in the eastern UIG area (MW-14 and MW-15).

In addition to these monitoring wells, 10 test wells (PW-1 through PW-10) (Figure 2.3) installed for aquifer testing provide information on both the hydrologic characteristics and water quality within representative stratigraphic units. Figure 2.7 shows generalized north-south geologic cross-section depicting completion units for all of the monitoring and test wells. Table 2-10 includes the completion details of each of these wells.

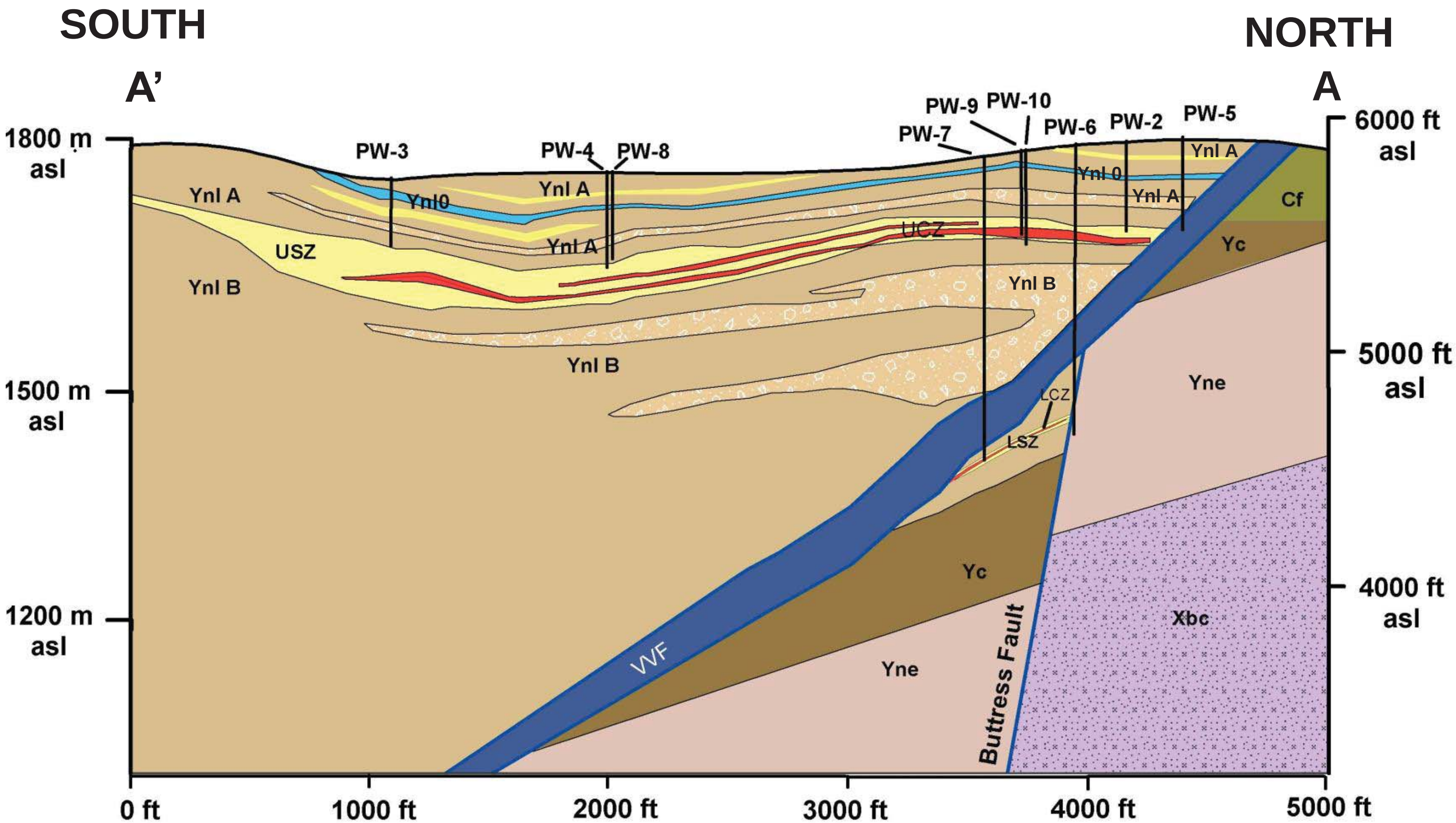
Twelve piezometers allow monitoring of the groundwater levels in the alluvial / colluvial systems of Sheep Creek, Coon Creek, and Dry Creek (Figure 2.3).

2.2.4.5 Groundwater Flow Directions

Figure 2.8 shows a compilation of water level data from the November 2016 sampling round (Hydrometrics, 2017a). The potentiometric surface shows an eastward trending flow direction in the bedrock groundwater system within the Project area consistent with the general topographic trend in the greater area. The potentiometric contours of the bedrock hydrologic system indicate hydraulic gradients ranging from 0.04 in the eastern UIG area to 0.1 in UCZ area. Groundwater in the Sheep Creek alluvium generally flows parallel to the creek; then turns northwest and finally turns to the north as Sheep Creek bends to the north around Strawberry Butte (Figure 2.8). Groundwater continues to flow north towards Sheep Creek as the creek crosses the northern extents of the alluvial system and enters a small canyon. The hydraulic gradient in the alluvial system is relatively flat (0.008) through most of the monitoring area and then increases slightly to 0.013 in the northern portion of the valley. Water level elevations at PZ-04 and PZ-05 (located in the northern portion of the alluvial valley, see Figure 2.8) typically rest near or above the ground surface. The increased gradient and near surface water level elevations in this area indicate that the alluvial groundwater system discharges to surface water as the alluvium thins and then pinches out against the less permeable bedrock which forces the water upward as Sheep Creek flows over the bedrock rise and downstream into the canyon.

Well pairs MW-1A/1B and PZ-07A/7B have downward hydraulic gradients that indicate that the surficial groundwater systems are likely perched systems that are not fed by the deeper bedrock aquifers in these areas. In contrast, all of the other well pairs (MW-2A/2B, MW-4A/4B, and MW-6A/6B) show upward hydraulic gradients. In addition, there is one set of triplet wells on site, PW-9, PW-10, and MW-9, completed in the Upper Copper Zone (*UCZ), Ynl B*, and *Ynl A* hydro-stratigraphic units (Figure 2.7), respectively. Water level elevations at these wells show a large upward gradient between the Upper Sulfide Zone (*USZ*, PW-9) to *Ynl A* and a downward gradient from *USZ* to *Ynl B* bedrock system. Note that *Ynl A* and *Ynl B* refer to hydro-stratigraphic units, not geologic units, though they presumably follow local geologic boundaries. *Ynl A* refers to the Lower Newland Formation shale above the *USZ* and below the Upper Newland Formation carbonates, while *Ynl B* refers to the Lower Newland Formation rocks below the *USZ* and above the Volcano Valley Fault. The hydrologic investigations define a separate hydro-stratigraphic unit coincident with the Upper Sulfide Zone (*USZ*).

Figure 2.7 is a schematic diagram showing the relationship of well completion depth intervals with geologic and hydro-stratigraphic units (as shown on the generalized geologic cross-section).



Notes: (1) See Figures 1.5 and 1.6 for rock unit descriptions
(2) See Figure 1.5 for cross-section A-A' line
(3) Test Wells are projected on cross-section to show tested HSUs; horizontal locations do not represent actual location

Prepared by Tintina and Hydrometrics (2016)

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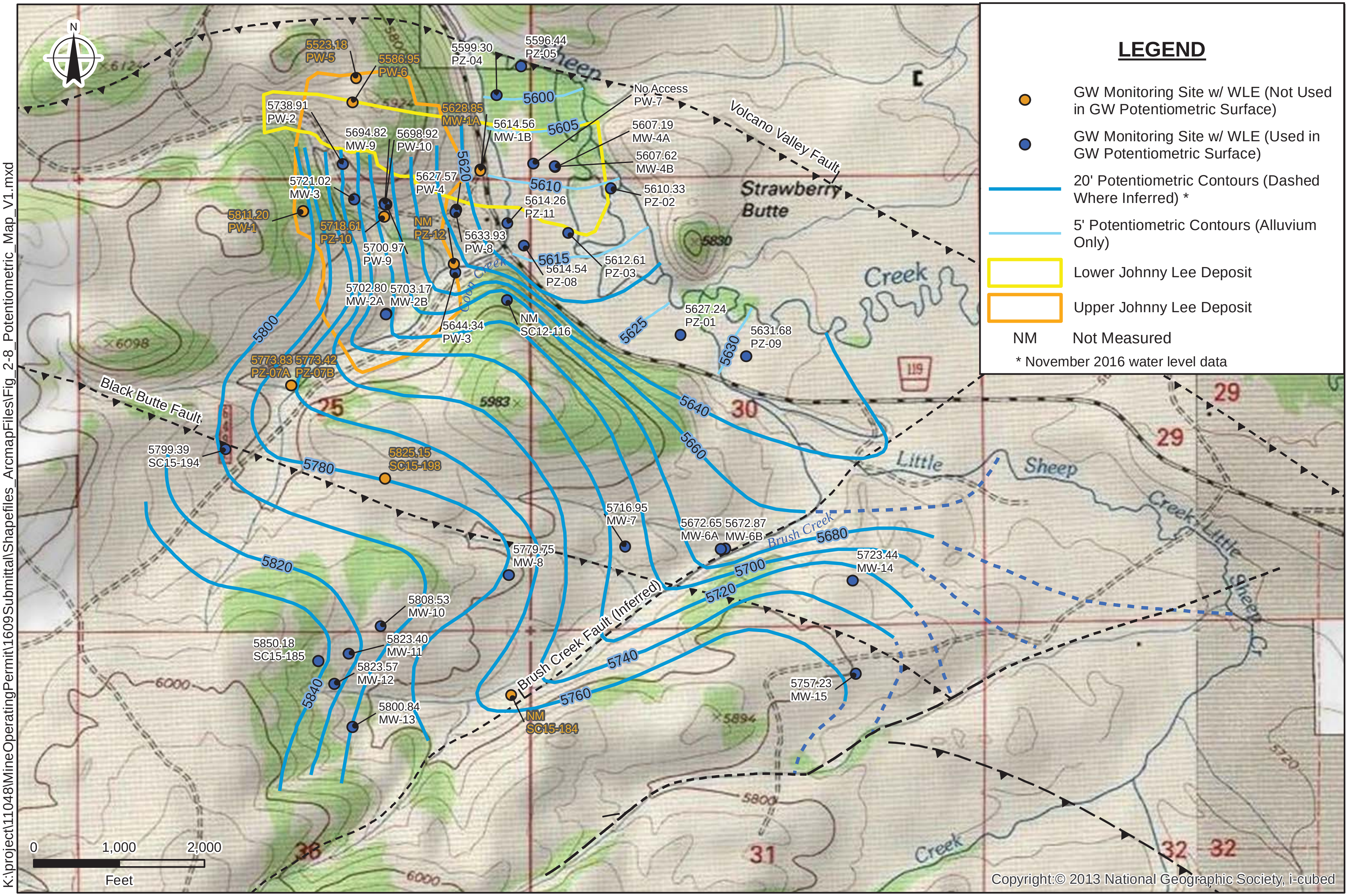
VVF = Volcano Valley Fault

PW-5 | Well location with identification number

Figure 2.7
Generalized Geologic Cross-Section A-A' Showing Well Locations
Black Butte Copper MOPA
Meagher County, Montana



Hydrometrics, Inc.
Consulting Scientists and Engineers

Figure 2.8
Potentiometric Surface Map
Black Butte Copper Project
Meagher County, Montana

Table 2-10. Well Completion Data

Well Name	Northing (meters)	Easting (meters)	Ground Surface Elev.	Measuring Point Elev.	Borehole Total Depth	Well Total Depth	Screen Interval	Hydro-stratigraphic Unit	Year Drilled	Purpose
			(feet, amsl)							
	UTM Zone 12 North				(feet, bgs)					
Monitoring Wells										
MW-1A	5,180,841.55	506,935.22	5635.81	5637.73	38	34	25 - 34	Overburden	2011	Baseline East of USZ
MW-1B	5,180,845.46	506,934.19	5636.14	5637.9	98	98	88 - 98	YNL-A		
MW-2A	5,180,331.93	506,598.18	5743.72	5745.31	62	62	52 - 62	Shallow Bedrock	2011	Baseline East of Coon Creek
MW-2B	5,180,328.73	506,596.96	5743.44	5745.53	80	80	70 - 80	YNL-A		
MW-3	5,180,740.22	506,484.07	5760.06	5762.17	305	305	285 - 305	USZ	2011	Baseline USZ
MW-4A	5,180,855.43	507,201.47	5610.12	5612.12	23	23	14-23	Sheep Creek Alluvium	2012	Baseline Sheep Cr. Alluvium
MW-4B	5,180,858.49	507,200.12	5610.07	5612.07	59	59	39-59	YNL-A	2012	Baseline YNL-A below Sheep Cr. Alluvium
MW-5	**Not Drilled**									
MW-6A	5,179,492.85	507,809.18	5680.08	5681.87	20	15	5-15	Quarternary	2013	UIG
MW-6B	5,179,490.71	507,792.76	5683.41	5685.31	50	50	40-50	Dolostone	2013	
MW-7	5,179,500.71	507,451.70	5747.48	5749.46	50	50	40-50	Dolostone	2013	UIG
MW-8	5,179,398.31	507,036.00	5809.1	5810.93	80	80	70-80	Dolostone	2013	UIG
MW-9	5,180,725.46	506,592.96	5744.35	5745.8	143.7	128	108-128	YNL-A	2014	Baseline YNL-A Characterization
MW-10	5,179,215.05	506,578.57	5882.78	5886.11	90	90	70-90	Granodiorite	2016	Baseline CTF
MW-11	5,179,117.47	506,464.72	5854.74	5857.86	70	70	50-70	Granodiorite	2016	Baseline CTF
MW-12	5,179,010.38	506,412.82	5841.51	5844.75	60	60	40-60	Granodiorite	2016	Baseline CTF
MW-13	5,178,855.81	506,477.79	5819.07	5822.48	40	40	20-40	Dolostone	2016	Baseline CTF
MW-14	5,179,376.77	508,255.63	5761.16	5763.873	68	66	56-66	YNL	2016	Eastern UIG
MW-15	5,179,071.07	508,290.89	5795.26	5797.34	80	80	70-80	YNL	2016	Eastern UIG

Well Name	Northing (meters)	Easting (meters)	Ground Surface Elev.	Measuring Point Elev.	Borehole Total Depth	Well Total Depth	Screen Interval	Hydro-stratigraphic Unit	Year Drilled	Purpose
			(feet, amsl)							
	UTM Zone 12 North				(feet, bgs)					
Test Wells										
PW-1	5,180,698.40	506,301.42	5912.07	5913.74	213	211	140-211	YNL-A - Perched	2011	Previous Decline
PW-2	5,180,865.03	506,443.15	5793.08	5794.88	215	212	132 - 212	USZ	2011	Previous Decline
PW-3	5,180,479.42	506,846.43	5655.21	5657.42	131	127	90-127	YNL-A	2012	Expl Decline
PW-4	5,180,701.75	506,849.44	5678.13	5680.01	242	239	200-239	USZ	2012	Expl Decline
PW-5	5,181,172.77	506,490.68	5913.22	5915.49	555	500	515-555	Volcano Valley Fault	2013	Volcano Valley Fault Hydrologic Characteristics
PW-6	5,181,085.67	506,477.44	5895.43	5897.4	1234	1204	1164-1204	Buttress Fault	2013	Buttress Fault Hydrologic Characteristics
PW-6N	5,181,085.67	506,477.44	5895.43	5897.4	1358	1358	Open Borehole 1234-1358	Niehart Quartzite	2015	Baseline YNE Hydrologic Characterization
PW-7	5,180,867.59	507,122.89	5609.11	5611.15	1350	1346	1306-1346	LCZ	2013	Baseline LCZ Characterization
PW-8	5,180,695.53	506,846.19	5679.12	5680.6	184	178.5	138.5-178.5	YNL-A	2014	Baseline YNL-A Characterization
PW-9	5,180,721.88	506,598.38	5743.59	5745.05	255.5	255.5	215.5-255.5	UCZ	2014	Baseline UCZ Characterization
PW-10	5,180,721.88	506,593.55	5743.57	5744.84	369.5	358.5	318.5-358.5	YNL-B	2014	Baseline YNL-B Characterization
SC15-184*	5,178,972.53	507,047.34	5747	5747	99	85	55-85	Granodiorite	2015	Project Facilities Baseline Characterization
SC15-185*	5,179,094.24	506,355.46	5917	5917	99	80	60-80	Granodiorite	2015	Project Facilities Baseline Characterization

Well Name	Northing (meters)	Easting (meters)	Ground Surface Elev.	Measuring Point Elev.	Borehole Total Depth	Well Total Depth	Screen Interval	Hydro-stratigraphic Unit	Year Drilled	Purpose
			(feet, amsl)							
	UTM Zone 12 North				(feet, bgs)					
SC15-194*	5,179,854.92	506,014.14	5878	5878	99	80	60-80	YNL-A	2015	Project Facilities Baseline Characterization
SC15-198*	5,179,854.92	506,621.36	5815	5815	99	70	60-70	YNL-A	2015	Project Facilities Baseline Characterization
Piezometers										
PZ-01	5,180,255.63	507,650.01	5628.69	5630.34	NA	5	2.3-5.3	Alluvium	2012	Alluvium Water Level Monitoring
PZ-02	5,180,778.79	507,400.72	5611.81	5613.51	NA	5	2.3-5.3	Alluvium	2012	Alluvium Water Level Monitoring
PZ-03	5,180,618.91	507,249.21	5616.08	5616.08	NA	9	6.3-9.3	Alluvium	2012	Alluvium Water Level Monitoring
PZ-04	5,181,110.82	506991..74	5599.34	5602.7	NA	8	4.7-7.7	Alluvium	2012	Alluvium Water Level Monitoring
PZ-05	5,181,214.68	507,080.04	5598.16	5599.79	NA	5	2.4-5.4	Alluvium	2012	Alluvium Water Level Monitoring
PZ-07A	5,180,074.65	506,258.39	5776.57	5777.5	NA	6	3-6	Alluvium	2014	Alluvium Water Level Monitoring
PZ-07B	5,180,075	506,258.47	5776.57	5777.59	NA	11	8-11	Alluvium	2014	Alluvium Water Level Monitoring
PZ-08	5,180,573.81	507,090.31	5618.9	5621.29	NA	12	7-12	Alluvium	2014	Alluvium Water Level Monitoring
PZ-09	5,180,178.58	507,883.78	5634.73	5637.27	NA	10	5-10	Alluvium	2014	Alluvium Water Level Monitoring
PZ-10	5,180,679.01	506,590.91	5723.51	5727.42	NA	11	9-11	Alluvium	2014	Alluvium Water Level Monitoring
PZ-11	5,180,654.89	507,031.15	5618.77	5622.24	NA	11	9-11	Alluvium	2014	Alluvium Water Level Monitoring
PZ-12	5,180,509.42	506,839.49	5644.56	5646.55	NA	7	5-7	Alluvium	2014	Alluvium Water Level Monitoring

Notes: *Northings, Eastings, and elevations are approximate. Wetland piezometers BB WM1 through BB WM8 well completion data are all in progress.

2.2.4.6 Groundwater Quality

Groundwater in shallow alluvial wells and shallow bedrock wells is calcium/magnesium bicarbonate type water with near neutral pH and moderately low dissolved solids. One exception is well MW-1B, which has calcium/magnesium sulfate type water with a lower pH range (6.02 to 6.51 s.u.) and moderate dissolved solids (336 to 425 mg/L). The water quality at MW-1B completed in *Ynl A* hydro-stratigraphic unit is similar to MW-3 and test well PW-4, both of which are completed in the Upper Sulfide Zone (*USZ*).

Wells completed in alluvium and shallow unconsolidated overburden include MW-1A, MW-4A, and MW-6A. These wells have neutral pH water (6.24 to 7.66 s.u.) with generally low to non-detectable concentrations of dissolved metals. MW-1A, however, periodically exhibits variable water quality with some excursions of arsenic, barium, iron, lead, manganese, and thallium above human health standards. Well MW-1A is screened in fine-grained sediments and monitoring events which detected metals at higher concentrations may reflect breakthrough of particulate through the filters due to the very high turbidity.

Wells completed in shallow bedrock above the Upper Sulfide Zone (*USZ*) include MW-2A, MW-2B, MW-4B, MW-6B, MW-7, MW-8, MW-9, and test wells PW-1, PW-3, and PW-8. Dissolved trace constituents that are present at detectable concentrations in these wells include arsenic, barium, iron, manganese, strontium, thallium, and uranium. The concentration of thallium at MW-2B (0.0024-0.004 mg/L) exceeds the groundwater standard of 0.002 mg/L. Thallium concentrations at the other shallow bedrock wells fall below regulatory limits. All other parameters in the shallow aquifer meet applicable regulatory limits. While thallium is present at detectable concentrations in MW-3 and PW-4, it does not exceed the groundwater standard.

Wells completed in the Upper Sulfide Zone (MW-3, PW-4, and PW-9) have the highest concentrations of dissolved solids and sulfate compared to the other wells. As previously discussed, MW-1B has similar water quality to these Upper Sulfide Zone wells. The pH of water at these Upper Sulfide Zone wells ranges from 6.04 to 7.31 s.u. which is slightly lower than other wells. Detectable dissolved trace constituents in the Upper Sulfide Zone wells include antimony, arsenic, barium, cobalt (MW-1B only), iron, lead, manganese, mercury, molybdenum, nickel, strontium, thallium, uranium, and zinc. Strontium concentrations range from 8.08 to 16.2 mg/L at MW-3, and PW-4 and exceed the human health standard of 4 mg/L. Arsenic concentrations at MW-1B, MW-3 and PW-4 range from 0.054 mg/L to 0.09 mg/L and exceed the human health standard of 0.010 mg/L. Arsenic speciation of samples from MW-1B and MW-3 indicate that the majority of the arsenic is present in reduced form as As (III), which would likely oxidize in contact with atmospheric oxygen and co-precipitate with iron as a ferri-hydroxide complex. Concentrations of thallium at MW-1B (0.013 mg/L) also exceed the human health groundwater standard of 0.002 mg/L.

Analytical results from PW-7 (completed in the Lower Sulfide Zone) indicate a sodium/potassium bicarbonate type water with highly basic pH (10.77 to 11.58 s.u.), and with higher concentrations of chloride and lower concentrations of sulfate than other wells on site. Trace constituents detected above the reporting limit include aluminum, antimony, arsenic, barium, molybdenum, selenium, strontium, and zinc. Dissolved aluminum concentrations (0.187 to 1.03 mg/L) were much higher than observed at other wells on the site. Antimony was the only trace constituent that exceeded the groundwater human health standard. This sample provides an initial assessment of the water quality in PW-7. However, the well did not produce sufficient water to allow for field parameter stabilization and drill mud was found in the well during the initial water level measurements and in subsequent monitoring events. These factors along with the atypical water quality including elevated aluminum, chloride, and sodium suggest the water quality from PW-7 may be contaminated from drilling muds and fluids.

Wells completed in the vicinity of the CTF (MW-10 through MW-13) have a calcium bicarbonate type water with low concentrations of magnesium and sulfate. All of the wells have near neutral pH and specific conductance concentrations ranging from 364 to 434 µmhos/cm. Dissolved metals concentrations were all below the human health standard. Concentrations for most dissolved trace constituents at wells MW-11, MW-12, and MW-13 were below or at the detection limit; trace constituents above the detection limit during a majority of the monitoring events include dissolved barium and strontium in all three wells, dissolved aluminum in wells MW-11 and -13, and dissolved iron in MW-11. Dissolved trace constituents are elevated in well MW-10 compared to the other CTF wells. Trace constituents above the detection limit in the majority of the samples from MW-10 include: dissolved aluminum, barium, iron, manganese, molybdenum, nickel, selenium, strontium and uranium.

Wells MW-14 and MW-15 were installed in the eastern UIG area (Hydrometrics, 2017b) to evaluate groundwater levels and water quality beneath the UIG. Groundwater from these wells are similar to other shallow wells in the area; which have a calcium bicarbonate type water with near neutral pH and specific conductance concentrations ranging from 411 to 498 µmhos/cm. Dissolved metals concentrations were all below groundwater standards and dissolved trace constituent concentrations were below or near the detection limit at both wells. Trace constituents detected in MW-14 and MW-15 above the reporting limit include dissolved aluminum, arsenic, barium, iron, manganese, strontium, and zinc. Water quality results from well MW-14 detected dissolved antimony, lead, molybdenum, nickel, and selenium above the reporting limit. The additional metals detected in MW-14 may be a result of the high suspended solids in the discharge from the well. Depth to the top of the water table in these two wells is about 40 feet.

2.2.4.7 Seeps and Springs

A field inventory completed in 2011 (Hydrometrics, 2011a) identified and mapped 9 seeps and 13 springs in the Project area and included sampling of some annually in the spring for water quality and flow. A field survey collected a second series of flow measurements and water quality samples of seeps and springs during July 2012. A number of springs discharge along the Volcano Valley Fault where the Flathead sandstone lies in contact with the Newland Formation (Chen-Northern, 1989). Seeps and springs are identified on Figure 2.4.

Identified small springs or seeps are typically located in ephemeral channels in the headwaters of small, unnamed tributaries. These springs form small boggy areas with limited flow and generally re-infiltrate within a few hundred feet downstream. A number of these springs (indicated by a DS designator (developed spring), Table 2-11) have been developed for stock watering and feed small livestock watering tanks. Slightly larger springs and seeps identified along the lower reaches of Coon Creek and on Little Sheep Creek support perennial downstream flow. Observed flow rates at the springs ranged from less than 1 gpm to over 100 gpm (4 to 379 Lpm) (Table 2-11).

Table 2-11. Summary of Spring Flow Data

Sta. Name	Flow Rate (gpm)			Sta. Name	Flow Rate (gpm)		
	min	max	avg		min	max	avg
SP-1	1.4	65	22	DS-1	<0.5	35	12
SP-2	2.2	9.4	6.9	DS-2	<0.5	12	4.7
SP-3	0.6	5.4	2.8	DS-3	4.9	117	38
SP-4	5.4	27	13	DS-4	2.2	20	8.7
SP-6	0.9	3.0	1.8	DS-5	<1	18	6.7
SP-7	9.4	112	38	DS-6	<0.5	18	7.3
SP-8	8.1	8.1	8.1				
SP-9	5.4	15	9.4				
SP-10	3.6	8.1	5.8				

Water samples from five of the primary spring sites (SP-1, SP-2, SP-3, SP-4, and SP-6) surrounding the proposed facility area exhibit neutral to slightly alkaline pHs (6.20-8.21 s.u.) with moderate to high alkalinities (50-240 mg/L). Background nitrate concentrations are low (<0.1 - 0.68 mg/L) at all of the spring sites. Metals concentrations are all within regulatory limits. However, SP-3 exhibits slightly higher concentrations of some dissolved metals (aluminum, copper, and chromium), but all are well below regulatory standards.

2.2.5 Aquifer Characterization Investigations

Tintina conducted a series of aquifer tests, including both slug tests and short-term and long-term pumping tests at the site to characterize the hydrogeologic characteristics of the principal hydro-stratigraphic units and the fault systems that bound the copper-rich deposits. Table 2-12 presents information for each test and the estimated aquifer characteristics derived from test results.

Aquifer testing at MW-4A indicates the Sheep Creek alluvial groundwater system is highly permeable with an estimated hydraulic conductivity of approximately 200 feet (61 m) per day. Underlying bedrock units exhibit much lower permeabilities. Hydraulic conductivity is the rate at which water can move through various (usually natural) media, and in this document it is typically measured in feet/day (or cm/sec). The highest conductivities within the Lower Newland Formation occur within the *Ynl A,* above the *Upper Sulfide Zone*, which exhibits hydraulic conductivities ranging from 1 to 5 feet per day (0.3 to 1.5 m/day). The permeability of the bedrock decreases by one to two orders of magnitude in the underlying *USZ* with hydraulic conductivities ranging from 0.01 to 1 ft. /day (0.003 to 0.3 m/day). The permeability of the *LSZ* is also low with hydraulic conductivities of 0.1 to 0.2 ft. /day (0.03 to 0.06 m/day).

In addition to testing of specific hydro-stratigraphic units, aquifer testing was conducted to evaluate the groundwater response in the vicinity of three different surface facility areas (CTF, central UIG, and eastern UIG). The shallow bedrock beneath the CTF have conductivities ranging from 0.001 to 10 ft./day (0.0003 to 3 m/day). The lower conductivity is associated with intrusive granodiorite. The median conductivity in the central UIG area is approximately 4 ft./day (1.2 m/day). Hydraulic conductivities in the eastern UIG vary with depth. Wells MW-14 and MW-15, which are completed approximately 30 feet below the top of the water table, have conductivities of about 0.3 ft./day (0.09 m/day). The conductivity calculated from the infiltration tests adjacent to well MW-14 and MW-15, which represent the conductivity at the top of the water table, range from 7.5 to 10 ft./day (2.3 to 3 m/day). Details of the testing conducted in the vicinity of the CTF and eastern UIG are summarized in Appendix B-1 and B-2, respectively. Curve matches for all of the testing is provided in Appendix B-D.

Table 2-12. Summary of Aquifer Test Results

Observation Well	Analysis Method	Pumping Test	Hydraulic Conductivity (ft./day)	Hydraulic Conductivity (cm/sec)	Storativity
Alluvium					
MW-4A	Springer-Gelhar	MW-4A (slug)	216	7.6E-02	NA
	Springer-Gelhar		210	7.4E-02	NA
	Springer-Gelhar		208	7.3E-02	NA
Perched Aquifer					
PW-1	Theis	PW-1	0.07	2.5E-05	NA
	Moench		0.03	1.1E-05	NA
	Theis-Rec.		0.07	2.5E-05	NA
Central UIG					
MW-6B	Hvorslev	MW-6B (slug)	13.3	4.7E-03	NA
	Hvorslev		14.2	5.0E-03	NA
	Hvorslev		14.2	5.0E-03	NA
MW-7	Hvorslev	MW-7 (slug)	1	3.5E-04	NA
MW-8	Hvorslev	MW-8 (slug)	3.7	1.3E-03	NA
	Hvorslev		3.8	1.3E-03	NA
Eastern UIG					
MW-14	Bouwer-Rice	MW-14 (slug)	0.33	1.2E-04	NA
	Hantush	MW-14 (infiltration)	8	2.8E-03	NA
MW-15	Bouwer-Rice	MW-15 (slug)	0.24	8.5E-05	NA
	Bouwer-Rice		0.25	8.8E-05	NA
	Hantush	MW-15 (infiltration)	10	3.5E-03	NA
Cemented Tailings Facility					
MW-10	Bouwer-Rice	MW-10 (slug)	0.001	3.5E-07	NA
MW-11	Bouwer-Rice	MW-11 (slug)	0.4	1.4E-04	NA
	Bouwer-Rice		0.4	1.4E-04	NA
	Bouwer-Rice		0.4	1.4E-04	NA
MW-12	Bouwer-Rice	MW-12 (slug)	8	2.8E-03	NA
	Bouwer-Rice		9	3.2E-03	NA
	Bouwer-Rice		10	3.5E-03	NA
MW-13	Bouwer-Rice	MW-13 (slug)	1.4	4.9E-04	NA
	Bouwer-Rice		1.9	6.7E-04	NA

Observation Well	Analysis Method	Pumping Test	Hydraulic Conductivity (ft./day)	Hydraulic Conductivity (cm/sec)	Storativity
YNL-A					
MW-4B	Hvorslev	MW-4B (slug)	7.4	2.6E-03	NA
	Hvorslev		7.0	2.5E-03	NA
	Hvorslev		7.3	2.6E-03	NA
PW-3	Theis	PW-3	2.1	7.4E-04	NA
	Moench		1.6	5.6E-04	NA
	Theis-Rec.		1.1	3.9E-04	NA
	Theis	PW-8	5.8	2.0E-03	1.00E-04
	Moench		5.5	1.9E-03	8.00E-06
	Theis-Rec.		4.6	1.6E-03	NA
PW-8	Theis	PW-8	2.3	8.1E-04	NA
	Moench		1.0	3.5E-04	NA
	Theis-Rec.		1.3	4.6E-04	NA
USZ/UCZ					
PW-2	Theis	PW-2	0.06	2.1E-05	NA
	Moench		0.3	8.8E-05	NA
	Theis-Rec.		0.1	3.9E-05	NA
PW-4	Theis	PW-4	0.02	7.1E-06	NA
	Moench		0.01	3.5E-06	NA
	Theis-Rec.		0.02	7.1E-06	NA
PW-9	Theis	PW-9	0.2	8.5E-05	NA
	Moench		0.2	7.1E-05	NA
	Theis-Rec.		0.7	2.5E-04	NA
MW-3	Theis	PW-2	0.3	1.0E-04	2.70E-06
	Moench		0.3	8.8E-05	1.20E-04
	Theis-Rec.		0.2	7.1E-05	NA
	Theis	PW-9	0.7	2.5E-04	9.00E-05
	Moench		1.0	3.4E-04	6.00E-05
	Theis-Rec.		0.4	1.6E-04	NA
	Hvorslev	MW-3 (slug)	1.1	3.9E-04	NA
	Bouwer-Rice		1.1	3.9E-04	NA
YNL-B					
PW-10	Moench	PW-10	0.007	2.5E-06	NA
	Barker		0.006	2.1E-06	NA
	Theis-Rec.		0.001	3.5E-07	NA
LCZ					
PW-7	Bouwer	PW-7 (slug)	0.2	7.4E-05	NA
	Barker-Black		0.1	3.2E-05	NA
	Moench	PW-7	0.0003	1.1E-07	NA
	Barker		0.001	3.5E-07	NA
	Theis-Rec.		0.0003	9.9E-08	NA

Observation Well	Analysis Method	Pumping Test	Hydraulic Conductivity (ft./day)	Hydraulic Conductivity (cm/sec)	Storativity
Faults					
PW-5 (VVF)	Papadopolus	PW-5	0.09	3.2E-05	NA
	Barker		0.02	5.3E-06	NA
	Theis-Rec.		0.04	1.3E-05	NA
SC-11-008 (VVF)	Permeameter	NA	0.00003	1.00E-08	NA
SC-11-036 (VVF)	Permeameter	NA	0.00002	8.10E-09	NA
SC-12-129 (VVF)	Permeameter	NA	0.00002	5.40E-09	NA
SC-14-164 (VVF)	Permeameter	NA	0.00006	2.10E-08	NA
SC-14-170 (VVF)	Permeameter	NA	0.0007	2.50E-07	NA
PW-6 (Buttress Fault)	Papadopolus	PW-6	0.04	1.4E-05	NA
	Moench		0.01	3.5E-06	NA
	Theis-Rec.		0.004	1.3E-06	NA
	Barker		0.06	2.1E-05	NA
Core Holes					
AH-4	Theis	PW-1	0.6	2.1E-04	2.20E-05
	Moench		0.03	1.1E-05	8.00E-05
SC11-044	Theis	PW-2	0.3	1.1E-04	2.70E-06
	Moench		0.3	1.1E-04	1.20E-04
	Theis-Rec.		0.3	1.1E-04	NA
SC12-116	Theis	PW-3	1.2	4.2E-04	NA
	Moench		1.3	4.6E-04	NA
	Theis-Rec.		1.7	6.0E-04	NA

References: Barker (1988); Barker and Black (1983); Bouwer and Rice (1976); Hantush (1967); Hvorslev (1951); Moench (1984); Papadopulus and Cooper (1967); Springer and Gelhar (1991); Theis (1935)

Aquifer testing of wells completed in the Volcano Valley Fault and the Buttress Fault yielded hydraulic conductivity (K) estimates of 0.004 to 0.09 ft. /day (0.001 to 0.027 m/day). However, effects from the well casing and well annulus storage dominated these tests and were difficult to isolate. Therefore the actual permeability of the faults may be substantially lower. To further assess the permeability of the Volcano Valley Fault, Tintina carried out Flexible Wall Permeameter tests on five samples of the gouge material within the fault zone, from three separate exploration cores. The testing yielded extremely low hydraulic conductivity estimates ranging from 7.1×10^{-4} to 1.5×10^{-5} ft. /day with an average hydraulic conductivity of 2.8×10^{-5} ft. /day (10^{-8} cm/s).

In addition to the aquifer testing discussed above, deepening of well PW-6 in the spring of 2015 helped evaluate the hydrologic characteristics of the Neihart Formation quartzite on the north side of the Volcano Valley Fault. Since quartzite units can contain higher permeability zones when fractured, Tintina deepened well PW-6N into the Neihart Formation adjacent to the Buttress fault. Air testing of the open borehole in the Neihart Formation quartzite at this location produced 500 plus gallons (1,893 L) per minute and confirmed that there are high permeability fractures within the Neihart Formation quartzite adjacent to the Buttress Fault. This resulted in a change in mine planning.

Because interpreting the results of aquifer testing using hydraulic conductivity is not always intuitive to everyone, Table 2-13 is used to illustrate hydraulic conductivities of some natural materials to help to put some of the values cited above and elsewhere in this document into perspective. Note that Table 2-13 has rows ranking relative permeability (pervious, semi-pervious, and impervious) and the character of the resulting aquifer (good, poor, and none). Color coded on this table are various material types discussed throughout this document. Going from high to low hydraulic conductivity these units are:

1. Yellow – the sand and gravel alluvial aquifer of Sheep Creek (flows around 200 feet (60 m) per day).
2. Blue - The range of highly fractured shallow bedrock into which the proposed underground infiltration galleries will discharge treated water (flow range from 0.2 to 19 feet per day). This blue color also represents the range of Ynl A bedrock (flow range from 1.0 to 5.8 feet per day).
3. Tan – the range of hydraulic conductivity in the Ynl B bedrock (flows range from 0.001 to 0.007 feet per day),
4. Green – the range of cemented paste tailings material with 2% and 4% binder content (flows range on the order of 10^{-3} to 10^{-5} feet per day).

Table 2-13. Hydraulic Conductivities of Natural and Project Specific Materials

				Alluvium	Range of Ynl A Bedrock & UIGs			Ynl B Bedrock	Ynl B Bedrock / Range of Cemented Paste Tailings	Range of Cemented Paste Tailings	Range of Cemented Paste Tailings				
K (cm/s)	10^2	10^1	$10^0=1$	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}
K (ft./day)	10^5	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}
Relative Permeability	Pervious				Semi-Pervious				Impervious						
Aquifer	Good					Poor				None					
Unconsolidated Sand & Gravel	Well Sorted Gravel		Well Sorted Sand or Sand & Gravel			Very Fine Sand, Silt, Loess, Loam									
Unconsolidated Clay & Organic					Peat		Layered Clay			Fat / Un-weathered Clay					
Consolidated Rocks	Highly Fractured Rocks				Oil Reservoir Rocks			Fresh Sandstone		Fresh Limestone, Dolomite		Fresh Granite			

Materials shown with colored fills are hydraulic conductivity values from Black Butte Copper project aquifer test results
UIGs = Underground Infiltration Galleries
Source: modified from Bear, 1972

Tintina conducted a long term (31 day) aquifer test on well PW-8 in July and August 2014. Well PW-8 is completed in *Ynl A* shale just above the contact with the *USZ*. In addition to characterizing the permeability of the *USZ*, the purpose of the extended test included an assessment of the extent to which prolonged pumping would affect water levels in overlying units and at nearby surface water sites. In addition, three piezometers temporarily installed in the Coon Creek, Sheep Creek, and Dry Creek wetland / alluvial systems and existing surface water sites (Figure 2.2) allowed additional monitoring during the pumping tests. The PW-8 aquifer test ran for 31 days. The test produced no drawdown in the shallow groundwater system or at observation sites associated with Sheep Creek, Coon Creek, and Dry Creek. Pumping well PW-8 recovered to pre-test levels within two days of shutting down the pump.

Tintina also conducted a long-term aquifer test on well PW-9 in the Upper Sulfide Zone. Pumping of the well for 19 days achieved drawdown stabilization in the pumping well and observation wells. Tintina collected flow and stage measurements at three surface water sites (SW-14-1, SW-14-2, and SW-3) and one spring (SP-06). Pumping of PW-9 produced limited drawdown in nearby well PW-10, completed below the Upper Sulfide Zone, and MW-9, completed above the Upper Sulfide Zone, suggesting that the hydro-stratigraphic units above and below the Upper Sulfide Zone are only partially or poorly connected to the Upper Sulfide Zone. Weekly surface water flow and/or stage monitoring conducted at three surface water sites (SW-3, SW-14-1, and SW-14-2) and in piezometers completed in the shallow alluvial systems during both the PW-8 and PW-9 aquifer tests showed no influence from extended pumping of the bedrock aquifer at the proposed development depths.

2.2.6 Groundwater – Surface Water Interactions

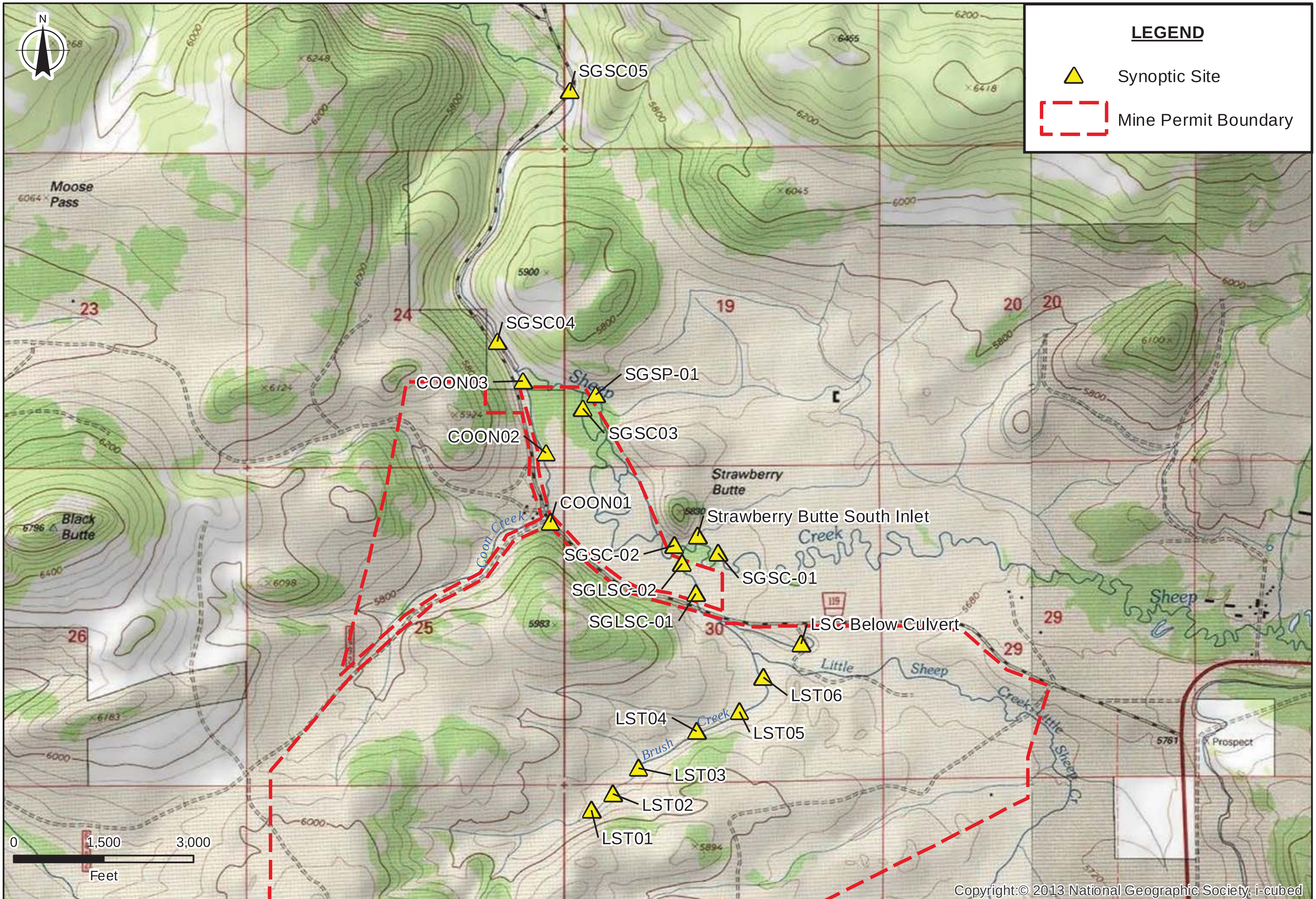
2.2.6.1 <u>Sheep Creek</u>

Potentiometric data indicate that Sheep Creek is hydrologically connected with the alluvial aquifer in the Sheep Creek Valley; however, synoptic surveys show that the contribution from the alluvial aquifer to Sheep Creek is minimal. Surface water monitoring data show a general increase in flow from upstream monitoring sites (USGS-SC1 & SW-2) to downstream (SW-1), although the majority of that increase appears to be attributable to tributary inflow. Tintina conducted two synoptic surveys in August and October 2012 to characterize groundwater inflows to Sheep Creek. Figure 2.9 shows synoptic survey sites. The results of the August 2012 synoptic survey (Table 2-14) showed large decreases and increases in flow along Sheep Creek that can be accounted for by inflow from groundwater and unmonitored springs and tributaries on inaccessible private property to the north of Sheep Creek. In addition, the synoptic survey was conducted shortly after discontinuation of irrigation in the hay meadow which may have influenced hydrologic conditions.

Table 2-14. August 2012 Synoptic Survey Results

Site	Sheep Creek Discharge (cfs)	Tributary Discharge (cfs)	Sum of Sheep Creek and Tributary Flow (cfs)	Notes
SGSC-01	14.03	--	--	Sheep Creek above Strawberry Butte South Inlet, most upstream Sheep Creek Site
Strawberry Butte South	--	1.3	15.33	Mouth of Strawberry Butte South Inlet upstream of Sheep Creek Confluence
SGLSC-01	--	2.2	17.53	Little Sheep Creek downstream of the Sheep Creek Rd culvert
SGSP-01	--	1.33	--	Mouth of Spring Creek before Sheep Creek confluence
Coon-03	--	0.52	--	Mouth of Coon Creek upstream of Sheep Creek confluence
SGSC-04	13.02	--	--	Sheep Creek downstream of Coon Creek confluence in canyon north of hay meadow
SGSC-05	15.24	--	--	Sheep Creek at quarterly monitoring site SW-1

The second synoptic survey was conducted in October 2012 to further evaluate the groundwater/surface water interaction on Sheep Creek and two small drainages (Coon Creek and Brush Creek; Figure 2.9 adjacent to the Project area (Figure 2.6)). Table 2-15 shows a tabulation of the results of the October 2012 survey. Measured changes in discharge to Sheep Creek were much smaller during the second synoptic survey (generally within the measurement error of 10-15%). Tributary inflows appear to account for most increases in stream flow in Sheep Creek during the October 2012 synoptic survey. The survey was unable to measure groundwater inflow to Sheep Creek within the Project area which indicates that groundwater contributions to the stream account for less than 10 to 15% of the total flow rate on this reach of Sheep Creek. Darcy's flow calculations (discussed below) confirm that groundwater inputs to Sheep Creek from the alluvial aquifer are too small to physically quantify using open channel flow measurement techniques as described below and in greater detail in Appendix B (Hydrometrics, 2017a) of this Permit application.



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Date: June 2016, Source: Hydrometrics, Inc. (2016)

TINTINA RESOURCES

Figure 2.9
2012 Synoptic Survey Sites
Black Butte Copper Project
Meagher County, Montana

Table 2-15. October 2012 Synoptic Flow Results

Site	Sheep Creek Discharge (cfs)	Tributary Discharge (cfs)	Sum of Sheep Creek and Tributary Discharge (cfs)	Notes
Brush Creek Survey				
LST-01	--	Dry	--	Most upstream site on Brush Creek
LST-02	--	0.07	--	Moving downstream
LST-03	--	0.09	--	
LST-04	--	0.1	--	
LST-05	--	0.1	--	
LST-06	--	0.16	--	Most downstream site on Brush Creek
Coon Creek Survey				
Coon-01	--	0.1	--	Coon Creek just as it enters the hay meadow, SW-3
Coon-02	--	0.22	--	Coon Creek mid-point in the hay meadow
Coon-03	--	0.19	--	Coon Creek immediately upstream of Sheep Creek confluence
Sheep Creek Survey				
2SGSC-01	21.5	--	--	Most upstream site in hay meadow
SGSC-02	22.2	--	--	Sheep Creek upstream of Little Sheep Creek confluence (includes discharge from un-named tributary south of Strawberry Butte
SGLSC-02	--	1.12	23.32	Little Sheep Creek before Sheep Creek confluence
SGSC-03	19.51		--	Sheep Creek upstream of Spring Creek confluence
SGSP-01	--	0.44	--	Spring Creek before Sheep Creek confluence
Coon-03	--	0.19	20.14	Coon Creek upstream of Sheep Creek confluence
SGSC-04	20.57	--	--	Sheep Creek downstream of Coon Creek confluence in canyon north of hay meadow
SGSC-05	19.05	--	--	Sheep Creek at quarterly monitoring site SW-1

A simple Darcy's flow calculation confirms that the estimated groundwater flux from the Sheep Creek alluvial groundwater system to Sheep Creek in this lower reach is consistent with the small fluctuations shown in the synoptic results. Darcy's Law can be used to estimate flow rate or discharge (*Q*) for a given hydraulic conductivity (*K*), hydraulic gradient (*I*) and flow cross-sectional area (*A*) where:

$$\text{Discharge } (Q) = (K) \times (I) \times (A)$$

Drilling and test data indicate a thickness of approximately 16 feet (4.9 m) for Sheep Creek alluvium near MW-4A, with a maximum alluvial deposit width of 1,500 feet (457 m), an average hydraulic gradient (*I*) of groundwater of 0.008, and an average alluvial hydraulic conductivity (*K*) of 200 feet/day (61 m/day). Using these values Darcy's Law yields a discharge (*Q*) estimate of 200 gpm (757 Lpm; 0.44 cfs) of groundwater flow through the alluvium towards Sheep Creek. This would be equivalent to just over 2% of the base flow observed in Sheep Creek during the synoptic survey and confirms that groundwater inputs to Sheep Creek from the alluvial aquifer are too small to physically quantify using open channel flow measurement techniques.

2.2.6.2 Brush Creek and Coon Creek

The October 2012 synoptic survey on Brush Creek (Figure 2.9) indicates discharge of shallow groundwater at the head of the draw and then no measureable change in flow between sites LST-02 and LST-05. There was a small increase (0.06 cfs) between LST-05 and LST-06 as Brush Creek approaches the Little Sheep Creek alluvial system. Water quality data help further assess groundwater and surface water interactions on Brush Creek in the 2013 investigation, and that evaluation found that the water quality in Brush Creek was not indicative of groundwater from the shallow bedrock groundwater system in the vicinity of the proposed underground infiltration gallery (UIG) area (see Figure 1.3; and Section 3.7.4). The source of the small increase in flow below LST-05 is unknown but may be associated with the Little Sheep Creek alluvial system.

The October 2012 synoptic survey included the lower reach of Coon Creek where it enters the Sheep Creek alluvial system (Table 2-15). The discharge in Coon Creek at the furthest upstream site (COON-01) was approximately 0.1 cfs. Coon Creek discharge approximately doubled between sites COON-01 and COON-02, and the discharge remained near 0.2 cfs until its confluence with Sheep Creek. Data from the drilling at PW-3 and the PW-8 pumping test and water level elevation data provide evidence that above SW-3 Coon Creek is not in direct connection with the deeper bedrock groundwater system.

2.2.6.3 Eastern UIG Tracer Test

In October 2016, Tintina initiated a tracer study in the eastern UIG (Hydrometrics, 2017b) to evaluate the connectivity of the groundwater beneath the UIG with adjacent streams (Brush Creek, Little Sheep Creek, and unnamed tributary to Little Sheep Creek). Three dye tracers were introduced to the groundwater system through infiltration (eosine and fluorescein) and direct injection into wells MW-14 and MW-15 (rhodamine). Dye tracers are currently being monitored at a total of 13 sites; 11 sites are surface water or groundwater seeps, and two sites are monitoring wells. The surface water sites and groundwater seeps are monitored by activated carbon sampler packets and grab samples of water. The monitoring wells were monitored using activated carbon sampler packets and grab samples of water until the introduction of rhodamine dye occurred on January 26, 2017. Subsequent tracer sampling at monitoring wells is based solely on grab samples of water to monitor the rate of tracer migration from the wells to the aquifer. There have been no detected occurrences of any tracer at the surface water or seep monitoring site through April 2017; indicating the groundwater system beneath the eastern UIG is not in direct connection to the monitored surface water sites or seeps. Details of the tracer study are summarized in Appendix B-2 (Hydrometrics, 2017b).

2.3 Wetlands Resources

2.3.1 Wetland Study Area and Methods

Wetlands are areas where the frequent and prolonged presence of water at or near the soil surface results in the formation of hydric soils and hydrophytic (water-loving) plants. Westech Environmental Services, Inc. (Westech) delineated wetlands and waterbodies and completed a functional analysis of wetlands within the Project area including all areas within the mine permit boundary area (Figure 1.3). This inventory/assessment was the basis for initiation of Clean Water Act Section 404 Permit Application activities with the U.S. Army Corps of Engineers (USACE). USACE has recently completed its review of the detailed technical wetland delineation report (Appendix C-1; Westech, 2014) and functional analysis report (Westech, 2015a, Appendix C-2 of this report). Tintina recently received a Jurisdictional Determination from the USACE (see Section 2.3.6).

Westech obtained background and supplementary sources of data for the wetland delineation and functional analysis from various environmental baseline studies conducted for the Project and publicly available data including:

- Hydrology, wetlands, and soils data are contained in the Amendment to Exploration License No. 00710 Tintina Alaska Exploration, Inc. Exploration Decline for Underground Drilling and Bulk Sampling Black Butte Copper Project, Meagher County, Montana (Tintina, 2013a);
- High-resolution aerial photographs (true color and infrared);
- USGS topographic maps;
- National Wetland Inventory mapping;
- Natural Resources Conservation Service (NRCS) soils mapping;
- Baseline wetland and waterbody inventory for the Black Butte Copper Project (Westech, 2014);
- Baseline fish (Montana Biological Survey, 2017) and wildlife resources (Westech, 2015c) inventories for the Black Butte Copper Project;
- Background hydrology and wetland mapping for the Black Butte Copper Project (Tintina 2013a);
- Montana Natural Heritage Program (MTNHP) plant and animal species of concern report (MTNHP, 2014); and
- MTNHP list of ecological communities for Montana (MTNHP, 2002).

2.3.2 Wetland Delineation Methods

Westech identified and delineated wetlands using the routine on-site approach described in the 1987 U.S. Army Corps of Engineers (USACE) *Wetland Delineation Manual* (Environmental Laboratory, 1987) and the final *Regional Supplement to the Corps of Engineers Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (USACE, 2010). They classified wetlands according to the Cowardin classification system (Cowardin *et al*., 1979), and classified non-wetland waterbodies, such as streams, according to flow regime (perennial, seasonal, etc.) and substrate (e.g., unconsolidated bottom, rock bottom, etc.) as outlined in the Cowardin system. The wetland delineation report attached as Appendix C-1 (Westech, 2014) to this report describes technical delineation and mapping methods used in this study.

2.3.3 Wetland Indicators

Wetland surveys use hydrology indicators, hydric soils indicators, and hydrophytic vegetation in combination to determine whether an area meets USACE criteria for wetlands (Environmental

Laboratory, 1987; USACE, 2010). Generally, consideration as a wetland requires the presence of indicators of all three wetland components.

Hydrologic indicators of repeated, extended episodes of inundation or soil saturation (e.g., surface water, saturation, oxidized rhizospheres along living roots, drainage patterns, geomorphic position, and frost-heave hummocks) infer the presence of wetland hydrology (USACE, 2010). Wetland hydrology indicators within the Project area occur adjacent to waterbodies, in sub-irrigated meadows, and at numerous springs and seeps. One indicator is flowing surface water recorded in Sheep Creek, Little Sheep Creek, and Black Butte Creek and in many of the tributaries to these streams. Another is standing surface water noted at most wetlands throughout the Project area, although in very limited quantities at many sites.

Hydric soils are defined as soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service, 1991). Generally, hydric soils are saturated, flooded, or ponded for one week or more during the period when soil temperatures are above biologic zero (41 degrees Fahrenheit or 5 degrees Celsius). These soils typically support hydrophytic vegetation and exhibit distinctive characteristics that result from repeated, extended periods of saturation; these characteristics tend to persist in the soils during both wet and dry periods. Hydric soils occur within the sub-irrigated zone around Sheep Creek, Little Sheep Creek, Black Butte Creek, in various tributaries to these waterbodies, and springs and seeps. In most of these locations the soils consist of finely-textured clays and clay-loams.

The USACE wetlands delineation methodology uses a plant community approach to determine whether a site is dominated by hydrophytic vegetation, which are species that require or can tolerate prolonged inundation or soil saturation during the growing season (Environmental Laboratory, 1987; USACE, 2010). Hydrophytic vegetation within the 7,768 acre study area was divided almost equally between shrub wetlands (Palustrine Scrub-Shrub) and herbaceous wetlands (Palustrine Emergent). Forested wetlands (Palustrine Forested) and un-vegetated potholes or ponds (Palustrine Unconsolidated Bottom) occurred in very limited areas. Table 2-16 lists the acreage of each wetland type according to its Cowardin classification as well as the percentage of each type within the study area.

Table 2-16. Wetland Acreage and Percent by Cowardin Type

Cowardin Type[1]	Acres	Percent of Total Wetlands Acres
Palustrine Emergent (Herbaceous wetland)	152.6	46.4
Palustrine Scrub-Shrub (Willow dominated)	90.8	27.6
Palustrine Scrub-Shrub (Shrubby cinquefoil dominated)	82.8	25.2
Palustrine Forested (Engelmann spruce dominated)	1.9	0.6
Palustrine Unconsolidated Bottom (Excavated pond)	0.5	0.1
Palustrine Unconsolidated Bottom (Natural depression)	0.2	0.1
TOTAL	**328.8**	**100.0**

[1] Cowardin *et al.* (1979)

Waterbodies shown on Figure 2.10 (Wetlands Delineation and Functional Assessment Map) have the following names (listed first) that correspond to waterbody names shown on Figures 1.3, 2.3, 2.6, and 2.9 (listed second) in the MOP Application: Sheep Creek Tributary 2 is equivalent to Coon Creek; and Little Sheep Creek Tributary 1 is equivalent to Brush Creek.

2.3.4 Water Bodies

Guidance in searching for water bodies (often termed "streams" by USACE even if flowing water is not present) comes from the *U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook* (USACE, 2007) in conjunction with the definition of the ordinary high water mark (OHWM) in 33 CFR § 328.3 which states:

> "The term *ordinary high water mark* means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

Surveyors' mapped non-wetland waterbodies using sub-meter GPS, or drew the waterbody using high-quality aerial imagery where the feature was large enough to accurately map on a photo. Classification of each waterbody according to hydrologic regime (perennial, seasonal, intermittent, and ephemeral) and substrate followed the criteria of Cowardin *et al.* (1979). Several waterbodies occur within the Project boundary. Sheep Creek is the largest stream, by flow volume, within the Project area while Little Sheep Creek is the longest stream within the Project area. Very little stream length of Black Butte Creek occurs within the Project area. Several tributaries to these streams occur within the Project area. Most waterbodies within the Project area have an unconsolidated bottom with at least 25% streambed cover of particles smaller than stones and vegetative cover less than 30%. Sheep Creek has the highest amount of rock cover, but most stones are cobbles and gravels, not bedrock or boulders, placing this stream within the unconsolidated bottom type similar to most other waterbodies within the Project area.

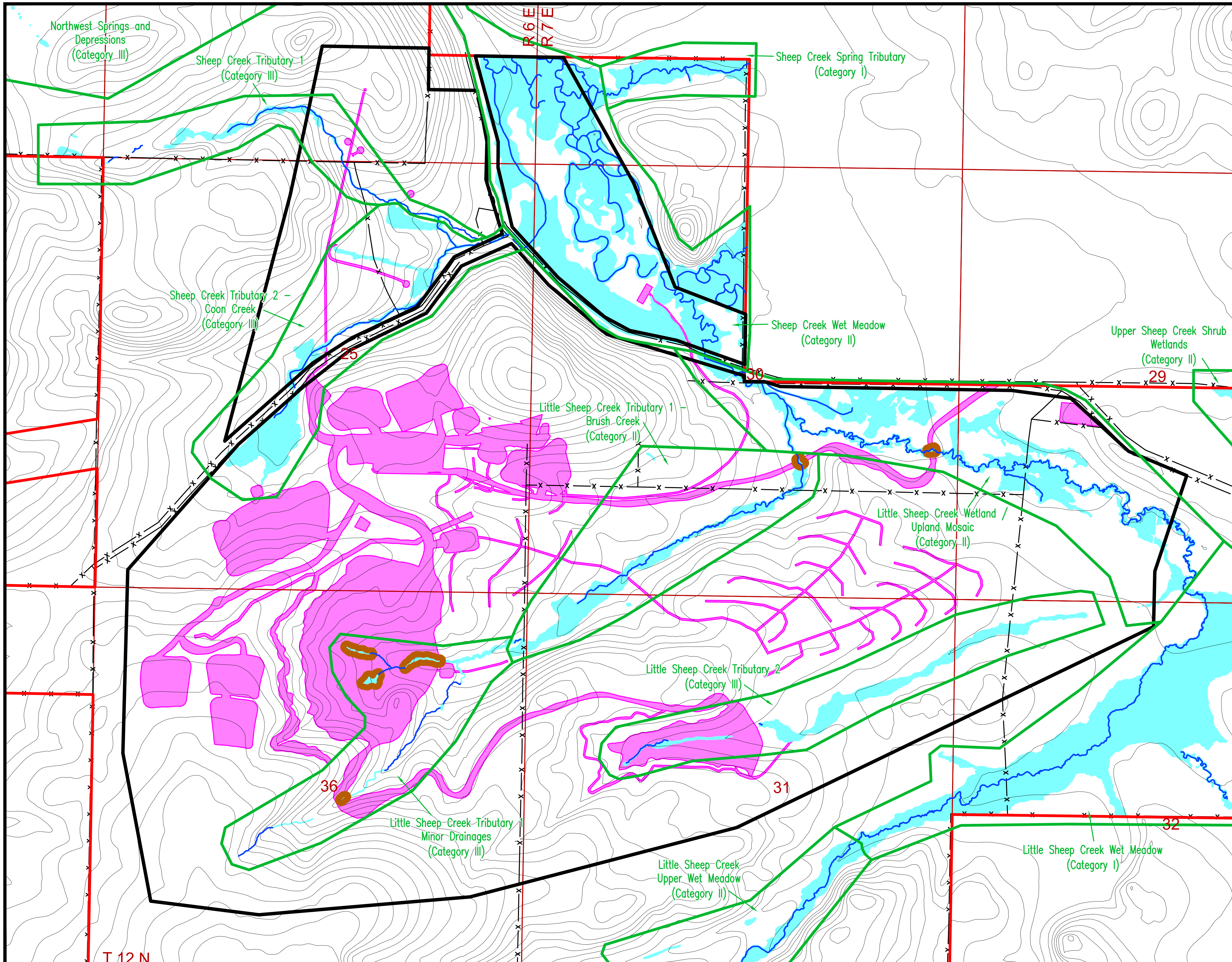
2.3.5 Potential Waters of the US

Waters of the U.S. (WOTUS), as defined in 33 CFR Part 328 (2014), encompass all major streams and their tributary streams, ponds, and adjacent wetlands. These waters have been determined to have significant nexus (connection) with a traditional navigable water by rule, and are considered per se jurisdictional waters without the need for additional study. Additional investigation, delineation, and avoidance/mitigation measures to comply with Section 404(b)(1) of the Clean Water Act which provides regulations for all WOTUS to determine where a "significant nexus" (connection) exists between other waters and a traditional navigable water. USACE and EPA regulators following a site visit with the Project team, have determined that some waters are "isolated" and not "jurisdictional", and therefore not subject to regulation under Section 404. A non-jurisdictional determination is only applicable for Section 404 compliance—other Federal or State regulations may still apply.

2.3.6 Wetland Delineation Summary

The wetland delineation and waterbody survey of the study area (Westech, 2015a) identified 328.8 acres of wetlands within the Project's leased lands boundary (

Figure 2.10 and Map Sheet 2) and listed in and shown on the larger scale three (3) sheets entitled Wetland Delineation and Waterbody Survey) (Westech, 2015a). The largest wetlands occur within the sub-irrigated herbaceous meadows and willow- or shrubby cinquefoil-dominated wetlands surrounding Sheep Creek and Little Sheep Creek. Upland areas within these sites are highly mesic (high moisture content), and the boundary between wetland and upland is often indistinct. Surveyors estimated that approximately 5% of the area within these wetlands is comprised of upland pockets.



TINTINA RESOURCES

Black Butte Copper Project

Wetland Delineation and Functional Assessment Map

WESTECH ENVIRONMENTAL

406-442-0950 | P.O. Box 6045 | Helena, MT 59604

Figure 2.10

07/05/17 | BBC17_Wetlands_MOPA_Fig_R1.dwg | 1:14,400

At the upper reaches, these wetlands generally transition to wider, dry channels and swales where wetland features (hydrophytic vegetation and supporting hydrology) become isolated and/or absent. Very small pockets of wetland also occur within the uplands at these sites, but were estimated to account for less than 1% of upland area and were too small or indistinct to delineate.

The majority of the remaining wetlands, in tributaries to Sheep Creek and Little Sheep Creek, as well as the wetlands surrounding Black Butte Creek, are a mosaic of shrub and herbaceous vegetation types. The hydrology at most of these wetlands appears primarily groundwater driven. Small streams are present but are themselves a function of local springs and do not appear to have enough water within them to support the relatively large wetlands surrounding them. Based on observations during the delineation, it appears that few of the wetlands within the Project area are specifically dependent on streamflow hydrology. Stockmen have developed many of the localized wetlands in the immediate vicinity of upper drainage springs and seeps for livestock water and cattle have heavily trampled these areas.

Various species of willow or shrubby cinquefoil dominate approximately half of the wetlands within the study area. Wetlands dominated by sedges as well as native and non-native grasses comprise the majority of the remaining wetlands within the Project area. The survey also delineated: a small forested wetland dominated by Engelmann spruce; a series of small, wetland depressions with minimal vegetation; and an excavated pond.

Surveyors recorded wetlands with fen characteristics within three (3) wetlands in the Project area, wetlands W-SCT1-02, W-LS-11, and W-LST1-06 (Westech, 2015a). Fens are a relatively rare wetland type in Montana and can result in a high wetland functional rating.

Tintina received an Approved Jurisdictional Determination Form for the Lease Boundary area from USACE in May 2016 (attached as Appendix C-3). A total of 327.4 acres (132.5 ha) of wetlands and 16.3 miles (21.9 km) of stream were determined by USACE to be jurisdictional within the (7,768 acres (3,144 ha) Study / Lease Boundary Area. A total of 1.32 acres (0.53 ha) of wetlands and 588 lineal feet (179 m) of streams were deemed non-jurisdictional. As can be seen in Section 3.8.3 only 0.85 acres (0.34 ha) of wetlands and 1,551 lineal feet (472.7 m) of streams are calculated to be impacted by project construction. Tintina will continue to work with USACE to evaluate and develop mitigation strategies for impacts to regulated wetlands.

Table 2-17 summarizes wetland acreage within the study area. Table 2-18 summarizes stream length (feet) within the study area. The tables summarize acreages and lengths by the local watershed for each wetland or stream. Watershed names allow organization, identification and location of individual wetlands and stream segments within the Project area, and equate to USACE terminology of "Local Waterways" (Westech 2014, Appendix A of the Westech report). With the exception of Black Butte Creek and Sheep Creek, these watersheds do not relate to larger order watersheds.

Table 2-17. Wetland Acreage by Cowardin Type and Watershed

Project Watershed[1]	Cowardin Type[2]					Total by Project Watershed (acres)
	Palustrine Emergent	Palustrine Shrub (Willow)	Palustrine Shrub (Shrubby Cinquefoil)	Palustrine Forested	Palustrine Unconsolidated Bottom	
Black Butte Creek	10.69	7.86	1.61	0.00	0.00	20.16
Black Butte Creek Total	**10.69**	**7.86**	**1.61**	**0.00**	**0.00**	**20.16**
Black Butte Creek Tributary 1	2.06	0.00	0.00	0.00	0.14	2.20
Black Butte Creek Tributary 2	0.02	0.00	0.00	0.00	0.00	0.02
Black Butte Creek Tributary 3	0.71	0.15	0.00	0.00	0.00	0.86
Black Butte Creek Tributaries Total	**2.79**	**0.15**	**0.00**	**0.00**	**0.14**	**3.08**
Little Sheep Creek	51.03	5.16	62.95	0.00	0.09	119.23
Little Sheep Creek Total	**51.03**	**5.16**	**62.95**	**0.00**	**0.09**	**119.23**
Little Sheep Creek Tributary 1 (Brush Creek)	8.57	3.33	3.13	0.00	0.00	15.03
Little Sheep Creek Tributary 2	4.12	3.59	5.33	0.00	0.00	13.04
Little Sheep Creek Tributary 3	0.00	0.00	0.35	0.00	0.00	0.35
Little Sheep Creek Tributary 4	1.27	0.00	0.00	0.00	0.00	1.27
Little Sheep Creek Tributary 5	10.62	0.47	0.00	0.00	0.38	11.47
Little Sheep Creek Tributary 7	0.01	0.00	0.00	0.00	0.00	0.01
Little Sheep Creek Tributaries Total	**24.59**	**7.39**	**8.81**	**0.00**	**0.38**	**41.17**
Sheep Creek	52.77	53.87	0.00	0.00	0.00	106.64
Sheep Creek Total	**52.77**	**53.87**	**0.00**	**0.00**	**0.00**	**106.64**
Sheep Creek Tributary 1	4.32	0.81	1.87	0.00	0.00	7.00
Sheep Creek Tributary 2 (Coon Creek)	0.94	0.00	3.51	0.00	0.00	4.45
Sheep Creek Tributary 3	1.17	1.04	0.94	0.00	0.00	3.15
Sheep Creek Tributary 4	0.93	0.00	0.00	0.00	0.00	0.93
Sheep Creek Tributary 5	3.38	14.56	3.15	1.86	0.00	22.95
Sheep Creek Tributaries Total	**10.74**	**16.41**	**9.47**	**1.86**	**0.00**	**38.48**
Project Total	**152.61**	**90.84**	**82.84**	**1.86**	**0.61**	**328.76**

1 Project watersheds are the specific, in many cases very small, watersheds within the Project area. With the exception of Sheep Creek and Black Butte Creek these watersheds do not correspond to larger order watersheds. In some cases, (e.g., Little Sheep Creek Tributary 6) a tributary is not listed in sequential order indicating that there were no wetlands, only streams, within that tributary.

2 See Cowardin *et al.* (1979) for further discussion. Note that emergent wetlands are dominated by herbaceous species such as sedges and grasses. Unconsolidated bottom wetlands are those with a mud/silt bottom with limited vegetation.

Table 2-18. Summary of Stream Length (feet) by Cowardin Type and Project Watershed

Project Watershed[1]	Cowardin Type[2]					Total by Project Watershed
	R3UB	R3RB	R3SB	R3AB	R4SB	
Black Butte Creek	3,256	0	0	0	0	3,256
Black Butte Creek Total	**3,256**	**0**	**0**	**0**	**0**	**3,256**
Black Butte Creek Tributary 1	0	3,226	0	0	852	4,078
Black Butte Creek Tributaries Total	**0**	**3,226**	**0**	**0**	**852**	**4,078**
Little Sheep Creek	29,606	0	0	0	0	29,606
Little Sheep Creek Total	**29,606**	**0**	**0**	**0**	**0**	**29,606**
Little Sheep Creek Tributary 1 (Brush Creek)	4,862	0	0	0	2,903	7,765
Little Sheep Creek Tributary 2	713	0	0	0	0	713
Little Sheep Creek Tributary 4	0	0	0	0	2,307	2,307
Little Sheep Creek Tributary 5	1,215	0	0	0	0	1,215
Little Sheep Creek Tributary 6	709	0	0	0	0	709
Little Sheep Creek Tributary 7	0	0	0	0	1,373	1,373
Little Sheep Creek Tributaries Total	**7,499**	**0**	**0**	**0**	**6,583**	**14,082**
Sheep Creek	6,663	0	0	0	0	6,663
Sheep Creek Total	**6,663**	**0**	**0**	**0**	**0**	**6,663**
Sheep Creek Overflow	0	0	0	0	9,446	9,446
Sheep Creek Overflow Total	**0**	**0**	**0**	**0**	**9,446**	**9,446**
Sheep Creek Overflow Tributaries	710	0	0	0	0	710
Sheep Creek Overflow Trib. Total	**710**	**0**	**0**	**0**	**0**	**710**
Sheep Creek Tributary 1	3,699	0	0	401	0	4,100
Sheep Creek Tributary 2 (Coon Creek)	889	0	0	0	0	889
Sheep Creek Tributary 5	11,451	0	0	0	2,150	13,601
Sheep Creek Tributaries Total	**16,039**	**0**	**0**	**401**	**2,150**	**18,590**
Project Total	**63,773**	**3,226**	**0**	**401**	**19,031**	**86,431**

1 Project watersheds are the specific, in many cases very small, watersheds within the Project area. With the exception of Sheep Creek and Black Butte Creek these watersheds do not correspond to larger order watersheds. In some cases, (e.g., Little Sheep Creek Tributary 3) a tributary is not listed in sequential order indicating that there were no streams, only wetlands, within that tributary.
2 See Cowardin *et al.* (1979) for further discussion. Note: R = Riverine; 3 = Upper Perennial; 4 = Intermittent; UB = Unconsolidated Bottom; RB = Rock Bottom; SB = Streambed; and AB = Aquatic Bed.

2.3.7 Functional Assessment of Wetlands

Based on a wetland delineation completed by Westech (2015a), as well as data from publicly available sources and Project-specific surveys, wetlands were grouped into Assessment Areas based on ecological function, including similar ecological and hydrologic indicators (Figure 2.10 and Map Sheet 2).

Rating of each Assessment Area followed the Montana Department of Transportation (MDT) Montana Wetland Assessment Method (MWAM) method, which provides relative ratings of each wetland or group of wetlands for as many as 12 wetland functions including:

- Habitat for federally listed or proposed threatened or endangered species
- Habitat for MTNHP S1, S2, or S3 Species of Concern
- General wildlife habitat
- General fish habitat
- Flood attenuation
- Surface water storage
- Sediment/nutrient/toxicant retention/removal
- Sediment/shoreline stabilization
- Production export/terrestrial and aquatic food chain support
- Groundwater discharge/recharge
- Uniqueness
- Recreation/education potential

MDT and Montana Fish, Wildlife and Parks (FWP) first developed this wetland evaluation method in 1989 and have revised it several times based on field-testing at several hundred wetlands (Berglund and McEldowney, 2008). Montana Wetland Assessment Method is widely used in Montana and elsewhere. In a 2004 evaluation of State- and tribe-developed wetland functional assessment methodologies, EPA found MWAM was one of seven systems (of forty evaluated) that met all of EPA's criteria for consideration as a model for development of functional assessment methods (Fennessy *et al.,* 2004). The most recently available version of the MDT MWAM data form and guidance was used (Berglund and McEldowney, 2008).

The functionality report includes ratings for a total of 14 Assessment Areas shown on Figure 2.10 and Map Sheet 2. A larger scale map sheet (Map 1 in appendix C) entitled Wetland Delineation and Waterbody Survey Assessment Map (Westech, 2015a) also shows the locations of these areas. Each Assessment Area consists of ecologically similar wetlands that are hydrologically connected or adjacent to one another. In some cases, large, contiguous wetlands were divided to better represent the qualities within a specific wetland reach. For example, in the Little Sheep Creek watershed, wetlands were parceled into three groups for assessment purposes. The wetland functional assessment report (Westech, 2015a) provides further information on the methodology for assessing wetland functions, forms, and photos.

Based on the hydrological, ecological, and biological properties of the wetlands and uplands within an Assessment Area, each Assessment Area groups within one of the four categories below:

- Category I: exceptionally high quality wetlands, generally rare to uncommon in the State or important from a regulatory standpoint; includes any Assessment Area that is documented primary habitat for a federally listed threatened or endangered species
- Category II: more common wetlands than Category I; provide habitat for rare species and/or provide high-quality fish or wildlife habitat, and/or have high values for other wetland functions
- Category III: more common and generally less diverse wetlands than Categories I and II
- Category IV: generally small, isolated wetlands that lack vegetative diversity, provide little wildlife habitat, and are often anthropogenically disturbed.

A total of 14 Assessment Areas were rated. Table 2-19 lists each assessment area's category designation.

Table 2-19. MWAM Wetland Rating by Assessment Area

Assessment Area	Category Rating Number[1]
Black Butte Creek Wetlands	II
Little Sheep Creek Wet Meadow	I
Little Sheep Creek Upper Wet Meadow	II
Little Sheep Creek Wetland/Upland Mosaic	II
Little Sheep Creek Tributary 1 (Brush Creek)	II
Little Sheep Creek Tributary 1 Minor Drainages	III
Little Sheep Creek Tributary 2	III
Sheep Creek Wet Meadow	II
Sheep Creek Tributary 1	III
Sheep Creek Tributary 2 (Coon Creek)	III
Sheep Creek Spring Tributary	I
Upper Sheep Creek Shrub Wetlands	II
Northwest Springs and Depressions	III
Southwest Minor Drainages	III

[1] Category Rating Number per Montana Wetland Assessment Method (MWAM) (Berglund and McEldowney 2008). Categories are rated I to IV, with I the highest and IV the lowest.

Two Assessment Areas were rated Category I, Little Sheep Creek Wet Meadow and Sheep Creek Spring Tributary (Figure 2.10). Both of these Assessment Areas likely contain fens (wetlands W-LS-11 and W-SCT1-02 respectively), resulting in a high rating for Uniqueness. Both Assessment Areas also have high ratings for General Fish Habitat and Groundwater Discharge/Recharge, and contain documented or suspected habitat for MTNHP Species.

Six Assessment Areas rated Category II (Figure 2.10). Important attributes of these Assessment Areas included: Groundwater Discharge/Recharge; Sediment/Nutrient/Toxicant Removal; Habitat for MTNHP Species; Sediment/Shoreline Stabilization; and in the case of Assessment Areas containing Sheep Creek, Recreational/Educational Potential due to the Sheep Creek fishery. The primary difference between Category I and II Assessment Areas is the probable fens within the Category I wetlands resulting in a higher total rating. One other Assessment Area, Little Sheep Creek Tributary 1, also may contain small fens within the overall wetlands but rated lower on other functions, primarily the lack of fish or rare species habitat, and thus scored a Category II.

Six Assessment Areas were rated Category III (Figure 2.10). These Assessment Areas differ from Category I and II Assessment Areas primarily in the extent of wetlands within the Assessment Area (Little Sheep Creek Tributary 1 Minor Drainages Assessment Area, Sheep Creek Tributary 1 Assessment Area, Northwest Springs and Depressions Assessment Area, and Southwest Minor Drainages Assessment Area), the lack of connection to other wetlands (Little Sheep Creek Tributary 2 and Northwest Springs and Depressions), and the general lack of consistent water or other habitat features. In general, the Category III wetlands appear to fit the concept of that category well: they are common types of wetlands in the region, are not notably diverse, and generally do not provide high-quality wildlife or fish habitat, yet they clearly provide greater functional values than a Category IV wetland. Two exceptions are the Little Sheep Creek Tributary 2 Assessment Area and the Sheep Creek Tributary 2 Assessment Area. Both of these Assessment Areas contain well-developed willow and herbaceous wetlands, numerous springs and seeps, and documented or suspected habitat for MTNHP species. Both Assessment Areas scored a 61%, near the criterion of 65% to rate as a Category II wetland. The Little Sheep Creek Tributary 2 Assessment Area rated lower due to lack of connection to other wetlands as the water from this Assessment Area goes subsurface resulting in an upland barrier between this Assessment Area and the remainder of the Little Sheep Creek Assessment Areas. Consequently, this Assessment Area did not receive a score for General Fish Habitat or Flood Attenuation, and a low score for Export/Food Chain Support. The Sheep Creek Tributary 2 Assessment Area likewise did not receive a score for these functions as the stream is very minor and does not result in flooding or shoreline stabilization. Further, the stream is isolated from Sheep Creek by at least 2 culverts preventing fish passage into this Assessment Area.

2.4 Environmental Geochemistry

2.4.1 Introduction

The acid generation and metal release potential of waste rock, construction rock, and tailings to be produced by the Project has been characterized using static multi-element analysis, acid-base accounting (ABA), net acid generation potential, and kinetic methods. Mineralogical analyses of metal residence and asbestiform mineral analyses were also completed. Results of all geochemical tests which are reported in Appendix D, are summarized below. Table 2-20 summarizes the number of tests completed by method, rock type, and tonnage for waste rock.

Table 2-21 provides a summary for tailings testing. These test methods are described and their results are also provided in detail in Appendix D (Enviromin, 2017a) and are summarized below.

Tintina proposes to mine waste rock from the Lower Newland Formation (*Ynl*), which contains copper-enriched rock in both the Upper Sulfide Zone (*USZ*) and the Lower Sulfide Zone (*LSZ*). Enviromin (a company providing geochemical consulting services to Tintina) has defined operational geochemical units for testing purposes based on mineralization and hydrogeology. Tintina's proposal includes mining waste rock from:

- Footwall of the Lower Sulfide Zone (*LZ FW*, 35% of waste rock tonnage),
- Lower Newland Formation dolomitic shale and turbidite clay-clast conglomerate below the *USZ* and above the Volcano Valley Fault in the Johnny Lee deposit area (*Ynl B*, 32%),
- Portions of the *USZ* outside of the copper-enriched Upper Copper Zone (*UCZ*), (*USZ*, 28%), and
- Lower Newland Formation above the *USZ* (*Ynl A*, 4%).

The *LZ FW* represents a silicified conglomerate, stratigraphically below the *LSZ*, that consists of shale clasts from both the lowermost Newland Formation and the Chamberlain Formation. The *Ynl B* consists of interbedded dolomitic shale and shale-clast conglomerate and lies beneath the *USZ*, which consists of stratabound bedded pyrite and contains the Upper Copper Zone. Undifferentiated dolomitic shale and shaley dolomites of the upper part of the Lower Newland Formation (*Ynl A*) overlie the *USZ*.

Specific tonnages for each waste lithotype are listed in Table 2-20. This rock will be exposed in underground access workings and, temporarily, in active stopes. It will also be stockpiled for approximately two years on a lined surface pad prior to being co-disposed with cemented tailings early in mine life. Once the WRS is reclaimed, all of the waste rock, including the rock to be mined from the *LZ FW* during development, will report directly to the CTF for use in constructing the foundation drain and ramp. Waste rock produced after the CTF begins full operations will be end dumped from the ramp, where it will be subsequently buried by paste tailings. Additional waste rock units representing tonnages below 1% (including *IG, Ynl 0, Yne*, and *Yc)* have also been characterized (Appendix D) (Enviromin, 2017a); those results are not discussed further here.

Operationally, tailings will be produced via flotation and blended with cement/binders to create cemented paste tailings. Tintina proposes to use a drift and fill mining method, placing 45% of produced tailings mixed with 4% cement as backfill into mined out underground stopes and access headings during operations. The remaining tailings (approximately 55%) will be amended with as much as 2% cement (and binder), and transferred as paste into a double lined surface tailings impoundment (the CTF). The CTF design allows little or no water storage on the facility. To provide information for the alternatives analysis that will be required under MEPA, straight (raw or non-amended) tailings were tested along with cemented paste tailings with 2% and 4% binders. Both straight and cemented paste tailings were tested under subaerial weathering and saturated conditions. Although as 4% cement binder mixed with 10% (by weight) waste rock (identified in figures and lab reports as “4%+ROM”) was also tested to simulate disposal of blended materials, that option has been eliminated. Those data are presented in Appendix D (Enviromin, 2017a) and are not considered further here.

2.4.2 Waste Rock Geochemistry

2.4.2.1 <u>Static Testing of Waste Rock</u>

Four-acid digestions followed by inductively coupled plasma-atomic emission spectroscopy (ICP-AES) multi-element analysis (method MEMS61) were completed by ALS Laboratories (Sparks, NV) to quantify whole rock metal content. A total of 5,642 samples of the four dominant waste rock types, were statistically analyzed to characterize overall geochemical variability within individual units and to identify representative sample subsets for static testing (Appendix D, Enviromin, 2017a).

To evaluate acid generation potential, ALS Laboratories (Sparks, NV) completed acid-base accounting (ABA) and net acid generation (NAG) analyses on 138 samples of the four dominant waste rock types and 37 samples of additional waste rock types, for a total of 175 samples. Results of ABA and NAG testing (Figure 2.11) indicate that the majority of *Ynl B* and *Ynl A* samples (90%) are unlikely to form acid, while many *USZ* and *LZ FW* samples have an uncertain potential or are likely to generate acid. Comparison of neutralization (NP) and acid generation potential (AP) in Figure 2.12 shows a similar relationship.

Energy Laboratories (Billings, MT) completed static tests of metal mobility for composites of the 2012 *Ynl B*, *Ynl A*, and *USZ* rock units using EPA Method 1312, the synthetic precipitation leachability procedure (SPLP). Because these tests show elevated pH values (> pH 9.5, a result of carbonate mineralization reacting with acids used in the test), these results were considered to be an unrealistic prediction of pH-sensitive metal concentrations. While they are presented and discussed in Appendix A of the Revised Baseline Environmental Geochemistry Baseline Report (Appendix D) (Enviromin, 2017a), they are not discussed further here. All estimates of metal mobility for this project rely on humidity cell test data.

Table 2-20. Geochemical Testing of Major Waste Rock and Near-surface Materials by Lithotype

Material type	Lithotypes	Description	Waste Rock % Tonnage	ICP	ABA / NAG	SPLP	Mineralogy	Asbestos	HCT
Waste Rock Materials	*LZ FW*	Silicified shale and debris flow	35	550	15	0	0	1	1
	Ynl B	Lower Newland shale and conglomerates	32	1412	34	2	1	2	2
	USZ	Lower Newland upper sulfide zone	28	2542	41	2	1	2	2
	Ynl A	Undifferentiated Lower Newland	4	1138	48	2	1	2	1
	Total Dominant Waste Rock Samples[1]		**99**	**5,642**	**138**	**6**	**3**	**7**	**6**
	Additional Waste Rock Samples[2]		**<1**	**1,855**	**37**	**3**	**1**	**4**	**2**
	All Waste Rock Samples[3]		**100**	**7,497**	**175**	**9**	**4**	**11**	**8**
Near-surface Materials	*Ynl Ex*	Near-Surface Lower Newland shale	<1	108	10	--	--	1	1
	Tgd	Tertiary Granodiorite	<1	76	8	--	--	1	1
	Total Excavation Tonnage		**NA**	**184**	**18**	**--**	**--**	**2**	**2**

*[1] **Total waste rock** tonnage over the life of the mine equals 706,525 tonnes (778,810 tons). A total of 7,497 ICP analyses of waste rock were evaluated.*
[2] Four waste rock types will be mined above 1% of total tonnage; 5,642 ICP analyses were evaluated for these units.
[3]Additional waste rock units were characterized representing less than 1% of tonnage; 1,855 samples were evaluated for these units.
All geochemical test results are presented in Appendices D and D-1.

Table 2-21. Black Butte Copper Project Tailings Treatments and Related Testing

Tailing Test Table	ABA	NAG	ICP metals	Sat. HCT	Unsat HCT	Diffusion Test
Straight (Raw) Tailings	X	X	X	X	X	-
Paste Tailings 2%	X	X	X	-	X[1]	-[2]
Paste Tailings 4%	X	X	X	-	X[1]	X
Paste Tailings 4% and Waste Rock	-	-	-	-	X[1]	X

[1]Unsaturated HCTs conducted on intact cement paste cylinders,
[2]An attempted test of 2% cemented paste tailings could not be completed.

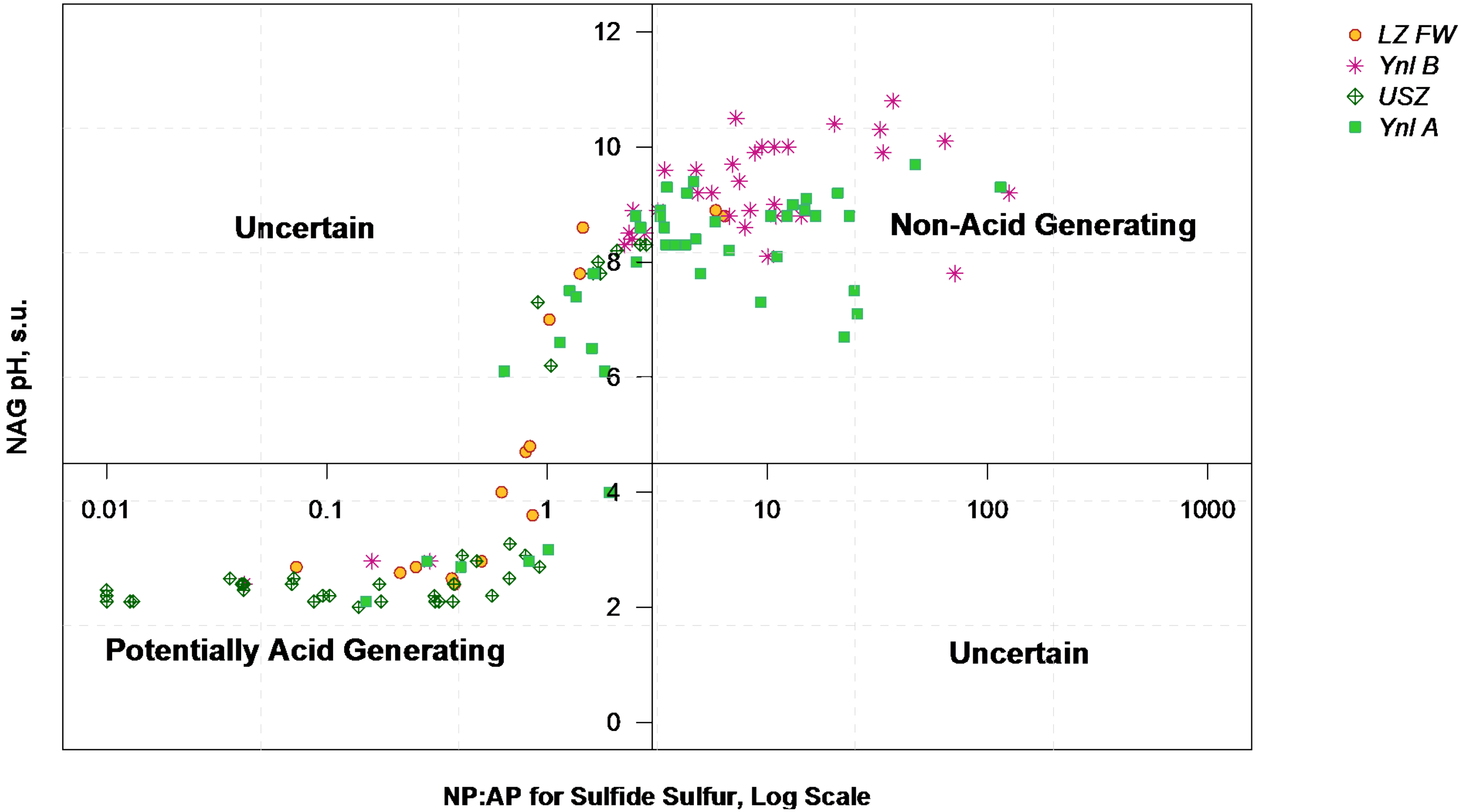


Figure 2.11. Comparison of NAG pH and NP:AP for Major Waste Rock Units

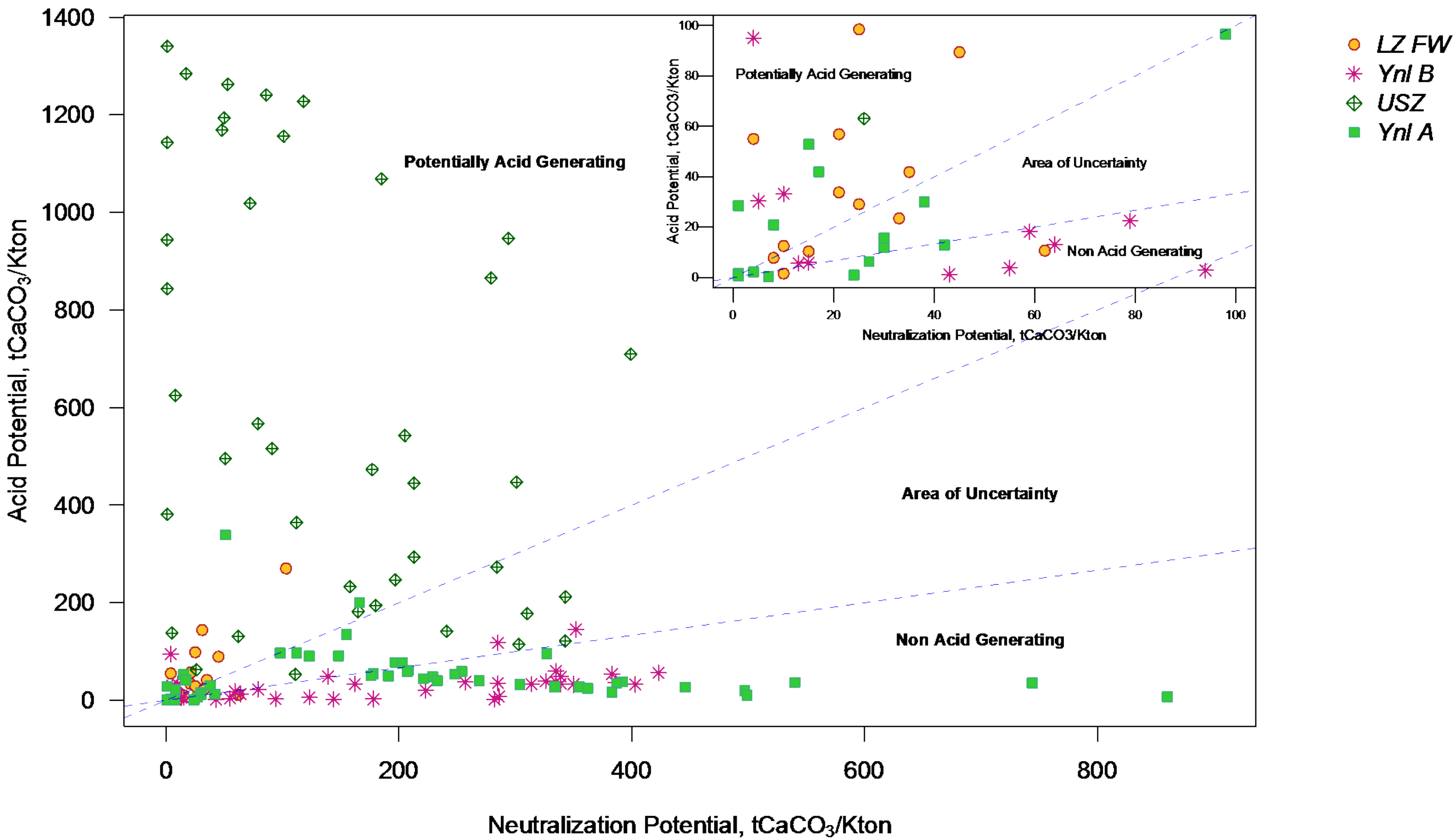


Figure 2.12. Comparison of NP/AP Data for Major Waste Rock Units

Asbestiform mineral testing was completed for all waste rock units by R.J. Lee Associates (Monroeville, PA). Although these types of minerals are highly unlikely to occur in the rock units to be mined from the Project, these tests were conducted to meet regulatory requirements. No asbestiform minerals were identified in any lithotype to be mined from the Project. Appendix D (Enviromin, 2017a) provides detailed methods and results for these tests.

2.4.2.2 Kinetic Testing of Waste Rock

Kinetic tests of waste rock acid generation and metal release potential have been conducted by McClelland Laboratories (Sparks, NV), following ASTM protocol D5744 for humidity cell tests (HCTs). This test exposes samples to alternating dry and humidified air, followed by weekly flushing to remove oxidation products; pH, alkalinity, acidity, dissolved iron, and sulfate are measured weekly as indications of sulfide oxidation and acid generation potential. All waste rock kinetic tests were conducted on composites of static test subsamples from the individual lithologies.

Kinetic tests of *Ynl B*, *USZ*, and *Ynl A* waste rock collected from the vicinity of the previously proposed Johnny Lee decline were conducted between 2012 and 2014. The *Ynl A* composite tested in 2012 consisted of subsamples that were representative of this lithotype site wide, but the *Ynl B* and *USZ* composites were representative only of rock in the immediate vicinity of the exploration decline. To address this limitation, additional tests of these two waste rock units were completed using representative samples collected site wide. As a result of 2015 changes to the mine plan, the *LZ FW* was identified as roughly one-third of the waste rock tonnage to be produced, and also included in the testing program. All testing was completed and reported to DEQ in November 2016.

Results of all kinetic tests of waste rock are summarized in Figure 2.13a and 2.13b. Sulfide oxidation was observed in HCT tests for the four volumetrically significant waste rock units. However, consistent with static test results, and the presence of abundant carbonate minerals, oxidation in the *Ynl B, Ynl A, and LZ FW* tests did not produced sufficient acidity to deplete alkalinity nor did these tests produced acidic pH values. The 2012 HCT of USZ rock samples from the vicinity of the Johnny Lee Decline indicated sulfide oxidation but maintained alkalinity and neutral pH throughout the test, which was terminated at 24 weeks. The 2015 HCT of site wide USZ rock samples also showed evidence of sulfide oxidation, with depleted alkalinity, increased acidity and lower pH observed after 60 weeks of testing.

All assessments of metal release potential for waste rock units (tonnage >1%) and tailings have been based on metal concentrations measured in kinetic test effluents in weeks 0, 1, 2, 4, and every 4 weeks thereafter. Appendix D (Enviromin, 2017a) provides a detailed summary of metal release for kinetic tests conducted in 2012 and 2015.

The *Ynl B and Ynl A* units showed very limited potential to exceed groundwater quality standards in any week of testing. The 2015 *Ynl B* only exceeded the Tl groundwater standard in week 0, while the *Ynl A* exceeded those standards for Ni in week 0 and Tl in weeks 0, 1 and 2. With no evidence of release in excess of groundwater standards after week 2, these early exceedances are the result of sample preparation rather than weathering in the column. The *LZ FW* effluent pH remained consistently neutral*, but* exhibited potential for release of metals at concentrations above groundwater quality standards. Specifically, As and U concentrations exceeded relevant groundwater standards in all weeks of testing, while Sb exceeded its groundwater standard in weeks 0-4. Ni was also observed to exceed the groundwater standard, but only in week 0. The *USZ* has also shown potential for release of metals in excess of groundwater standards in multiple weeks. The 2012 *USZ* HCT exceeded As, Pb, Ni, and Tl groundwater standards in leachate from week 0, and for Tl in week 1; no groundwater standards were exceeded thereafter for this test of the *USZ* in the vicinity of decline. In contrast, the 2015 HCT representing the USZ site-wide exceeded groundwater standards for As, Be, and Cd, in week 0, and not thereafter. Groundwater standards were exceeded Cu, Pb, Ni in early weeks and then regularly after week 44. The Hg groundwater standard was exceeded only in weeks 1 and 2. However, the groundwater standards for Sr and Tl were exceeded in leachate from all weeks of testing.

Because each of the waste rock units has some, if not significant, potential to generate acid or release concentrations of metals in excess of groundwater quality standards, all mined waste rock will be encapsulated in cemented paste tailings in the lined CTF impoundment. Furthermore, Tintina proposes to collect all seepage from the WRS, the CTF, and the underground workings (UG) for treatment to meet non-degradation criteria for groundwater prior to discharge. Potential for impact to surface and groundwater is therefore low.

In 2014, Montana Tech Center for Advanced Mineral Processing (in Butte, MT) completed mineralogical analyses using the Mineral Liberation Analysis/scanning electron microscopy method on samples of waste rock, both pre- and post-weathering, to evaluate the mineral residence of metals of interest, such as thallium and selenium. The *Ynl B* (2013 sample) was comprised of quartz, dolomite, muscovite, potassium feldspar and pyrite (1.6%); the *Ynl* sample showed similar composition, but also contained biotite, barite and 10.8% pyrite. The *USZ*, like the other *Ynl* units, contained quartz, dolomite, muscovite, and potassium feldspar; it also contained 45% pyrite. No discrete mineral phases containing thallium or selenium were identified, but analysis of the thallium and selenium content of heavy liquid separates (which separated the lighter minerals, e.g., feldspars from the heavy sulfides) suggested that these elements which occurred commonly in humidity cell effluent occur as trace substitutes in the sulfides. Appendix D (Enviromin, 2017a) provides details on these analyses and results.

Modeled predictions of water quality have been developed for the UG and CTF during operations and at closure, and for the WRS and the PWP during operations. These are discussed in Sections 4.2 and 4.3 and Appendix N (Enviromin, 2017c) of this MOP Application.

2.4.2.3 Total Organic Carbon Analysis of Waste Rock

The total organic carbon (TOC) content of several waste rock composites from Tintina Montana's Black Butte Copper deposit, were analyzed to support observations of organic carbon made in hand specimen (see Appendix N-2) (Enviromin 2017d). Organic carbon was identified in Appendix N (Section 4.6) as one of three possible sinks of oxygen from infiltrating groundwater, which is likely consumed via (1) aerobic microbial metabolism, (2) oxidation of sulfide minerals and (3) reaction with available organic carbon (DEQ, 2017). Further, i*n situ* measurements of dissolved oxygen in site groundwater support its depletion with depth (see Appendix B).

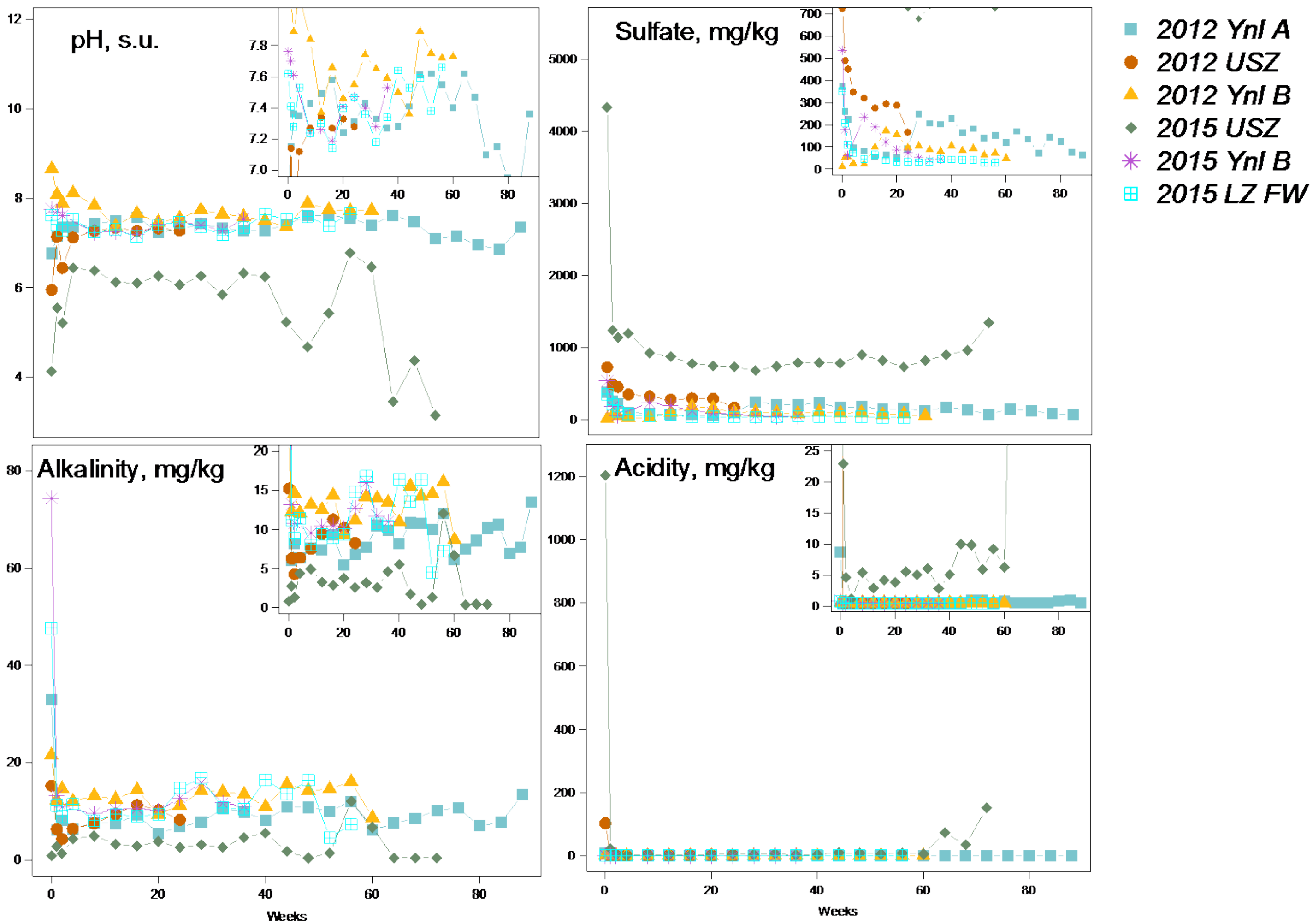
Results of LECO analyses of TOC in waste rock analyzed by Enviromin are compared with values from published literature (Lyons et al, 2000) in the table below.

Table 2-22. Total Organic Carbon Content of Waste Rock Composite Samples

SAMPLE ID	TOC (weight %)
2012 *Ynl A*	0.81
2015 *USZ*	0.41
2015 *Ynl B*	0.5
2015 *LZ FW*	0.39
2016 *Ynl Ex*	0.3
Lyons *et al* 2000*	0.13-3.39

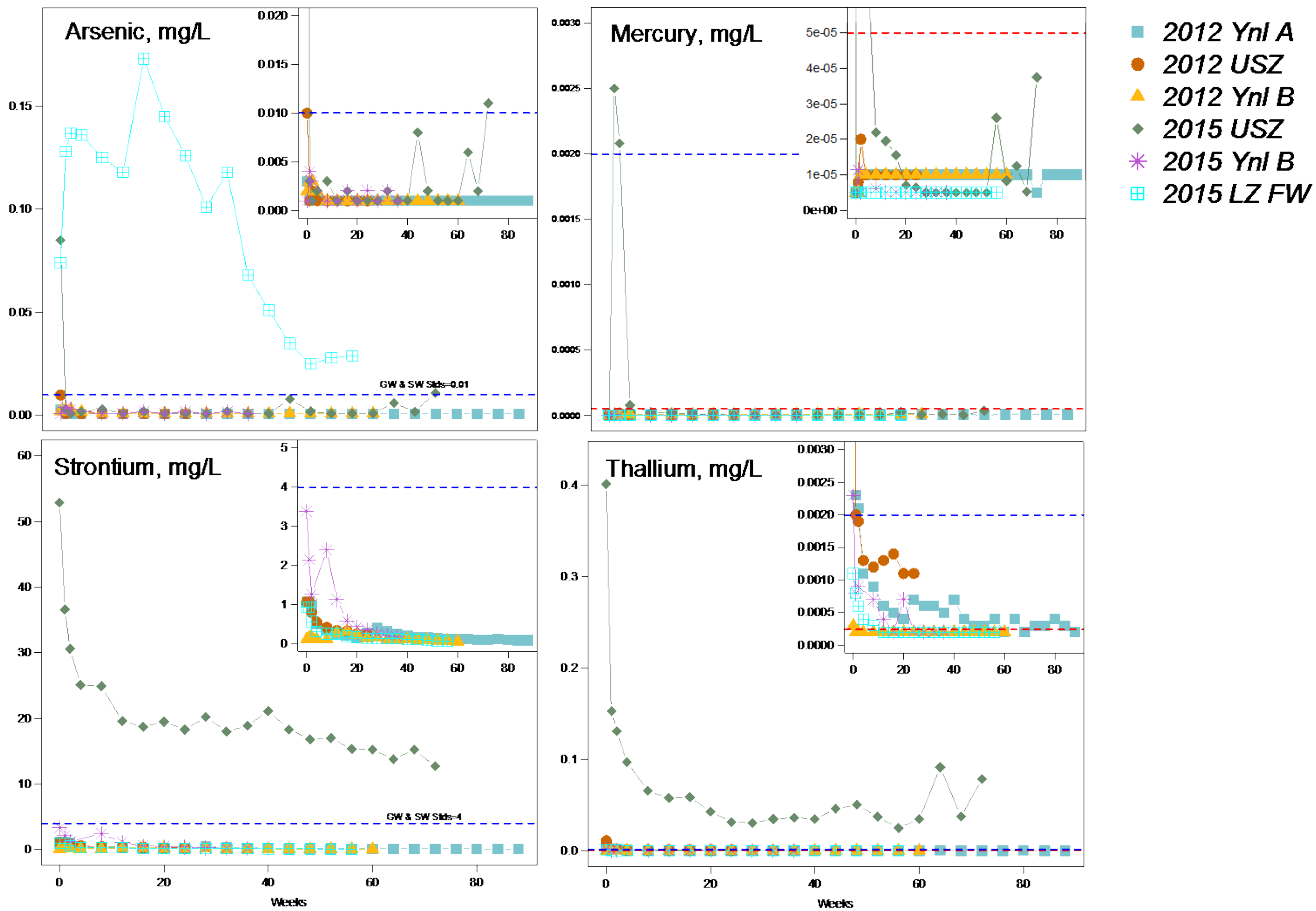
* Range of values for samples collected at Tintina's Black Butte Copper Project site, averaging 1.30 % as reported by Lyons et. al. (2000).

The results reported by Lyons et. al. are comparable to the values measured in the Black Butte Copper Project composites and support the hand specimen observations of organic carbon in these sediments. A memo describing these test results has been added as Appendix N-2 (Enviromin, 2017d).



Note: Some data obscured in insets. All data visible in large figures; test durations varied.

Figure 2.13a. Comparison of Select Parameters for Waste Rock Kinetic Humidity Cells



Note: Shows surface and groundwater quality standards in red and blue, respectively, for select metals with exceedances; test durations varied; Some data obscured in insets, all data visible in large figures.

Figure 2.13b. Comparison of Select Parameters for Waste Rock Kinetic Humidity Cells

2.4.3 Tailings Geochemistry

2.4.3.1 Static Testing of Tailings

Splits of homogenized tailings reject produced in bench-scale metallurgical testing were used for all tests. While there is some variation in AP and NP between subsamples (Table 2-23), ABA and NAG tests indicate that the tailings will have a strong potential to generate acid regardless of cement addition (Table 2-23). The neutralization potential resulting from the addition of 2% to 4% cement is not sufficient to neutralize the sulfide in the tailings; this was not the intent of cement addition, however. Cement was added to provide structural strength in support of drift and fill mining methods underground, and to change the physical properties of the material to a stable, non-flowable material with low hydraulic conductivities on the order of 10^{-9} m/sec in both surface and underground settings.

2.4.3.2 Kinetic Testing of Tailings

Kinetic tests of straight (raw, non-amended) tailings were completed at McClelland Laboratories and cemented paste tailings tests at Western Environmental Testing Laboratory (WETLab, Sparks NV). Table 2-24 summarizes the tailings characteristics, testing methods and conditions, and ultimate disposition of tailings, in various scenarios represented by each kinetic test. Cemented paste tailings cylinders were tested (without crushing) in conventional ASTM method D5744 HCTs (as described above for kinetic testing of waste rock) to simulate subaerial weathering. They were also tested using ASTM C1308 diffusion tests to simulate diffusion through backfill in saturated underground workings. The ASTM C1308 diffusion test involves the submergence of paste tailings cylinders (with a height:diameter ratio of 2:1) in 14 sequential deionized water baths over a period of 11 days; the test is designed to predict sulfide reactivity and solute release as a result of diffusion. While ASTM C1308 allows the use of groundwater or deionized water these tests used the chemically more aggressive deionized water to limit related shipping of groundwater and to be consistent with the ASTM D5744 tests conducted for this project. Straight (raw, non-amended) tailings were also tested using ASTM method D5744 (as described above for kinetic testing of waste rock), both sub-aerially and in a modified, saturated test, to represent dry stack surface placement and subaqueous impoundment deposition scenarios, respectively.

Acid generation parameters for all kinetic tests of tailings are shown in Figure 2.14 and Figure 2.15 and details are provided in Appendix D (Enviromin, 2017a). In the diffusion tests, the 4% cemented paste cylinder maintained a variable neutral to alkaline pH between 6.5 and 9.5 s.u., and produced alkalinity with low sulfate and acidity throughout the test. The 4% cemented paste cylinder maintained a pH above 5.0 until week 8, while the 2% cemented paste cylinder only maintained a pH above 5.0 in weeks 0 and 1. After dropping below a pH of 5.0, each cylinder demonstrated steady decline in pH and increasing acid and metal production as the cylinder disaggregated. This indicates that the addition of more neutralizing waste rock and cement did not reduce sulfide oxidation, but acted, as intended, to increase stability of the material and reduce its reactive surface area.

Similar to pH, acid and sulfate production also varied between the cemented paste tests, with the 2% test exhibiting greater oxidation and release of related solutes than the 4% test. Given the fact that the 2% and 4% cemented pastes have very similar NNP and NP/AP characteristics with obvious potential for acid generation, the elevated acidity of the 2% test cylinder is explained by its faster disaggregation under leach in the HCT, which exposed significantly greater amounts of sulfide to oxidation.

Straight (raw, non-amended) tailings weathered in a conventional, subaerial humidity cell were strongly acidic and showed a correspondingly high potential to generate sulfate at low pH. In contrast, Tintina proposes to place 0.5 to 2% cemented paste materials in its surface CTF, and to collect and remove water from that impoundment continuously. Discharge of tailings seepage to surface water is not anticipated because mine-affected water will be treated prior to discharge to groundwater. The following discussion, therefore, compares results to groundwater standards, with the exception of the saturated humidity cell test of raw tailings, which represents surface water in a subaqueous tailings facility pond.

Metal release data for tailings kinetic tests are summarized in Figure 2.16 for select metals and provided for all metals in Appendix D (Enviromin, 2017a). Although the initial rate of metal release for cemented paste tailings was lower than straight (raw) tailings for most metals, the release rates of many metals from the 2% cement paste HCT approached that of the unsaturated straight (raw) tailings HCT after 8 weeks, as a result of disaggregation during testing. Metal concentrations in effluent from the 28 week long 4% paste cement HCT exhibited groundwater exceedances for Tl in early weeks (0-2), with later exceedances of groundwater standards for Cu and Ni (after week 8) and As and Cr (after week 20). Beryllium was detected at concentrations above standards only in weeks 16 and 20. In comparison, only the As standard for groundwater was exceeded in the 4% diffusion test. In the unsaturated HCT of straight (raw, non-amended) tailings, metal release potential was much higher, with regular exceedances of groundwater standards observed for numerous constituents (see list in Appendix C of Appendix D). At the lower oxidation rate in the saturated HCT of straight (raw, non-amended) tailings, which is intended to represent tailings deposited in a subaqueous impoundment, fewer metals exceeded relevant surface water quality standards and they were detected at much lower concentrations; these are also reported in Appendix C of Appendix D).

Table 2-23. Static ABA and NAG pH Test Results for Straight (Raw) and Paste Tailings

Sample Identification		NAG @pH 4.5	NAG @pH 7.0	NAG pH	Fizz Rating	AP	NP*	NNP	NP/AP	Paste pH	Total S (%)	NaOH-leachable S (%)	HCl-leachable S (%)	Sulfide S (%)	Total Carbon (%)	Carbonate (%)
						tCaCO3/Kt										
Straight (Raw) tailings	CA12185-JUN15	NA	NA	NA	1	802	2.0	-800	0.003	3.23	25.5	NA	<0.01	25.7	0.372	0.220
	CA15079-JUL15	NA	NA	NA	1	935	*<1*	*-934*	*0.01*	3.30	28.9	NA	<0.01	29.9	0.304	0.100
	CA12531-JUL15	NA	NA	NA	1	781	*<1*	*-780*	*0.01*	3.31	24.1	NA	<0.01	25.0	0.459	0.145
	CA15000-AUG15	NA	NA	NA	1	845	9.4	-836	0.01	3.58	28.3	NA	1.29	27.0	0.406	0.295
	CA14523-AUG15	NA	NA	NA	1	554	61.1	-493	0.11	3.92	21.4	NA	3.70	17.7	1.19	3.20
	Enviromin Tails Sample	282	406	2.2	1	775	*<1*	*-770*	*0.01*	4.0	24.8	0.71	0.68	24.1	NA	NA
Paste tailings	C601-15 (2% Binders)	131.5	182	2.1	1	741	*<1*	*-740*	*0.01*	3.8	23.7	2.08	1.15	21.6	NA	NA
	C586-15 (4% Binders)	124	179.5	2.3	1	744	9	-738	0.01	7.9	23.9	1.99	1.19	21.9	NA	NA

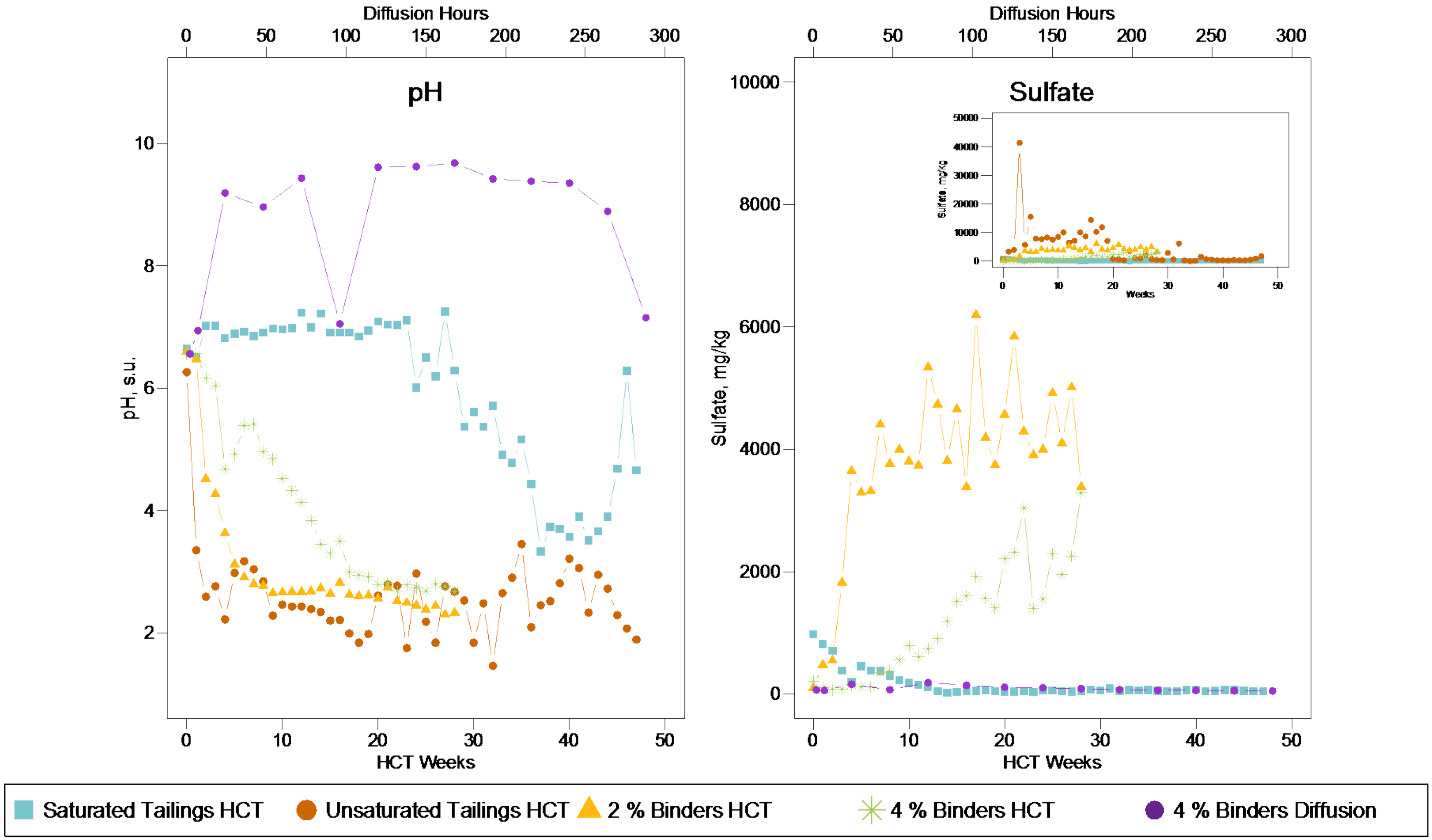
**negative NP values (italicized) adjusted to <1; "1" used for calculation of NP:AP and NNP*

Red shading indicates that based on the ratings systems presented in Tables 3-1 and 3-2 of Appendix D, these samples all have potential to generate acid.

Table 2-24. Tailings Characteristics, Kinetic Test Methods, and Facility Scenarios

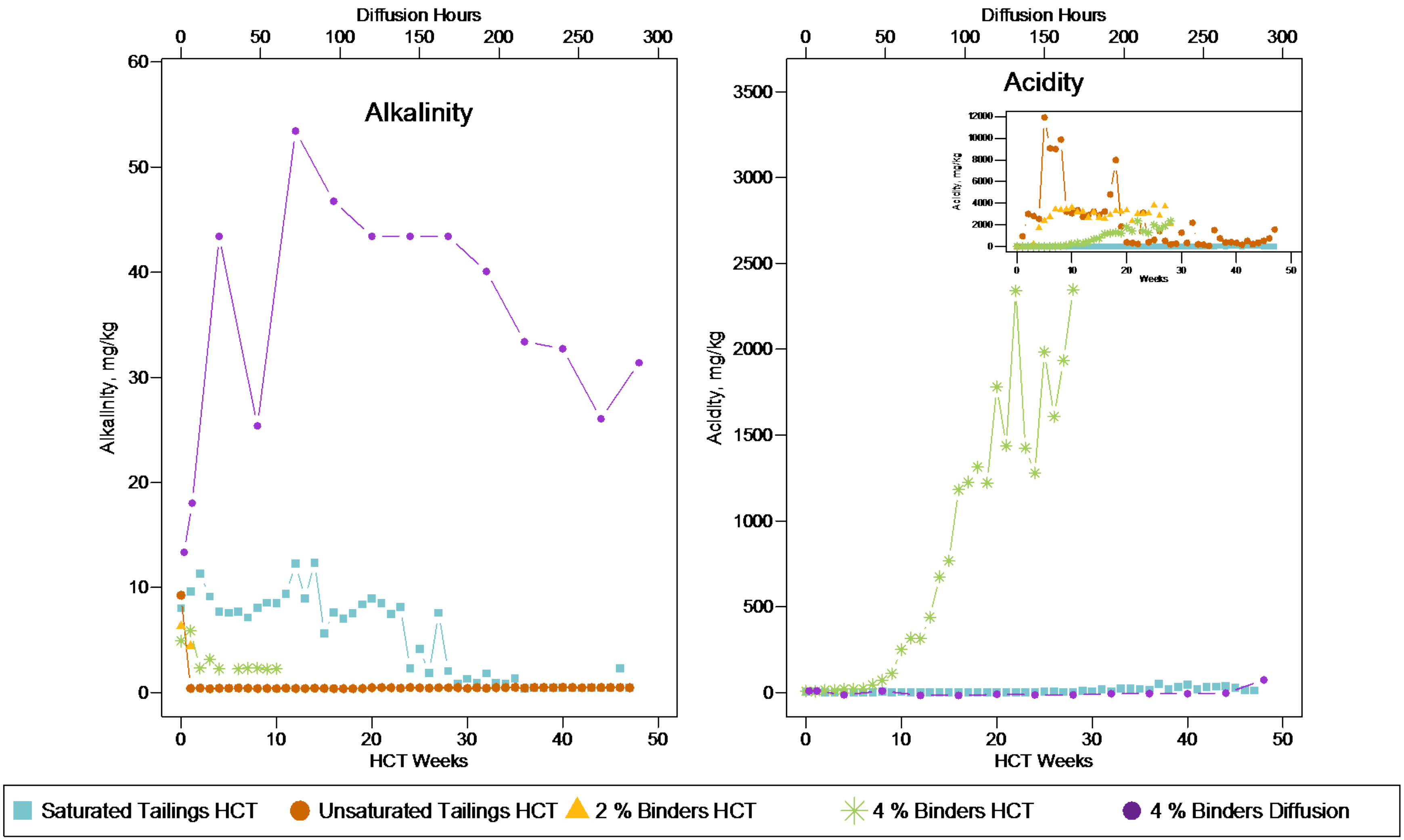
Action Scenarios	Facility Represented	Tailings Characteristics	Test Method
Proposed	Backfilled Paste in flooded workings	4% binder	ASTM C1308 diffusion test
	Cement paste in CTF, subaerial weathering, routine operations	2% binder	ASTM method D5744 (HCT)
	Cement paste in CTF, subaerial weathering, final closure lift	4% binder	ASTM method D5744 (HCT)
Alternative	Saturated tailing e.g., subaqueous impoundment	Straight (Raw)	Modified ASTM method D5744 (saturated HCT)
	Subaerial weathering, e.g., dry stack tailing pile	Straight (Raw)	ASTM method D5744 (HCT)
Additional*	Cement paste in CTF, subaerial weathering	4% co-disposed with waste rock	ASTM method D5744 (HCT)
	Backfilled Paste in flooded workings	4% co-disposed with waste rock	ASTM C1308 diffusion test

**Geochemical testing of paste tailings mixed with ROM was conducted to evaluate previously considered scenarios that are no longer pertinent to Tintina's operational plans. These tests are described here for completeness but are not relevant to compliance assessments or modeling. See Appendix D for data.*



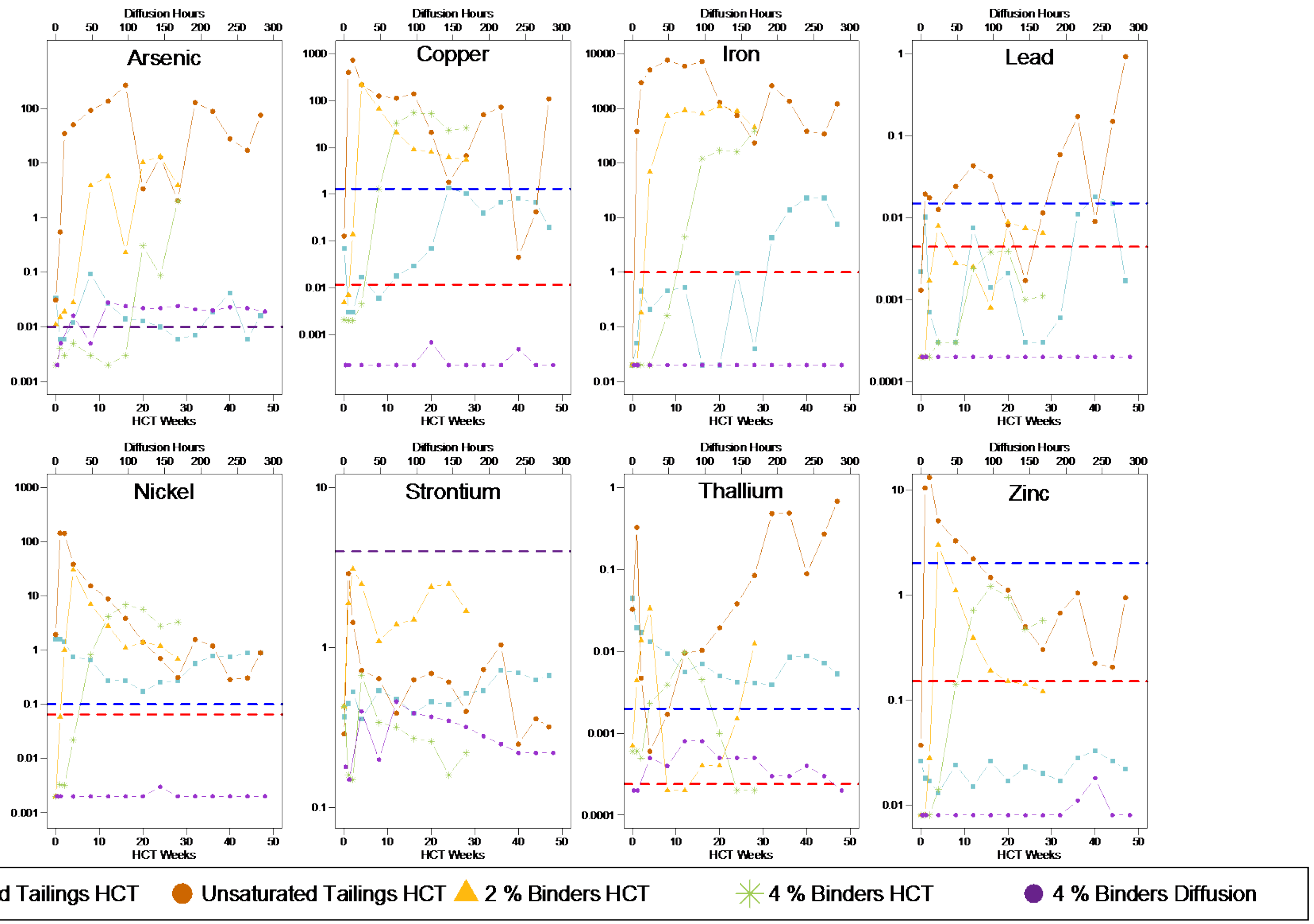
Note: To facilitate data interpretation, the Unsat HCT sulfate data are only presented in the inset with the expanded view of the y-axis. Diffusion Hours on upper x-axis only relate to 4% Diffusion test data in purple. All other HCT data relate to the lower x-axis (Weeks)

Figure 2.14 Kinetic Test Results for Tailings with pH, Alkalinity, Acidity, and Sulfate.



Note: To facilitate data interpretation, the Unsat HCT and 2% binders HCT acidity data are only presented in the inset with the expanded view of the y-axis. Diffusion Hours on upper x-axis only relate to 4% Diffusion test data in purple. All other HCT data relate to the lower x-axis (Weeks).

Figure 2.15. Kinetic Test Results for Tailings with pH, Alkalinity, Acidity



Note: All data are presented in mg/L. Y-axes are log-scale and vary by parameter. Shows surface and groundwater quality standards in red and blue, respectively, (and purple where standards are the same). Diffusion Hours on upper x-axis only relate to 4% Diffusion test data in purple. All other HCT data relate to the lower x-axis (Weeks).

Figure 2.16. Kinetic Test Results for Tailings showing Select Metals (Set 2)

2.4.4 Near-Surface Materials

Shallow, weathered, highly-fractured and oxidized near-surface bedrock zones of the Lower Newland Formation (*Ynl Ex*) and Tertiary sill-form granodiorite intrusive rocks (*Tgd*) will be excavated and used for construction of BBC mine facilities, such as embankments, protective layers for liners, and drain-rock.

Figure 2.17 shows the geology of the proposed mine area with the location of geotechnical drill holes and soil and infiltration test pits where samples used in this study were collected. Figure 2.18 also illustrates the proposed construction footprint for the mine facilities of interest along with these same drill holes and test pits. The final selection of samples for composite geochemical testing of *Ynl Ex* and *Tgd* is described in Appendix D-1. Of the approximately 3.9 million cubic yards (cu yds.) (3.0 million m^3) of bulked rock (20% after excavation) to be excavated during construction of the facilities listed in Table 3-14a, approximately half (or 1.5 m^3) will be from each of the *Ynl Ex* and *Tgd* units. Tintina proposes to use an estimated total of 184,520 m^3 (241,343 cu. yds.) of the excavated *Tgd* as prepared sub-grade bedding and drainage gravel project wide (Table 3-14b).

The *Ynl Ex* is a mix of dolomitic and non-dolomitic shale with rip-up-clast conglomerate from the Proterozoic Lower Newland Formation that has been thrust to the surface along the Black Butte Fault (*BBF*). The *Tgd* is younger granodiorite which intruded the *Ynl Ex* rocks as sill-like tabular bodies. The site geologic map (Figure 2.17) shows that these two rock units occur together as folds within the thrust sheet in the facility footprints. Geochemical data described below indicate that these highly fractured rocks in the near-surface weathering zone have been significantly leached by infiltrating meteoric water, with resulting depletion of sulfide and metals.

A statistical review of select multi-element data as a function of depth was used to determine whether Ynl Ex and Tgd, were comparable to deeper Ynl B and IG test units, respectively. Summary statistics, based on ten elements from multi-element analyses, were used to test these relationships. Examples of these comparisons is presented in Figure 2.19. Results and summary statistics are included in Appendix D-1 by Enviromin (2017b) of this report.

Comparisons of the geochemistry as a function of depth demonstrate that weathered surface materials are relatively depleted in metals and sulfur, and are therefore distinct from the deeper materials. This is consistent with observations made from drill samples (highly fractured with iron-oxide stained fractures) collected while drilling (Knight Piésold, 2017b). Because the near-surface deposits of Ynl Ex and Tgd are geochemically distinct from the deeper bedrock material, they have been independently tested to evaluate acid generation and metal release potential using static and kinetic methods.

Figure 2.17 shows locations where the *Ynl Ex* and *Tgd* near-surface deposits (<20 m or 65 feet depth) have been sampled extensively by geotechnical drilling and soil test pits, providing a population of samples that is representative of the shallow bedrock materials that will be excavated or disturbed by near surface facilities.

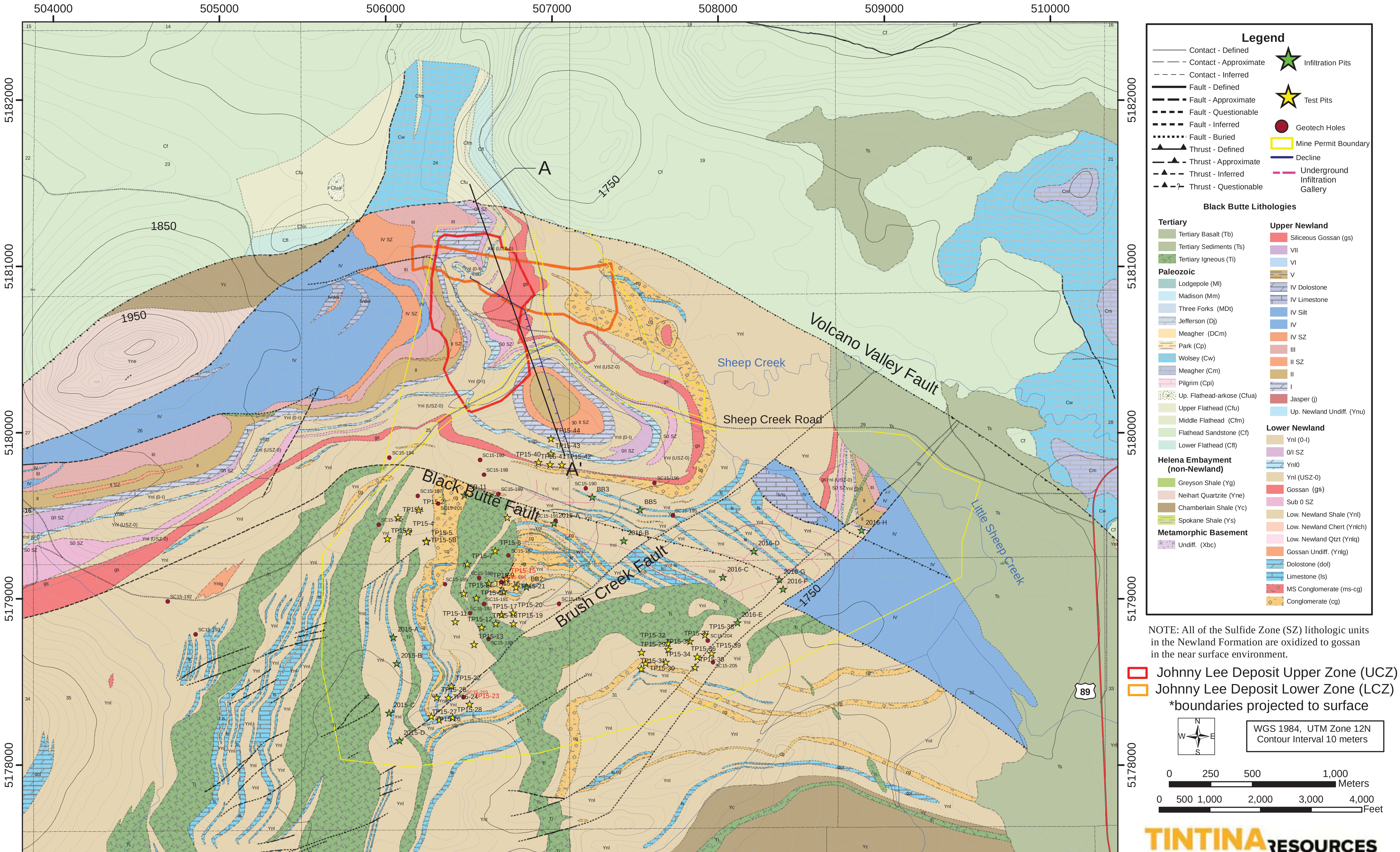
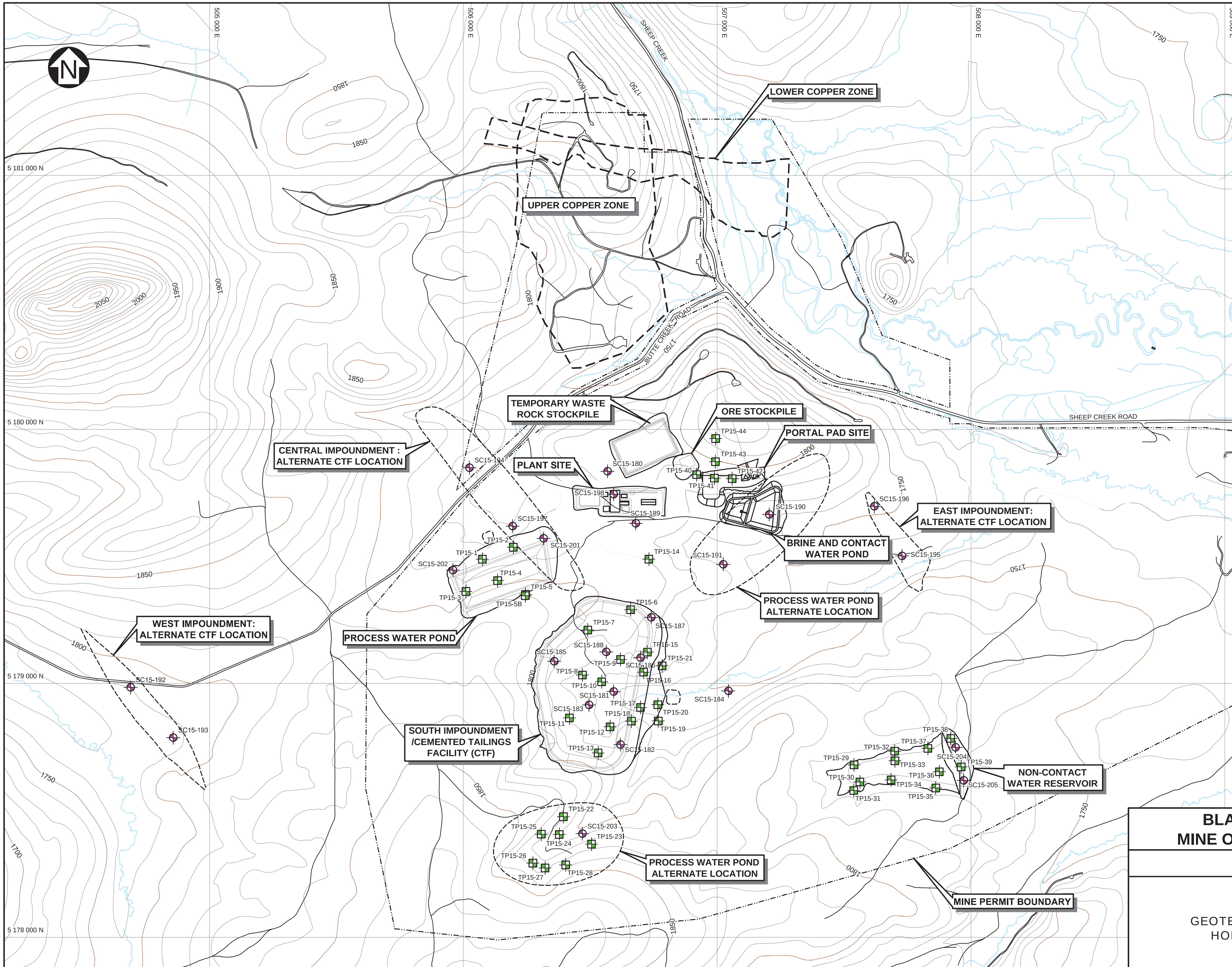


Figure 2.17
Site Geologic Map Showing 2015 Geotechnical Boreholes and Testpits



LEGEND:

- DRILL HOLE
- TEST PIT
- ALTERNATE CTF AND PWP LOCATION
- MINE PERMIT BOUNDARY

NOTES:

1. TOPOGRAPHIC BASE MAP FROM 2011 AERIAL LIDAR SURVEY WITH MAP PROJECTION: UTM ZONE 12N AND MAP DATUM: NAD83.
2. CONTOUR INTERVAL IS 10 METERS.
3. ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 2.18
GEOTECHNICAL SITE INVESTIGATION DRILL HOLE AND TEST-PIT LOCATIONS WITH FACILITIES

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
		REVISIONS				

REVISED DATE:
MAY 2016

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-1 Rev 2

SOURCE FIGURE NUMBERS: FIGURE D1.1_r2

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 2.18 & 3.13 Geotechnical Site Investigation Drill Hole and Test-Pit Locations with Facilities(D1.1_r2), PRINTED: 4/26/2017 2:44:13 PM

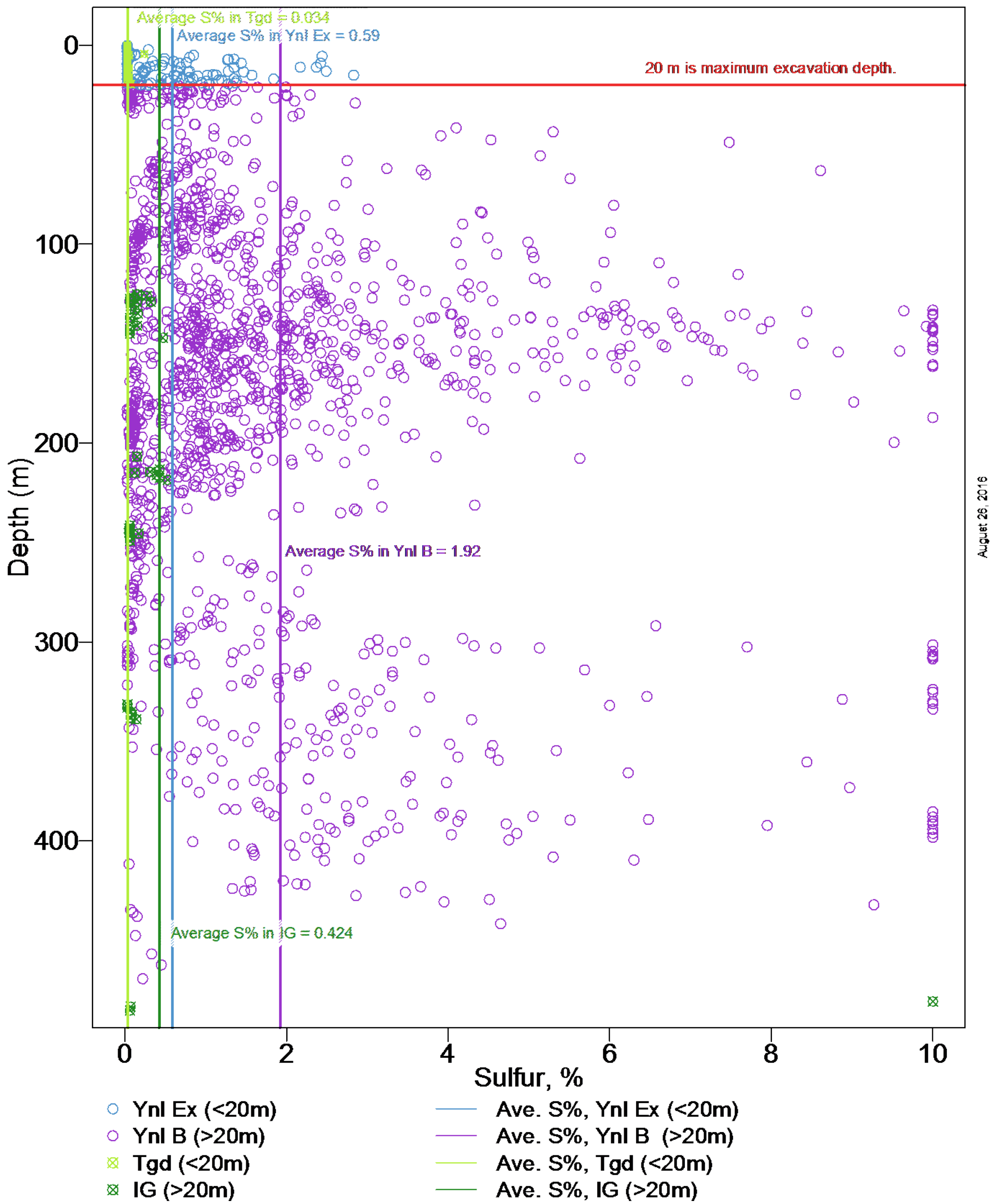


Figure 2.19. Comparison of S (%) with Rock Depth (Including Near-Surface Materials)

The near-surface bedrock excavated materials (*Ynl Ex* and *Tgd*) have been characterized using static multi-element analysis, acid-base accounting (ABA), net acid generation (NAG) potential, and kinetic methods. Figure 2.20 through Figure 2.24 summarize test results. Composites of *Tgd* and *Ynl Ex* were tested for asbestiform minerals; none were identified. Kinetic tests were conducted as reported in Enviromin (2017b) (Appendix D-1).

Information provided by static test results and kinetic testing suggests that it is unlikely that either the *Ynl Ex* or *Tgd* material will produce acid or release significant concentrations of metals. Static test were confirmed by kinetic testing, and metal release has been very low. As demonstrated in Figure 2.24 and Figure 2.25, effluent from these humidity cell tests met MT groundwater quality standards in all weeks. These effluents also met surface water quality standards, with the exception of selenium exceedances in weeks 0 through 4 in *Ynl Ex.* No metals were detected above standards for the *Tgd*.

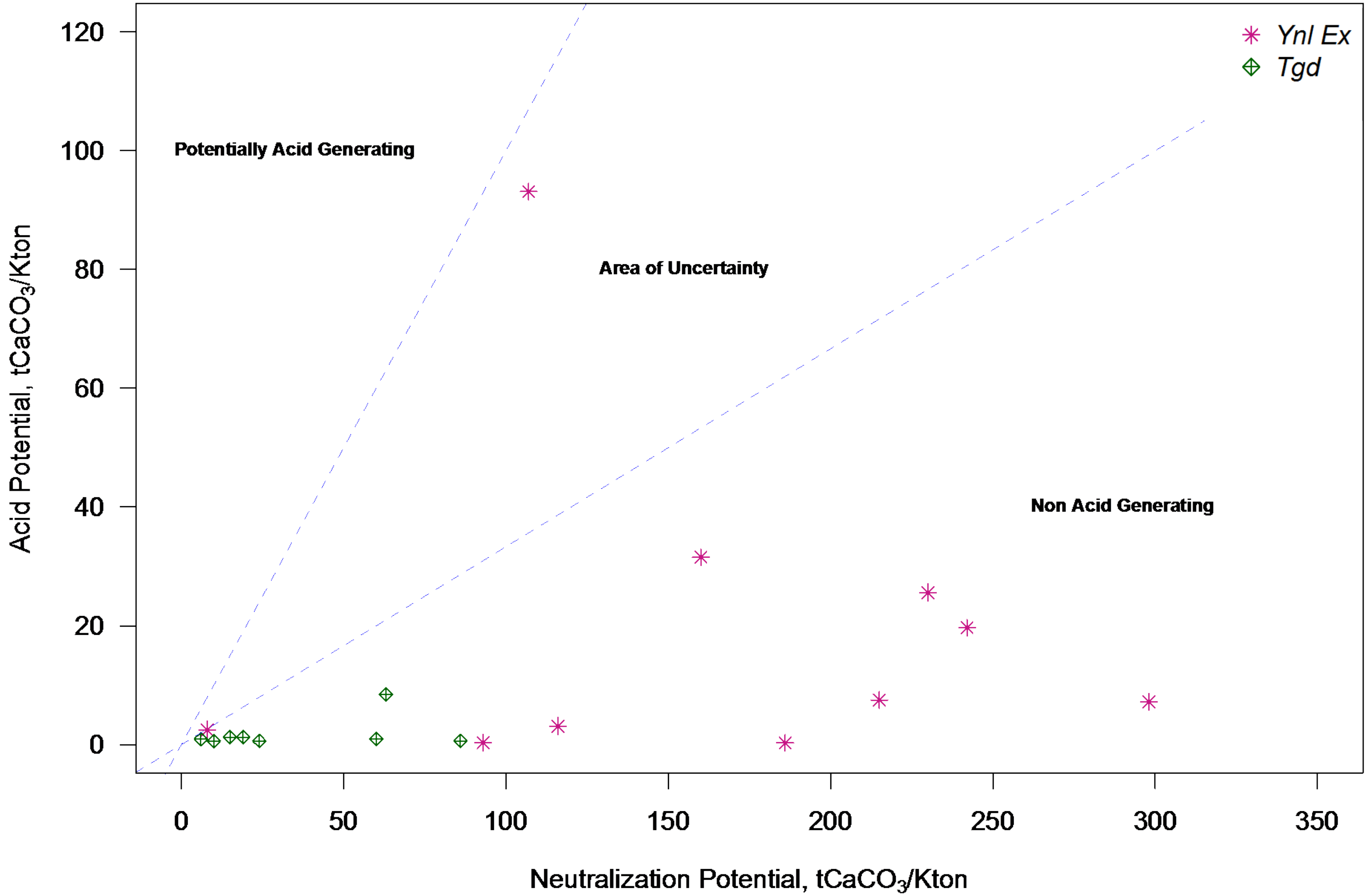


Figure 2.20. Acid Generation Potential for Surface Materials

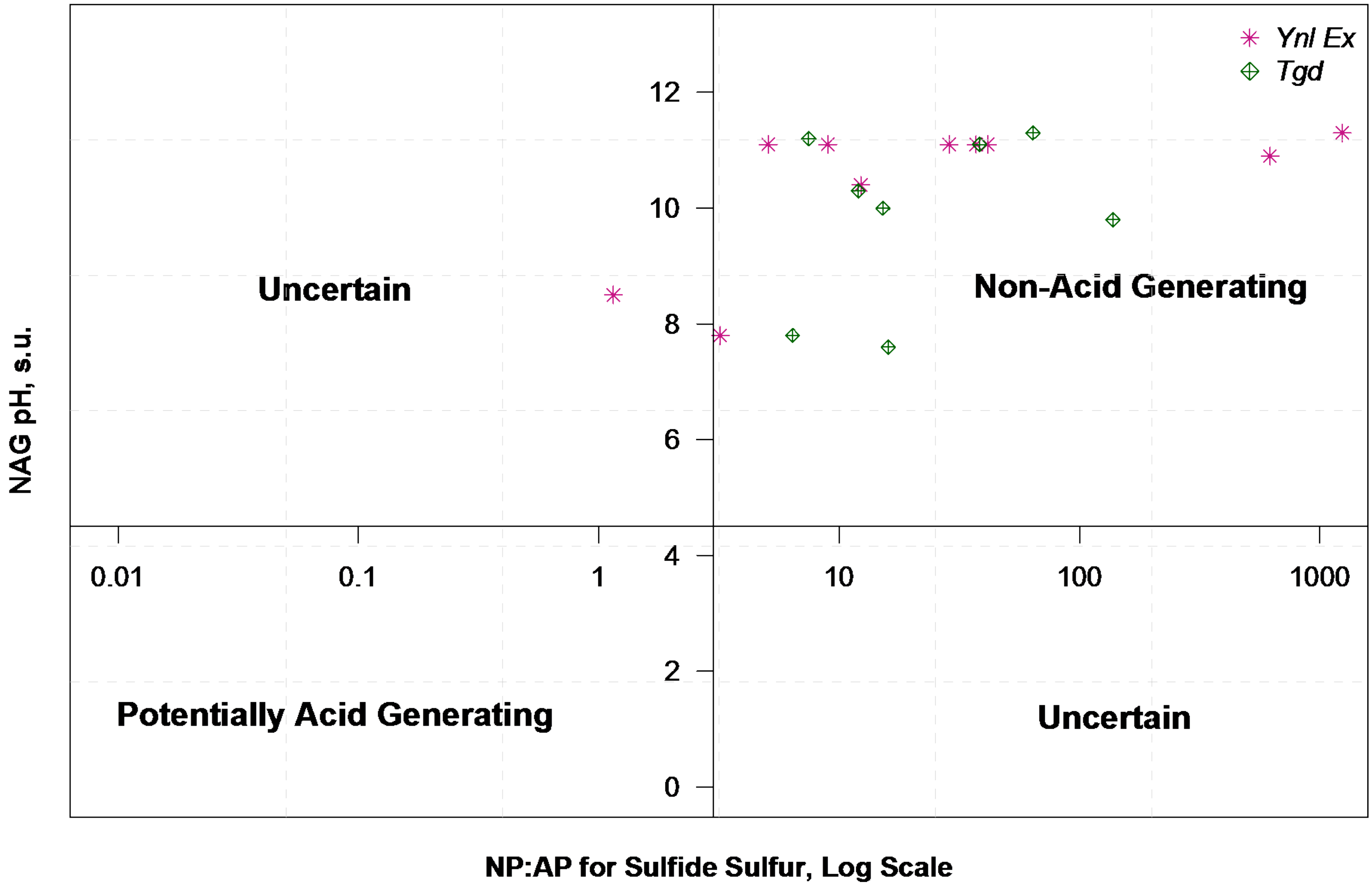


Figure 2.21. Comparison of NAG pH with NP:AP for Surface Materials

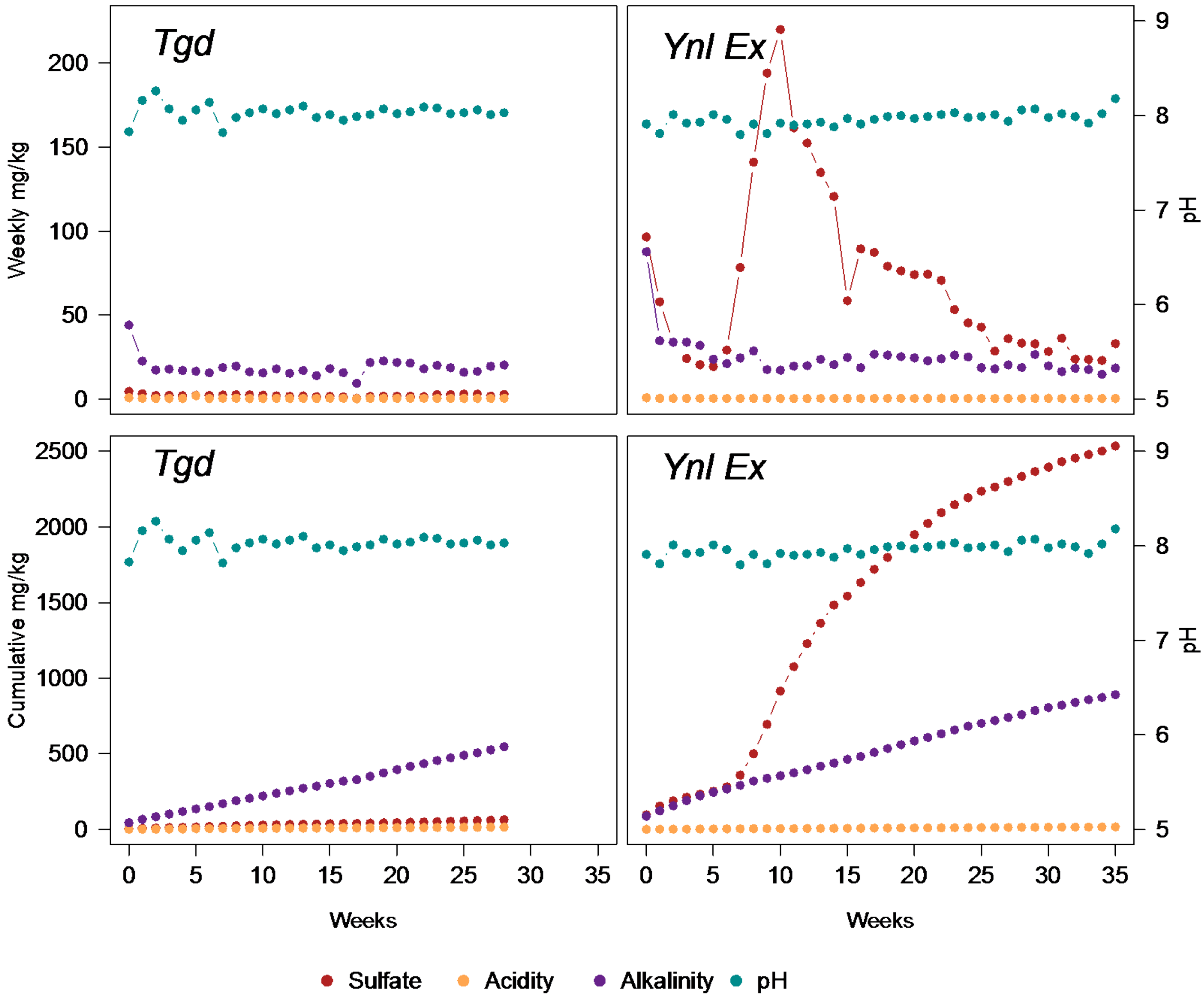
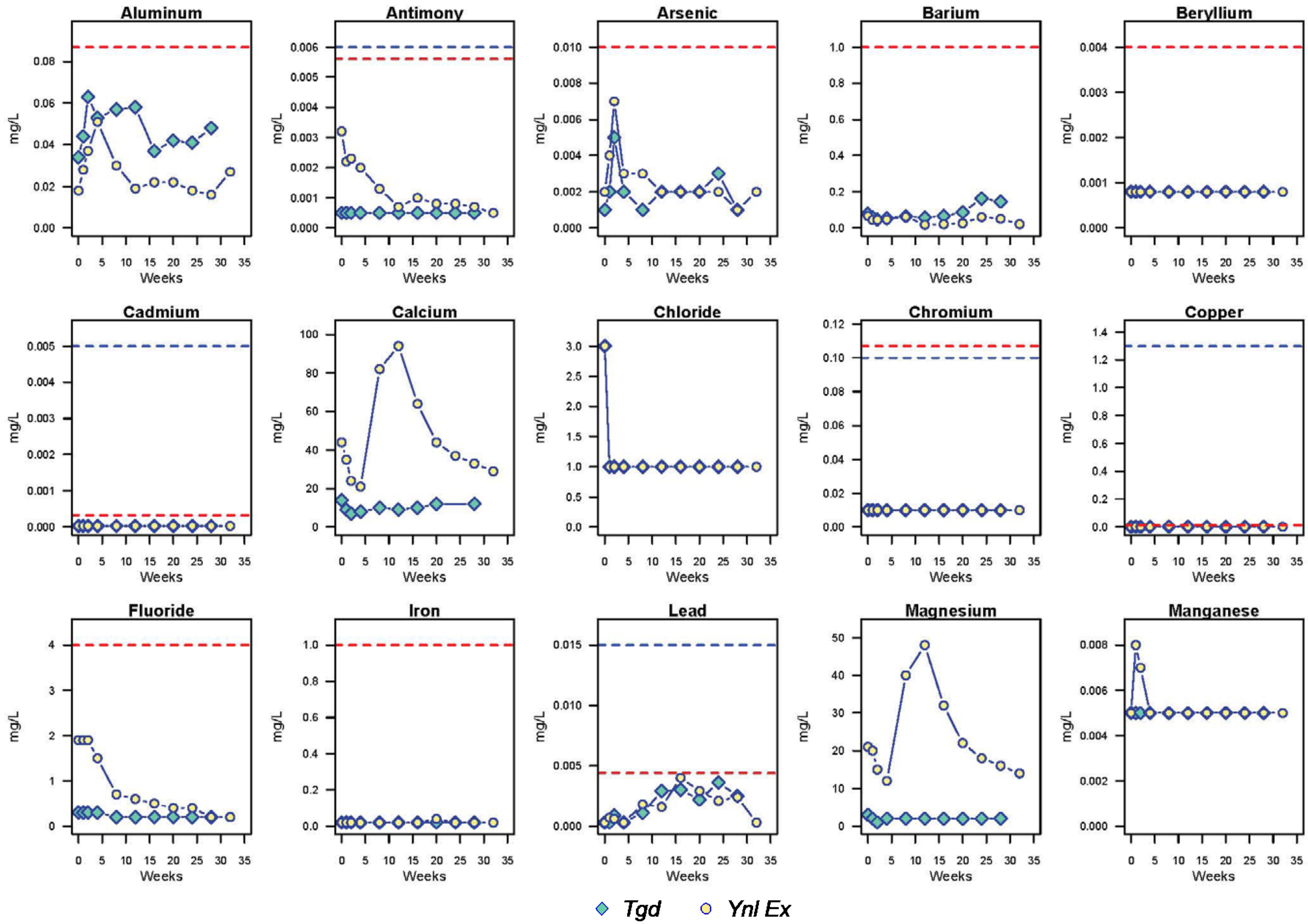
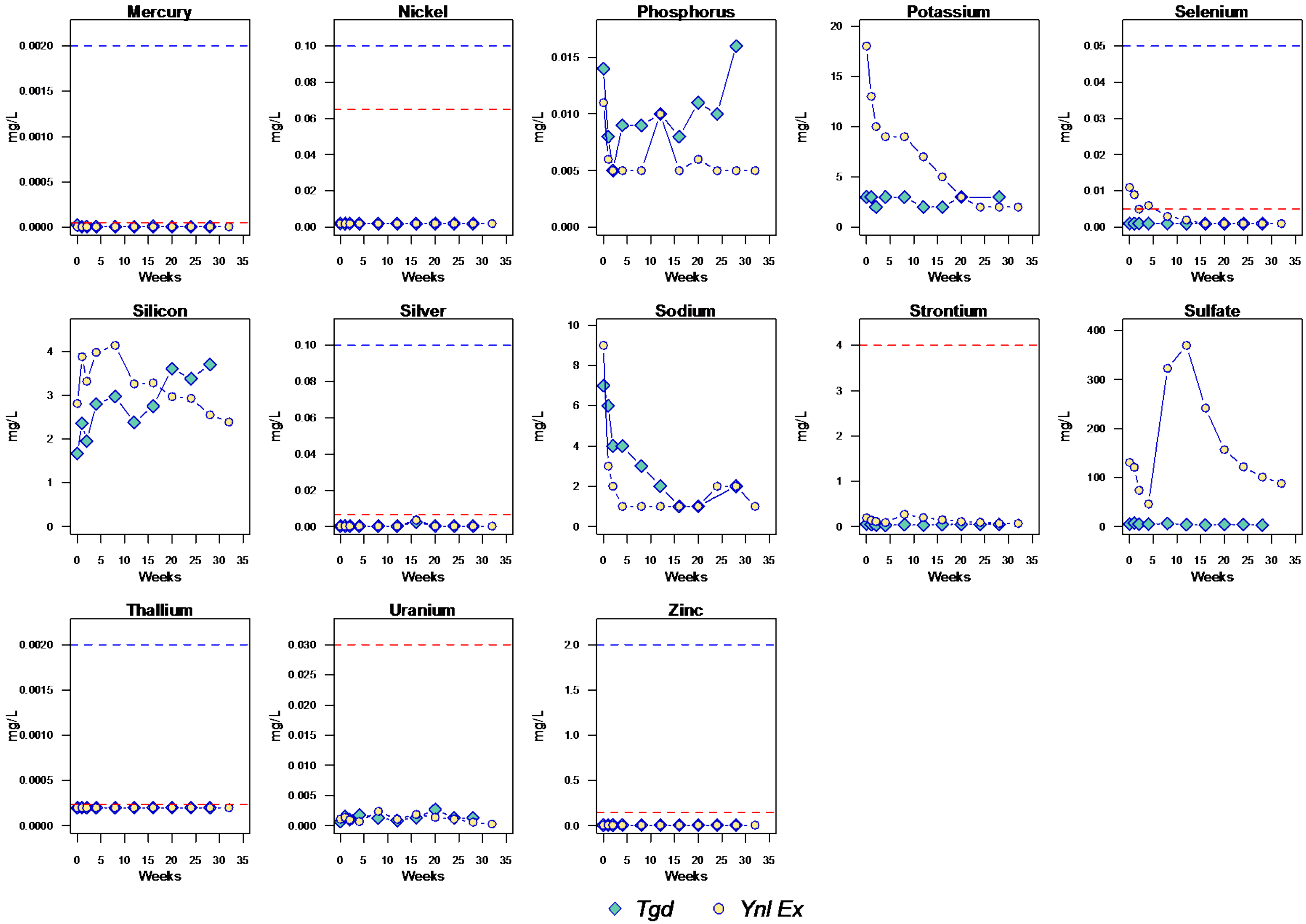


Figure 2.22. Kinetic Test Parameters for *Tgd* and *Ynl Ex*



Note: All data are presented in mg/L. Y-axes vary by parameter. Shows surface and groundwater quality standards in red and blue, respectively

Figure 2.23. Periodic Metals for *Tgd* and *Ynl Ex* HCTs (Set 1)



Note: All data are presented in mg/L. Y-axes vary by parameter. Shows surface and groundwater quality standards in red and blue, respectively

Figure 2.24. Periodic Metals for *Tgd* and *Ynl Ex* HCT (Set 2)

2.4.5 Environmental Chemistry Conclusions

The four dominant waste rock units have shown evidence of sulfide oxidation in the HCT tests. However, consistent with the static test results and the presence of abundant carbonate mineralization, acid generation in waste rock HCTs was limited. Furthermore, metal release from waste rock HCTs was varied. The *Ynl A* and *Ynl B* released relatively low concentrations of a few metals (with Se and/or Tl at or slightly above groundwater standards). In contrast, the *USZ* released Sr and Tl at concentrations exceeding groundwater standards throughout the test, with additional metals (notably, Cu, Pb, Ni) exceeding groundwater standards after the pH dropped in week 60. The *LZ FW* released a different suite of metals, with Sb and Se exceeding groundwater standards in the early weeks of testing, and U and As exceeding standards throughout the test.

Due to the potential for release of various metals at different times in the expected weathering process, all waste rock will be encapsulated in paste tailings in the lined CTF impoundment. Furthermore, Tintina proposes to collect all seepage from the temporary WRS, the copper-enriched rock stockpile, the CTF, and the UG for treatment to meet non-degradation criteria prior to discharge via underground infiltration galleries. Impacts to surface water and groundwater are therefore not anticipated. Models of water quality for these facilities which incorporates these data are described in Section 4.2 and Appendix N of this MOP Application.

HCTs indicate that all of the cemented paste tailings have potential to oxidize after a lag time and to release at least some sulfate, acidity, and metals if left exposed to air and water. Importantly, this is not observed immediately in test cells, and the rate of weathering in a humidity cell is recognized to be significantly greater than in the field. Given Tintina's proposed drift and fill method of mining, distinct surfaces of backfilled material will only be exposed to air for a short period of time, thus reducing the production of sulfate, acidity, and metals. At closure, the backfill material will be submerged in groundwater, reducing oxygen availability (the diffusivity of oxygen in water is 10,000 less than in air) and resulting sulfide oxidation to negligible levels. Results of the kinetic diffusion tests indicate that the 4% cemented paste tailings that Tintina plans to use for backfill is unlikely to become acidic and has potential to release only As in concentrations above groundwater standards under saturated conditions at closure. Furthermore, because of the extremely low hydraulic conductivity of this material, interaction with groundwater will be limited.

In the CTF, each new lift of cemented paste tailings will behave as a massive block of material with low transmissivity, with a thin upper surface that will be exposed to some degree of oxidation before being covered by fresh cemented paste tailings within 30 days of placement. This is the longest duration of exposure that is anticipated; average exposure times are expected to be shorter, on the order of 7 to 15 days. The unsaturated kinetic tests of cemented paste tailings reflect the type of oxidation to be expected along this surface, while the diffusion tests better represent the majority of tailings placed in each lift. However, it is highly unlikely that the rate of disaggregation observed in the field would approach that observed in the laboratory test, which optimized sulfide oxidation and disaggregation of the small (and unconfined) test cylinders. Waste rock will be placed in lenses adjacent to the ramp in the CTF where it will be encapsulated by cemented paste tailings. The cemented paste tailings placed within the CTF is best represented by the 2% cemented paste tailing HCT data, while the final lift of paste tailings in the CTF is best represented by the 4% HCT data. If material is covered in a timely manner (on the scale of weeks and less than 30 days, average range expected to be 7 to 15 days), relatively less oxidation, acidity, and leaching of metals is expected to occur and it would be limited to the exposed surface of the cemented paste tailings. If operations were to be interrupted, as in the case of a temporary suspension in tailing production, or during early closure, Tintina will increase the cement binder content to reduce weathering during the period of extended exposure. Also, any water interacting with oxidized tailings will subsequently flow through and react with waste rock before being collected in a sump within a lined facility for treatment.

At closure, the CTF will be covered with a geotextile membrane over a period of months, which will be welded to the lower liner, eliminating long-term exposure of the final lifts to oxygen and water. The double lined CTF with drainage collection is designed to prevent discharge to surface water and groundwater. Thus, any solutes resulting from oxidation and release of metals by cemented paste tailings within the CTF are unlikely to reach or affect surface water or groundwater.

As a potential alternative to Tintina's proposed scenario for placement of 4% cemented paste tailings in saturated underground workings, subaqueous placement of tailings in surface ponds as represented by the saturated HCT of straight tailings appears to be the next most effective at limiting sulfide oxidation. However, if a subaqueous impoundment alternative were to be considered, some release of metals to the tailings pond would be expected to occur based on these HCT results, and in the long run, depletion of alkalinity and a subsequent drop in pH are possible. In addition, significant acid rock drainage would also be expected to develop in sub-aerially weathered, fine-grained non-amended tailings, suggesting that a "dry stack" management method for tailings is not an ideal alternative scenario in this setting either. Therefore, management of tails as cemented paste, co-disposed with waste rock, appears to be significantly superior to the subaqueous and dry stack alternatives.

The acid generation and metal release potential of near-surface rock to be excavated near the Project facilities has been characterized. Mineralogical analyses of asbestiform mineral content were also completed; no asbestiform minerals were identified.

Results of static ABA indicate *Tgd* is net neutralizing, which was confirmed by kinetic testing. No metals were detected above any relevant groundwater or surface water standard. Due to the excellent quality of this material and its lack of chemical reactivity and metals release, Tintina plans to use it as protective sub-grade bedding below lined facilities, and as drainage rock in its facility foundation drains and underground infiltration galleries.

The *Ynl Ex* also appears unlikely to produce acid, despite a temporary spike in sulfate concentrations. These rocks released low concentrations of selenium that exceeded surface water standards (but not groundwater) in early weeks of testing.

2.5 Soil Resources

2.5.1 Soils Study Area

Tintina conducted an Order 2 soil survey within a 3,368 acre (1,363 ha) Study Area (Figure 2.25). The survey provided descriptions, classifications of soil profiles to the family level, and correlating these families to map unit names provided in the existing NRCS soil survey. Additionally, collection of soil samples from representative horizons allowed for analysis of physical and chemical properties in order to assess soil suitability for reclamation. The remainder of this section summarizes the survey methods and results while Appendix E (Westech, 2017a) provides a more detailed description including analytical data and photos.

2.5.2 Soils Methods

Tintina completed an Order 2 soil survey in accordance with procedures developed by the NRCS (USDA, 1993). The survey began with a review of existing soils information (i.e., NRCS soil survey data, aerial photographs, geologic maps, and other information) to identify the dominant soil series in the area and to develop a preliminary soils map that included 28 original soil sample sites. An additional two sample sites were added in October 2015 to bring the total number of sample sites to 30.

Initial field inventory activities were completed in July 2015, with supplemental surveys in October 2015. Field surveys included soil profile (pedon) observations, soil sampling, and refinement of preliminary map unit boundaries. Soil samples collected from discrete horizons at each of the 28 sample sites were analyzed to determine soil texture, organic matter content, coarse fragment content, pH, salinity/conductivity, and total arsenic, cadmium, copper, lead, and zinc concentrations.

Surveyors identified preliminary map unit boundaries in the field based on the results of pedon descriptions and development of conceptual map units. A review of information including laboratory results and final pedon classifications allowed a refinement of soil map unit descriptions and boundaries.

In addition to the Order 2 soil survey, surveyors completed field investigations to determine the hydraulic properties of soils and shallow bedrock to support site selection for underground infiltration galleries.

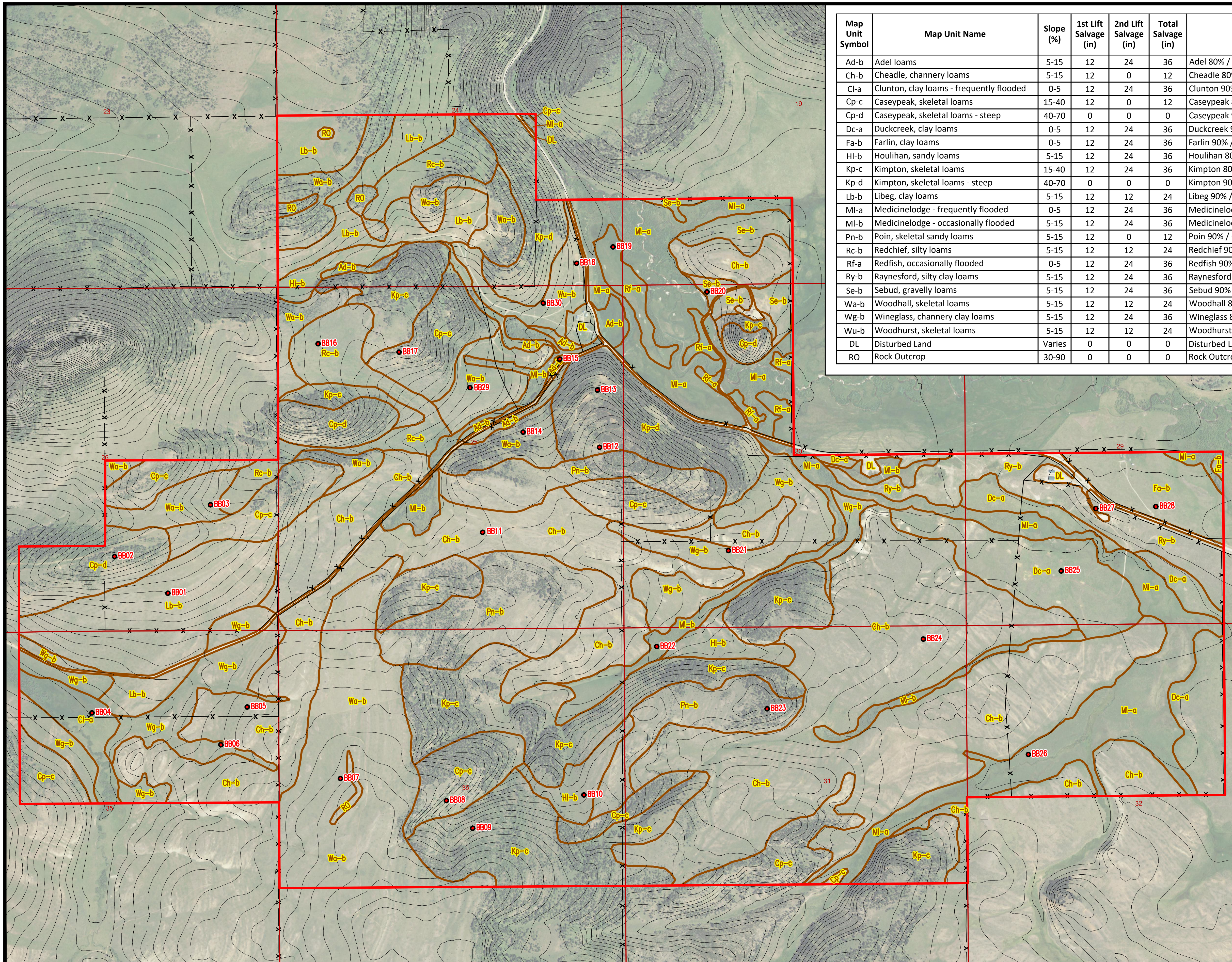
2.5.3 Soils Results

The study identified eighteen soil series in the Study Area composed of 23 map units shown on Figure 2.25 and Map Sheet 3. Table 2-25 lists the map units, their composition (i.e., the proportion of the map unit occupied by each soil series), and other data.

The following sections summarize relevant physical and chemical properties of the map units, which may limit the suitability of these soils for salvage operations. Appendix E (Westech, 2017a) provides more detailed descriptions of the suitability of individual map units.

The DEQ (MDEQ, 1998) provide soil salvage suitability guidelines which include such characteristics as coarse fragment content (i.e., greater than 50 % coarse fragments are unsuitable for salvage), slope steepness (slopes greater than 2 to 1 are unsuitable), and other characteristics. In addition, in March of 2017, Westech incorporated newly published soil suitability guidelines by the Montana DEQ (2016) to revise recommended salvage depths (that were in Mine Operating Permit Application [Revision 1]) for the following soil units within the Black Butte Project Survey Area: Ch-b, Ch-c, Hl-b, Kp-c, and Lb-b (see Table 2-26) in this Mine Operating Permit Application (Revision 3) and in Table A-1 in Appendix E.

Map Unit Symbol	Map Unit Name	Slope (%)	1st Lift Salvage (in)	2nd Lift Salvage (in)	Total Salvage (in)	Components and Proportions (%)	Acres in Study Area	Percent of Study Area
Ad-b	Adel loams	5-15	12	24	36	Adel 80% / Medicinelodge 10% / Caseypeak 5% / Kimpton 5%	26.9	0.8%
Ch-b	Cheadle, channery loams	5-15	12	0	12	Cheadle 80% / Wineglass 10% / Duckcreek 5% / Medicinelodge 5%	798.5	23.7%
Cl-a	Clunton, clay loams - frequently flooded	0-5	12	24	36	Clunton 90% / Wineglass 10%	26.5	0.8%
Cp-c	Caseypeak, skeletal loams	15-40	12	0	12	Caseypeak 80% / Woodhall 10% / Kimpton 10%	222.4	6.6%
Cp-d	Caseypeak, skeletal loams - steep	40-70	0	0	0	Caseypeak 90% / Woodhall 5% / Kimpton 5%	79.3	2.4%
Dc-a	Duckcreek, clay loams	0-5	12	24	36	Duckcreek 90% / Cheadle 5% / Medicinelodge 5%	138.0	4.1%
Fa-b	Farlin, clay loams	0-5	12	24	36	Farlin 90% / Medicinelodge 5% / Raynesford 5%	46.5	1.4%
Hl-b	Houlihan, sandy loams	5-15	12	24	36	Houlihan 80% / Kimpton 10% / Caseypeak 5% / Cheadle 5%	50.2	1.5%
Kp-c	Kimpton, skeletal loams	15-40	12	24	36	Kimpton 80% / Caseypeak 10% / Woodhall 10%	345.8	10.3%
Kp-d	Kimpton, skeletal loams - steep	40-70	0	0	0	Kimpton 90% / Poin 5% / Woodhall 5%	127.7	3.8%
Lb-b	Libeg, clay loams	5-15	12	12	24	Libeg 90% / Caseypeak 5% / Cheadle 5%	197.8	5.9%
Ml-a	Medicinelodge - frequently flooded	0-5	12	24	36	Medicinelodge 80% / Duckcreek 10% / Redfish 10%	256.4	7.6%
Ml-b	Medicinelodge - occasionally flooded	5-15	12	24	36	Medicinelodge 90% / Wineglass 5% / Woodhurst 5%	71.7	2.1%
Pn-b	Poin, skeletal sandy loams	5-15	12	0	12	Poin 90% / Cheadle 5% / Kimpton 5%	188.3	5.6%
Rc-b	Redchief, silty loams	5-15	12	12	24	Redchief 90% / Kimpton 5% / Woodhall 5%	86.5	2.6%
Rf-a	Redfish, occasionally flooded	0-5	12	24	36	Redfish 90% / Medicinelodge 10%	31.5	0.9%
Ry-b	Raynesford, silty clay loams	5-15	12	24	36	Raynesford 90% / Duckcreek 5% / Farlin 5%	67.5	2.0%
Se-b	Sebud, gravelly loams	5-15	12	24	36	Sebud 90% / Cheadle 10%	35.7	1.1%
Wa-b	Woodhall, skeletal loams	5-15	12	12	24	Woodhall 80% / Caseypeak 10% / Kimpton 5% / Redchief 5%	328.1	9.7%
Wg-b	Wineglass, channery clay loams	5-15	12	24	36	Wineglass 80% / Cheadle 10% / Clunton 5% / Medicinelodge 5%	166.4	4.9%
Wu-b	Woodhurst, skeletal loams	5-15	12	12	24	Woodhurst 90% / Caseypeak 5% / Kimpton 5%	27.9	0.8%
DL	Disturbed Land	Varies	0	0	0	Disturbed Land 100%	36.9	1.1%
RO	Rock Outcrop	30-90	0	0	0	Rock Outcrop 90% / Woodhall 5% / Libeg 5%	11.3	0.3%
						Total	3367.5	100%



TINTINA RESOURCES

Black Butte Copper Project

Baseline Soil Survey Map

WESTECH ENVIRONMENTAL
406-442-0950 | P.O. Box 6045 | Helena, MT 59604

Figure 2.25

07/05/17 | BBC17_Soils_Baseline_MOPA_Fig_R1.dwg | 1:14,400

Table 2-25. Summary of Soil Map Units in Black Butte Copper Study Area

Map Unit Symbol	Map Unit Name	Slope (%)	Map Unit Composition (% by Soil Series)	Acres in Study Area	Percent of Study Area
Ad-b	Adel loams	5-15	Adel 80% / Medicinelodge 10% / Caseypeak 5% / Kimpton 5%	26.9	0.8
Ch-b	Cheadle, channery loams	5-15	Cheadle 80% / Wineglass 10% / Duckcreek 5% / Medicinelodge 5%	798.5	23.7
Cl-a	Clunton, clay loams	0-5	Clunton 90% / Wineglass 10%	26.5	0.8
Cp-c	Caseypeak, skeletal loams	15-40	Caseypeak 80% / Woodhall 10% / Kimpton 10%	222.4	6.6
Cp-d	Caseypeak, skeletal loams - steep	40-70	Caseypeak 90% / Woodhall 5% / Kimpton 5%	79.3	2.4
Dc-a	Duckcreek, clay loams	0-5	Duckcreek 90% / Cheadle 5% / Medicinelodge 5%	138.0	4.1
Fa-b	Farlin, clay loams	0-5	Farlin 90% / Medicinelodge 5% / Raynesford 5%	46.5	1.4
Hl-b	Houlihan, sandy loams	5-15	Houlihan 80% / Kimpton 10% / Caseypeak 5% / Cheadle 5%	50.2	1.5
Kp-c	Kimpton, skeletal loams	15-40	Kimpton 80% / Caseypeak 10% / Woodhall 10%	345.8	10.3
Kp-d	Kimpton, skeletal loams - steep	40-70	Kimpton 90% / Poin 5% / Woodhall 5%	127.7	3.8
Lb-b	Libeg, clay loams	5-15	Libeg 90% / Caseypeak 5% / Cheadle 5%	197.8	5.9
Ml-a	Medicinelodge - frequently flooded	0-5	Medicinelodge 80% / Duckcreek 10% / Redfish 10%	256.4	7.6
Ml-b	Medicinelodge - occasionally flooded	5-15	Medicinelodge 90% / Wineglass 5% / Woodhurst 5%	71.7	2.1
Pn-b	Poin, skeletal sandy loams	5-15	Poin 90% / Cheadle 5% / Kimpton 5%	188.3	5.6
Rc-b	Redchief, silty loams	5-15	Redchief 90% / Kimpton 5% / Woodhall 5%	86.5	2.6
Rf-a	Redfish, occasionally flooded	0-5	Redfish 90% / Medicinelodge 10%	31.5	0.9
Ry-b	Raynesford, silty clay loams	5-15	Raynesford 90% / Duckcreek 5% / Farlin 5%	67.5	2.0
Se-b	Sebud, gravelly loams	5-15	Sebud 90% / Cheadle 10%	35.7	1.1
Wa-b	Woodhall, skeletal loams	5-15	Woodhall 80% / Caseypeak 10% / Kimpton 5% / Redchief 5%	328.1	9.7
Wg-b	Wineglass, channery clay loams	5-15	Wineglass 80% / Cheadle 10% / Clunton 5% / Medicinelodge 5%	166.4	4.9
Wu-b	Woodhurst, skeletal loams	5-15	Woodhurst 90% / Caseypeak 5% / Kimpton 5%	27.9	0.8
DL	Disturbed Land	Varies	Disturbed Land 100%	36.9	1.1
RO	Rock Outcrop	30-90	Rock Outcrop 90% / Woodhall 5% / Libeg 5%	11.3	0.3
			Total	**3,367.5**	**100**

2.5.3.1 Physical Properties of Soils

Physical soil properties that can affect suitability for salvage include texture, coarse fragment content, depth to bedrock, depth to groundwater, slope, organic matter content, and erosion potential.

Certain soil textures such as clay, silty clay, sand, and others can pose suitability problems in regards to soil handling and site stability. Three of the 28 pedon locations observed in the Study Area contained horizons with unsuitable clay textures. However, undesirable soil textures will not significantly impact the reclamation potential of soils due to the limited distribution of these soils in the Study Area. Mechanical mixing of soils during the salvage and redistribution processes will result in soils with suitable textures upon reclamation.

Coarse fragment concentrations greater than 50% can inhibit reclamation success. Thirteen of the 28 observed pedons included horizons with high coarse fragment concentrations that range from 50 to 90%. The majority of these coarse fragments consisted of gravels less than 3-in in diameter, which often do not impede salvage potential. However, Adel, Caseypeak, Poin, and Woodhurst soils also contain larger sized fragments that can limit soil suitability. However, DEQ considers rock that can be picked up by a scraper (as large as 24-in. (60 cm) as suitable for salvage.

Shallow depths to bedrock or groundwater can limit salvage suitability by providing a relative lack of soil or restricting equipment operation. Eleven of the observed pedons occurring in the Caseypeak, Cheadle, Kimpton, Poin, Redchief, and Woodhall soil types had shallow depths to bedrock ranging from 3 to 30 in. below ground surface. The Clunton, Medicinelodge, and Redfish soils had shallow depths to groundwater ranging from 10 to 32 in. below ground surface.

Slopes steeper than 50% , such as those found in or near dissected drainages, steep ridges, or rock outcrops, limit soil salvage operations due to safety hazards associated with heavy equipment use. The Caseypeak soil type within Map Unit Cp-d and the Kimpton soil type within Map Unit Kp-d both occur on slopes ranging in steepness from 40 to 70%.

Organic matter content is considered a beneficial soil characteristic as it is directly related to soil fertility. Guidelines describing minimum desirable organic matter content vary, however 2 percent or greater is generally considered suitable for salvage and reclamation. The soils sampled in the Study Area had organic matter contents that ranged from 1.9 to 49.4% and averaged 9.7% in the upper 12 in. (30.5 cm) of the soil profile. Deeper horizons averaged 5.1% . No soils within the study area are considered unsuitable based on organic matter content.

Susceptibility to wind and water erosion negatively affects soil suitability for salvage. The soil erodibility factor (K-Factor) allows assessment of erosion potential due to water while Wind Erodibility Group rating (WEG) (USDA, 2009 and 2013) allows assessment of wind erodibility. Appendix E (Westech, 2017a) gives a more detailed description of K-Factor and WEG. Soils in the Study Area generally exhibit low to moderate susceptibility to erosion.

2.5.3.2 Chemical Properties of Soils

Chemical properties affecting soil suitability for reclamation include pH, electrical conductivity, and concentrations of certain metals or metalloids including arsenic, cadmium, copper, lead, and zinc.

Soils with pH values below 5.5 s.u. or above 8.5 s.u. are not recommended for plant growth or establishment and are considered unsuitable for salvage (Brady and Weil, 1999) unless soil volumes are limited and site-specific conditions require salvage of those materials. Soils in the Survey Area generally exhibited suitable pH conditions for plants (5.5 to 7.0), although these values vary between soil types and within individual soil pedons. A total of six sample locations, representing six soil series, exhibited pH levels below DEQ reclamation guidelines (MDEQ, 1998). This study indicates no adverse impacts on vegetation from salvaged soil due to the prevalence of neutral pH in the majority of soils in the Study Area, despite the presence of some acidic soil horizons.

Electrical conductivity measures the concentration of soluble salts, or salinity, in the soil. Elevated salinity can hinder plant establishment and growth by preventing uptake of water by plant roots. Soils with electrical conductivity values greater than 4 mmhos/cm are considered undesirable for topsoil while soils with values greater than 8 mmhos/cm are undesirable for subsoils (MDEQ, 1998). No soils in the Study Area exhibit electrical conductivity values that exceed DEQ topsoil or subsoil guidelines.

Some inorganic elements naturally occur at concentrations higher than the Regional Screening Levels (RSL) established by the Environmental Protection Agency (EPA) for industrial soils in Montana (EPA, 2015; MDEQ, 2005). Due to these elevated baseline concentrations, DEQ established a statewide study based on soil samples gathered from each county in Montana to identify background threshold values (BTV) for common inorganic elements in soils (MDEQ, 2013). Multiple soils in the Study Area exhibited DEQ-BTV exceedances for arsenic, cadmium, lead and/or zinc. Woodhurst soils exhibited DEQ-BTV exceedances for copper as well as the other four inorganic elements. These exceedances in native soils, which currently support vegetation, are unlikely to substantially reduce soil suitability for reclamation with the possible exception of the high level of inorganic elements in the deeper horizons of Woodhurst soils. This was taken into consideration in the development of soil salvage depths. These exceedances would likely not be considered unsuitable soils on most ranchland sites.

2.5.3.3 Suitability of Soils by Soil Series

The primary physical properties limiting soil salvage are high coarse fragment content, shallow bedrock, and shallow groundwater. Chemical properties limiting salvage include low pH and elevated metal/metalloid concentrations. A review of each of the soil pedon descriptions determined the most appropriate salvage depth for each soil series in consideration of the various limitations. Table 2-26 presents the recommended salvage depth for each soil series, the map unit that the series occurs in, and the limitations which formed the basis for the salvage depth determination was based.

Table 2-26. Summary of Recommended Salvage Depths

Soil Series	Map Unit Symbol[1]	1st Lift Depth[2] (Inches) Topsoil	2nd Lift Depth[2] (Inches) Subsoil	Limitation
Adel	Ad-b	12	36	Coarse fragments, arsenic
Caseypeak	Cp-c, *Cp-d*	12	0	Coarse fragments, bedrock, slope
Cheadle	Ch-b	12	0	Coarse fragments, bedrock,
Clunton	Cl-a	12	36	None[3]
Duckcreek	Dc-a	12	36	None
Farlin	Fa-b	12	36	Clay
Houlihan	Hl-b	12	36	Coarse fragments
Kimpton	Kp-c, *Kp-d*	12	36	Coarse fragments, pH, slope
Liberg	Lb-b	12	24	Coarse fragments, pH
Medicinelodge	Ml-a, Ml-b	12	36	Coarse fragments, shallow groundwater
Poin	Pn-b	12	0	Coarse fragments, pH, bedrock
Raynesford	Ry-b	12	36	Clay
Redchief	Rc-b	12	24	Coarse fragments, pH
Redfish	Rf-a	12	36	Coarse fragments, shallow groundwater
Sebud	Se-b	12	36	Coarse fragments
Wineglass	Wg-b	12	36	Coarse fragments
Woodhall	Wa-b	12	24	Coarse fragments, arsenic, pH
Woodhurst	Wu-b	12	24	Coarse fragments, arsenic, copper, lead

[1] Italicized font indicates that the soil series is present in, but should not be salvaged from, the respective map unit.

[2] Listed depths are measured from non-disturbed soil surface. In other words, if Lift 1 = 12 inches and Lift 2 = 36 inches, a 24-inch thickness of material should be salvaged for Lift 2.

2.5.3.4 Hydraulic Properties of Soil / Shallow Bedrock and UIG Design

In addition to the Order 2 soil survey, surveyors completed field investigations to determine the hydraulic properties of soils and shallow bedrock to support site selection for underground infiltration galleries. This work was initially completed to support construction of an exploration decline and included areas that are no longer considered for infiltration gallery construction (Tintina Alaska, Inc. 2012, Appendix E). For this reason, subsequent investigations were completed in 2015 and 2016 in areas currently proposed for infiltration galleries systems. The remainder of this discussion includes only those areas and tests applicable to the currently proposed MOP application.

Saturated hydraulic conductivity of surface soil and shallow bedrock was measured using constant head tests (ASTM D 3385-88 using a double-ring infiltrometer) to evaluate suitability for operation of shallow underground infiltration gallery systems. In areas where underground infiltration systems will be constructed, soil was excavated to the surface of fractured bedrock parent material and the infiltrometer test apparatus was pressed into the parent material using the bucket of an excavator to create a water tight seal between the apparatus and parent material. A minimal amount of bentonite was used if necessary to plug small leaks. Field data sheets and data plots are provided in Appendix E-1.

Two areas are proposed for construction of underground infiltration gallery (UIG) systems (Figure 1.3 and Figure 2.25). Soils in these areas tend to have high clay content which limits their ability to infiltrate water. Therefore, land application via surface irrigation will not provide optimum efficiency and may only be possible on a seasonal basis or of limited duration. This finding is consistent with NRCS data which rates these soils' ability to infiltrate water as "very limited" due to slow water movement based on modeled results (NRCS, 2011).

Conversely, these soils are generally shallow and overly fractured bedrock which has a relatively high capacity to infiltrate water. Therefore, underground infiltration galleries will be the most favorable system to dispose of water. It is important to note that it is not technically possible to discharge water evenly across the entire land surface area using a subsurface piping system. Therefore the discharge rates described for such a system should be considered the maximum volume possible per unit trenching area and not the amount possible per total unit land surface area.

Underground Infiltration Gallery Design: In the central underground infiltration area approximately 5,700 lineal feet (1,737 m) of perforated underground infiltration piping will be constructed primarily within the Ch-b and Wg-b soil map units. Six infiltration tests were conducted in the bedrock parent material in this area at locations identified as BB-2, BB-3, BB-5, SP-11, 2016-A and 2016-B (Figure 2.25). The average steady state infiltration rate measured across the six test sites was 0.006 ft./minute (Table 2-26). Assuming that the infiltration system piping is bedded in trenches measuring 3 feet in width, a total infiltration area of 17,100 square feet (1,587 m^2) will be available to infiltrate water. This equates to 102 cubic feet (2.9 m^3) per minute or 770 gpm (2,915 L/min.).

In the eastern-most underground infiltration area approximately 11,900 lineal feet (3,627 m) of perforated underground infiltration piping will be constructed within the Ch-b soil map unit. Four infiltration tests were conducted in the bedrock parent material in this area at locations identified as 2016-C, -D, -E, and –F (Figure 2.25). The average steady state infiltration rate measured across the four test sites was 0.007 ft./minute (Table 2-27). Assuming that the infiltration system piping is bedded in trenches measuring 3 feet in width a total infiltration area of 35,700 square feet (3,317 m^2) will be available to infiltrate water. This equates to 250 cubic feet (7.08 m^3) per minute or 1,870 gpm (7,079 L/min.).

Table 2-27. Summary of Infiltration Test Data

Underground Infiltration Area	Test Site	Soil Map Unit	Infiltration Rate (ft./day)	Infiltration Rate (ft./minute)	Area (ft²)	Total System Infiltration Capacity (gpm)
Central Underground Infiltration	2016-A	Ch-b	18.6	0.013	17,100*	770
	BB2	Ch-b	6.6	0.004		
	SP-11	Ch-b	1.2	0.001		
	2016-B	Wg-b	13.4	0.009		
	BB3	Wg-b	2.8	0.002		
	BB5	Wg-b	8.7	0.006		
	Average	--	8.6	0.006		
Eastern Underground Infiltration	2016-C	Ch-b	17.4	0.012	35,700*	1,870
	2016-D	Ch-b	0.23	0.0002		
	2016-E	Ch-b	13.5	0.009		
	2016-F	Ch-b	11.1	0.008		
	Average	--	10.5	0.007		
				Total	**52,800***	**2,640**

* Area for underground infiltration systems based on length of lateral perforated piping and a 3-foot trench width.

Based on the data in Table 2-27, the two proposed underground infiltration systems will have the combined capacity to infiltrate a total of about 2,640 gpm (9,993 L/min.).

2.6 Terrestrial Wildlife Resources

2.6.1 Wildlife Study Area and Methods

Terrestrial wildlife resources in the Project vicinity were evaluated for four seasons in 2014-2015 (Westech, 2017b). A study area of approximately 5,290 acres (2,141 ha) ranged from the Sheep Creek bottomlands south and west through the adjacent uplands, and encompassed the permit area and associated facilities areas. Incidental observations near the study area were also recorded.

Elevations in the area are comparatively high, ranging from approximately 5,400 feet (1,646 m) in the east to approximately 6,200 feet (1,890 m) in the south, and averaging approximately 5,700 feet (1,737 m). Consequently, winters are comparatively long and cold, with deep snows, while summers are cool. Wildlife habitat diversity (Map Sheet 4) (Primarily Douglas-fir, sagebrush and bunchgrass with several minor types) in the study area is considered good, but the high elevations and harsh seasonal conditions appear to limit both wildlife species richness and favor limited seasonal use. A wildlife resources technical report is included as Appendix F (Westech, 2015b).

2.6.2 Wildlife Observed

The study recorded a total of 83 species (0 amphibians, 1 reptile, 20 mammals and 62 birds) in the study area in 2014-2015. Although the area has limited habitat availability for some species, all of the species recorded during the study were expected, based on habitat availability. The total number of species is undoubtedly low because many species are difficult to observe by the methods employed during the evaluation. Nevertheless, the Project area is considered to support good wildlife species richness.

The evaluation recorded no amphibians. However, a Columbian spotted frog (*Rana columbiana*) was observed near Sheep Creek during aquatic sampling (Section 2.7.7). Appropriate breeding habitat in the study area was limited to several small ponds, most of which were seasonal. The study noted no adults, egg masses, or larvae at any of these sites. The only reptile observed was the common garter snake (*Thamnophis elegans*), which was recorded in a drainage near wetlands.

Big game species recorded in 2014-2015 include pronghorn, elk, mule deer, white-tailed deer and black bear. Pronghorn inhabited upland, non-forested habitats from spring through early autumn, and wintered at lower elevations several miles to the west. The study area is transitional range for elk; few were present in summer, and most use occurs in spring and autumn when elk move to/from winter range at lower elevations to the west. Mule deer inhabit the area in low numbers year-round and white-tailed deer were present in low numbers from spring through autumn, particularly along Sheep and Little Sheep creeks. Black bear were occasionally reported from spring through autumn, although denning in the Study Area was not observed.

The only upland game species observed during the study was the dusky grouse which is considered uncommon.

Eleven species of raptors (vultures, eagles, hawks, falcons and owls) were recorded in the vicinity in 2014-2015: bald eagle, golden eagle, red-tailed hawk, ferruginous hawk, rough-legged hawk, northern harrier, sharp-shinned hawk, northern goshawk, American kestrel, great horned owl and great gray owl. The study located no nests of any raptors in the area.

2.6.3 Listed, Proposed or Candidate Species under the Endangered Species Act

The USFWS (2015) identified three terrestrial wildlife species that are listed or proposed candidates for listing under the Endangered Species Act for Meagher County. These include: Canada lynx (listed threatened), greater sage-grouse (candidate) and Sprague's pipit (candidate).

The dominant vegetation constituting lynx habitat in the Northern Rocky Mountains is subalpine fir, Engelmann spruce, and lodgepole pine. Dry forest types (*e.g.*, dry Douglas-fir found in the Project area) are not attractive lynx habitat (USFWS, 2014). The Project area does not have the preferred habitat for the Canada lynx and the probability of a sighting in the area is considered to be very low. The USFWS's (2014) delineated Designated Critical Habitat for the Canada lynx in Montana does not include Meagher County.

The greater sage-grouse (sage-grouse) is considered to be a sagebrush-dependent species (e.g., Connelly et al., 2011). There are known sage-grouse leks (display sites) 10-13 miles from the Project area, but there are no known occurrences recorded within 10 miles (MTNHP, 2015b).

Sprague's pipits prefer flat-to-gently rolling native mixed-grass prairie with intermediate height grasses (4 -10 inches, 10 - 20 cm), little bare ground or club moss, no or few shrubs and no trees. They do not nest in patches of habitat less than 70 acres (28 ha), and prefer patches greater than 350 acres (142 ha) in size. Based on this description, the Project terrestrial wildlife study areas does compromise suitable Sprague's pipit habitat.

2.6.4 Montana Vertebrate Species of Concern

Montana has established lists of vertebrate animal Species of Concern (MTNHP and FWP, 2015). These lists comprise three categories: Species of Concern are "…considered to be "at risk" due to declining population trends, threats to their habitats, and/or restricted distribution." Potential Species of Concern are "…animals for which current, often limited, information suggests potential vulnerability or for which additional data are needed before an accurate status assessment can be made." Special Status Species "…have some legal protections in place, but are otherwise not recognized as federally listed under the Endangered Species Act and are not Montana Species of Concern."

Eleven such species were recorded in 2014-2015 field work:

- **Special Status Species:** the study recorded a single sighting of a transient bald eagle.
- **Potential Species of Concern:** The study recorded occasional evidence of porcupine (chews) in Douglas-fir habitat. The rufous hummingbird was observed in the area in August, but nesting sites were not documented.
- **Species of Concern:** The study recorded occasional sightings of great blue herons along Sheep Creek but no nesting in or near the area; three sightings of transient golden eagles; and one sighting of a northern goshawk in spring but nesting was not documented. The study also included two observations of transient ferruginous hawks, both in autumn; and a single sighting of a great gray owl, in early autumn. The study area and vicinity has suitable habitat, but no great grey owls were observed in the area during the nesting season. Clark's nutcrackers were common in the study area; Baird's sparrow was recorded in big sagebrush and bunchgrass habitats in spring; and bobolinks were observed in the hay and tame pasture during late summer. Both Baird's sparrows and bobolinks were considered to be migrants.

2.7 Aquatic Resources

It is important to document existing water quality, baseline aquatic community surveys, and stream habitat conditions in the study area prior to any actual mine development. In this study, habitat evaluations were based on the health and diversity of aquatic populations of fish, mussels, macroinvertebrates, and periphyton.

2.7.1 Aquatics Study Area and Methods

Baseline Aquatic Surveys were conducted during the fall of 2014, the spring and summer of 2015, and all seasons in 2016 and have been reported in Appendix G of the MOP Application by Montana Biological Survey (2017). The first two years of seasonal baseline surveys for the assessment of fish, mussels, macroinvertebrates, periphyton, and stream habitat at ten sites in the Project area and Sheep Creek drainage basin used Tenderfoot Creek as a reference reach. Project goals were:

1. To conduct standardized surveys and collection of baseline information on the aquatic communities present at stream sites some associated with established long-term surface water quality monitoring sites prior to mine development, and
2. To perform an assessment of aquatic community integrity with key indicators comparing these against biotic impairment thresholds of reference condition standards.

These 2014 - 2016 data represent two years of a multi-year, seasonal, reach-scale baseline conditions to be completed prior to proposed mine activity (i.e., pre-impact sampling design).

Surveyors performed habitat assessments, and macroinvertebrate, mussel, periphyton and fish surveys on similar dates along the same stream reaches of Sheep, Little Sheep and Tenderfoot creeks in 2014, 2015, and 2016. Figure 2.26 shows baseline aquatic survey sampling sites for the Sheep and Tenderfoot Creek drainages. Stream reaches were delineated and mapped in August of 2014 according to protocols outlined in MDEQ Field Manual SOP (MDEQ 2012b). Two additional sites were added to the sampling program in 2016. These sites are located approximately three (AQ10) and five miles (AQ11) downstream from site AQ1 (Figure 2.26). This insured that four monitoring sites (eight stream sections) were monitored below the proposed mine area. Survey design used a “Before, After, Control,” and Impact (BACI) sampling scheme (Underwood, 1994) with “Before, After Control” sample reaches located both at upstream and at off-site reference points; and Impact sample sites located both within and downstream of proposed mine activity. Surveyors sampled Coon Creek, another potential impact site, for fish in 2014 and macroinvertebrates in 2015 and 2016. In 2016, surveyors sampled 10 stream reaches with 26 fish survey events; 34 macroinvertebrate and 10 periphyton samples at the sites.

The surveys included visual inspection of all stream reaches for mussels and amphibians. Calculations for biological community integrity for 10 survey reaches and 26 fish surveys used fish Integrated Biotic Indices (IBIs) and Observed/Expected models (O/E), while assessments of the macroinvertebrate and periphyton samples used DEQ’s multi-metric indices (MMIs). Appendix G contains a detailed technical report on aquatic resources inventoried and stream assessments completed from 2014 to 2016.

The 2016 field sampling program included sampling events in late April, early July and early September with late October brown trout redd counts. The fish sampling methods followed MT Fish, Wildlife, and Parks electrofishing protocols (MFWP, 2002) and wadable stream methodology (Dunham et al. 2009). Macroinvertebrate sampling conducted during this study during the July visit complies with the standard methodology and quality assurance protocols specified in the MT Department of Environmental Quality SAP (MDEQ, 2012b). Sampling periphyton at the 10 sites complied with the standard methodology, preservation and quality assurance protocols specified in the DEQ Periphyton SAP (MDEQ, 2011). In addition to adding quantitative macroinvertebrate samples at 10 sites (n=30), rocky mountain sculpin (*Cottus bondi)* were collected for baseline tissue metals testing (Cd, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn) from two sites both above and below the proposed mine area.

Sampling periphyton at the 10 sites complied with the standard methodology, preservation and quality assurance protocols specified in the DEQ Periphyton SAP (MDEQ, 2011). In addition to adding quantitative macroinvertebrate samples at 10 sites (n=30), rocky mountain sculpin (*Cottus bondi)* were collected for baseline tissue metals testing (Cd, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn) from two sites both above and below the proposed mine area.

2.7.2 Habitat and Water Quality Evaluations

Hydrometrics, Inc. has conducted water quality sampling at four aquatic community sampling sites (AQ1, AQ2, AQ8, and AQ9) quarterly over a four year period beginning in the spring of 2011 (see Appendix B). Stream habitat morphology is dominated by riffle and runs at all sites; Sheep Creek sites averaged 85% riffle/run, Coon Creek 100%, Little Sheep 73% and Tenderfoot Creek 75% of the total stream reach. Tenderfoot Creek sites AQ5/AQ6 had slightly more pool area than the Sheep Creek sites overall and are closest in geomorphology to AQ2/AQ3.

Of the eleven aquatic sampling reaches evaluated in the study area, the survey found five in Proper Functioning Condition (PFC) with a stable trend, and six were deemed Functional at Risk (FAR) (Appendix G). Sites ranked FAR because they had riparian habitat altered recently or historically by cattle (Little Sheep Creek AQ7 and AQ8, Sheep Creek AQ2 and AQ10, Tenderfoot Creek AQ5) or because of by human stream encroachment or manipulation (Sheep Creek AQ1 and AQ2) (Appendix G). Highest site integrity scores using both the BLM Habitat and PFC Assessment methods were recorded at the Sheep Creek AQ3 and AQ4 meadow reaches, AQ11 and the Tenderfoot Creek site AQ6 (Appendix G). Sites reporting lower habitat scores were structurally degraded by cattle use and had high associated livestock use indices (Little Sheep AQ8, Sheep Creek AQ2 and Tenderfoot AQ5). It is important to note that the riparian habitat of the lower reference reach on Tenderfoot Creek (AQ5) is moderately degraded.

2.7.3 Fish Communities

The 2016 fish population sampling program includes three separate sampling events (spring, summer and fall) on the following sites (Figure 2.26):

- Four Sheep Creek reaches downstream of the project site (AQ1, AQ4, AQ10, and AQ11)
- Two Sheep Creek reaches upstream of the project site (AQ2 and AQ3)
- Two sites on Little Sheep Creek above and below the project access road (AQ7 and AQ8)
- One site on Coon Creek impact stream (AQ9), and
- Two control stream reaches in Tenderfoot Creek out of the Sheep Creek sub-basin (AQ5 and AQ6)

Overall, the surveys identified seven fish species and one hybrid (four native / four introduced) from 5,031 individuals collected during 26 stream reach surveys in 2016. Average number of fish species per site across the project area was 4.3 (standard error of ± 0.2), while native species averaged 1.8 (SE ± 0.4). Fish were collected during all surveys at all sites, except at Coon Creek AQ9 which was documented to be fishless in 2014 upstream of the county road, but downstream near its confluence with Sheep Creek, juvenile brown (n=4) and brook trout (n=1) were collected. Average number of fish species per site across the study area was 4.3 (SE ± 0.2), while the average number of native species averaged 1.8 (SE ± 0.4). This is an increase from 3.6 species per site reported for 2014-2015 due to increased detection of mountain whitefish and white suckers at some sites. Rocky mountain sculpin comprised the highest proportion of total individuals collected (74%) and had 100% site occupancy (n=10). Other native species, mountain whitefish, longnose dace and white sucker had site occupancy rates of 52%, 12% and 12%, respectively. Rainbow trout were the dominant salmonid by numbers at all Sheep Creek sites except AQ4. Rainbow and brook trout were collected at nine of 10 sites in total, achieving highest average densities at site AQ1 (344.1 per mile) and AQ7 (847.2 per mile), respectively. Brown trout were detected at 7 of 10 sites, achieving highest densities at sites AQ3 and AQ4 averaging ~85 per mile. The most diverse fish site in the study area was Sheep Creek (AQ3) with eight species, four native. Coon Creek (AQ9) upstream of the county road near SW3 is fishless, but near its confluence with Sheep Creek, it provides a refuge for young-of-the-year brown trout. No fish species of concern (SOC) were identified during any of the surveys. In 2016, we documented white suckers and mountain whitefish juveniles using Little Sheep Creek. Whole body metals analysis were conducted on sculpins at two sites above and below the proposed mine to determine baseline levels. There were no significant differences in baseline levels of metals in the sculpin tissue between the upstream or downstream sites where the fish were collected. Seasonal salmonid densities at all sites varied significantly with lowest densities reported in the spring. All salmonids captured during the 2016 surveys were scanned using a Biomark 601 pit-tag reader. No pit-tagged brown or rainbow trout were detected at any sites above the USFS boundary during the seasonal fish surveys in 2016, only tagged mountain whitefish (n=4) were detected in the project area at Sheep Creek AQ3 and AQ4. Approximately 2.8 miles of Sheep and Little Sheep Creek were evaluated during fall redd counts (late-October); brown trout redd counts averaged 3.5 and 2.8 per 100m at Sheep Creek AQ3 and AQ4, respectively. Brook trout redds averaged 3.3 per 100m in Little Sheep Creek (AQ7).

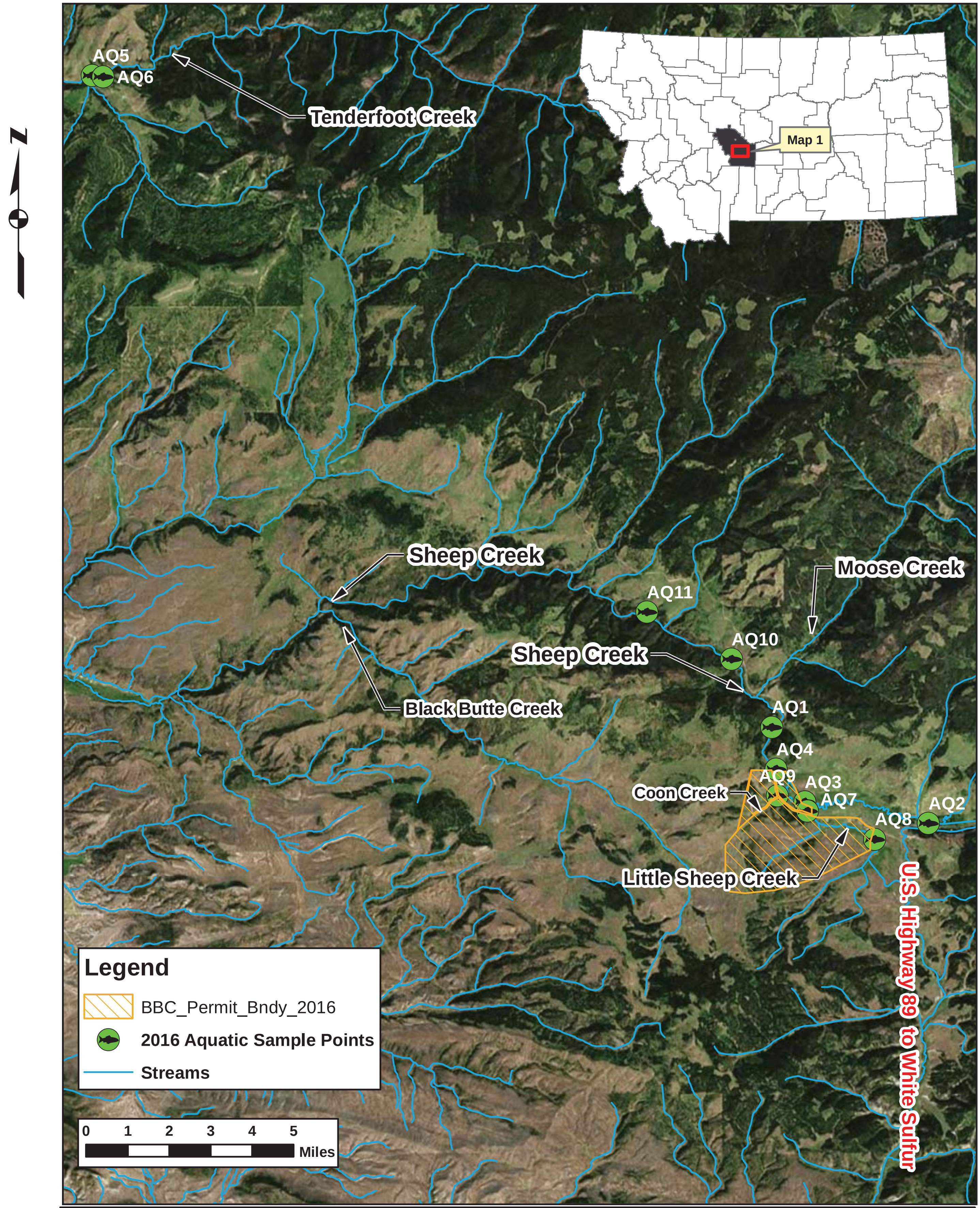
2.7.4 Mussel Surveys

Within the Project area, no previous surveys identified the western pearlshell mussel (WEPE), a Montana SOC well documented in the Smith River basin. Therefore, the study included a specific search for WEPE in all stream reaches (approximately 1 man-hour per 300m reach, with aqua-scopes using a longitudinal transect survey technique covering all stream geomorphic units. This effort provided no evidence of WEPE presence (live or dead shells) during the surveys in Sheep, Little Sheep or Tenderfoot creeks. In addition, the study found no shell fragments which would have indicated earlier historic populations.

Since no evidence of the presence of freshwater mussels (western pearlshell) was observed at any site during the 2014-2016 study periods, no additional surveys for freshwater mussels will be performed.

2.7.5 Macroinvertebrate Communities

Overall, 145 unique macroinvertebrate taxa were reported from the macroinvertebrate assessment samples collected from the 10 sites in 2016. No Montana SOC invertebrates were collected. The macroinvertebrate community at Sheep Creek AQ2 reported the highest biological integrity score (MMI=70.1), which has increased since 2014, and resembles the biotic integrity of the Tenderfoot Creek reference site (average MMI=70.4). Overall, Sheep Creek MMI scores (n=6) averaged 62.6 which is a point higher than in 2014, but still ranks slightly impaired by DEQ standards (<63). Sheep Creek AQ2 also reported the highest number of combined mayfly, caddisfly and stonefly taxa (EPT) at 21 species. Average macroinvertebrate richness across all sites was 44.7 taxa, while EPT taxa averaged 15 per site. Mountain streams with less than 20 EPT taxa per site are considered slightly impaired by most measures. Both Little Sheep Creek sites were ranked impaired by the MDEQ MMI with scores <63. Six of the 11 sites showed significant improvements in biotic integrity in both the MMI and HBI since 2014; these are sites AQ1, AQ2, AQ5, AQ6, AQ7 and AQ8. The MDEQ MMI ranked upstream and downstream reaches of the Sheep Creek treatment/control sites similarly and there are no significant differences between control and reference. It is important to note that the Sheep Creek impact sites are again reporting significantly lower macroinvertebrate MMI scores than the Tenderfoot Creek reference sites. Hilsenhoff Biotic Index (HBI) scores averaged 3.4 across all 2016 sites; this is slightly impaired for mountain streams (>3), indicating probable nutrient or other organic impairment to all sites.



Montana Biological Survey	DRAWN BY: DS CHK'D BY: AK APPR. BY: AK DATE: April 2016	**Tintina Resources** Black Butte Copper Mine Project Meagher County MT	PROJECT NO. T01.2016
		Aquatic Sampling Sites Overview	FIGURE NUMBER 2.26

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2.7.6 Periphyton Communities

Overall, 10 periphyton assessment samples collected in 2016 contained 167 unique diatom and algae taxa, increased the total study's taxa list by 21 taxa from 146 taxa collected in 2014. No periphyton species are listed as SOC in Montana. Diatoms were the dominant taxa at 7 of the 10 study sites. The diatom, *Didymosphenia geminata* (a.k.a. rock snot) which can sometimes become invasive, was abundant in the Tenderfoot Creek reference reaches, as it was in 2014, but not in Sheep Creek. The Cyanobacteria, *Phormidium* sp. was the dominant, non-diatom species at 4 of 10 sites in 2016; especially in Sheep Creek meadow reaches (AQ3, AQ4, and AQ7) and at the canyon site (AQ1). Sheep Creek AQ3 reported the highest periphyton taxa richness (86 spp.), while Sheep Creek AQ2 reported the lowest (44 spp.). The average periphyton richness per site was 68.6 taxa, which is ~10 taxa higher than in 2014. Tenderfoot Creek periphyton taxa richness was not significantly different than Sheep or Little Sheep Creeks (T-test, p=0.2 and p=0.33, respectively), as it was significantly lower in 2014. Based on Teply's Diatom Index (TDI), the lower meadow site, Sheep Creek AQ4 had the highest probability of impairment (82.2%) followed by Sheep Creek AQ3 at 62.1%. Other Sheep and Little Sheep Creek sites had less than a 42% chance of being impaired based on the TDI (Table 10 in Appendix G). Both of the Tenderfoot Creek reference sites were least likely to be impaired (<20%), but with Nostoc representing the 2nd dominant periphyton taxa, there is likely some nutrient loading from cattle use in the adjacent watershed.

2.7.7 Amphibian and Reptile Incidentals

Two amphibian species, the Columbia Spotted Frog (*Rana columbiana*) and the western toad (*Anaxyrus boreas*), MTSOC, were incidentally recorded during 2016 summer surveys at Sheep Creek AQ4 and AQ2, respectively. The western toad had been previously recorded within one kilometer of Sheep Creek site AQ2 (MTNHP 2015), but had not been observed during our 2014 or 2015 surveys. Two terrestrial garter snakes (*Thamnophis elegans*) were observed during the summer 2016 survey along the Tenderfoot Creek AQ5 reach, as in 2015.

2.7.8 Conclusions

Despite reports that westslope cutthroat trout occur in the study area (MFWP 2014, MNHP 2015), none were collected during 42 seasonal site surveys between 2014 and 2016; therefore, we conclude that no fish species of concern (SOC) are present. We did incidentally observe the MT SOC western toad (1 juvenile) during the summer fisheries survey in 2016 at Sheep Creek AQ2. Fish species richness and diversity were higher in the Sheep Creek sites than the Tenderfoot reference reaches, and were similar between the Sheep Creek upstream control reaches and the downstream "impact" reaches of the study area. Overall fish densities were highest in the Tenderfoot Creek reference reach (avg. 7,900 per mile) due to high sculpin densities and the highest combined rainbow/cutthroat hybrid numbers (averaging 678 per mile) of all sites. Brook trout reported highest average densities in Little Sheep Creek AQ7, and brown trout attained highest densities and biomass in the meadow reaches of Sheep Creek AQ3 and AQ4. Assemblage tolerance indices (ATI) were dominated by large percentages of intermediate tolerant species, because of the abundant and ubiquitous rocky mountain sculpin populations.

Fisheries population conclusions can be summed up as follows:

1) Rainbow trout adults were virtually absent from the Sheep Creek project area in the spring, and no pit-tagged rainbows were reported upstream of Sheep Creek AQ1 at any time in 2016.

2) Brown trout adults in the project area are using lower Little Sheep Creek as a thermal refuge in the winter, and based on the recapture rate and no detected pit-tagged fish during any season, are largely resident.

3) Fall redd counts indicated that the highest number of brown trout redds (avg. 3.1 per 100m or ~50 per mile) are located within the Sheep Creek meadow reaches AQ3 and AQ4. This agrees favorably with the population density estimates reported. Brook trout redds were concentrated in lower Little Sheep Creek (AQ7)

4) Mountain whitefish are moving into the Sheep Creek project reach from downstream, especially in the summer, as indicated by 4 pit-tagged individuals being collected at AQ3 and AQ4. Other pit-tagged salmonids detected in 2016 were largely being recaptured at the sites of tagging, AQ1 and AQ10.

5) Aquatic benthic communities at all sites are exhibiting signs of nutrient or organic enrichment based on the HBI index, likely due to cattle ranching, but this was less prevalent in the Tenderfoot Creek site AQ6. Riparian habitat at five sites (AQ2, AQ5, AQ7, AQ8 and AQ10) ranked degraded because of cattle use, while Sheep Creek AQ1 and AQ2 are functional, but at risk because of adjacent road effects on the hydrology. In contrast, initial baseline biotic integrity of macroinvertebrate and periphyton communities was significantly higher in the Tenderfoot Creek reaches despite riparian degradation at AQ5. Diverse aquatic communities with high biological integrity are usually correlated with intact riparian conditions and diverse habitat quality (Allen et al. 1997), but the streams of this study have a mixed relationship (Table 11 in Appendix G). Tenderfoot Creek AQ6 and Sheep Creek AQ4 had both high aquatic diversity and habitat quality, while Tenderfoot AQ5 and Sheep Creek AQ2 had high biotic integrity, but lower habitat quality. During these initial 2 years of the study, macroinvertebrate and periphyton communities indicated that many sites in Sheep and Little Sheep Creeks are slightly to moderately impaired, likely from nutrients, even those with high quality riparian and in-stream habitat condition. This is corroborated by the HBI scores being moderately elevated across all sites indicating probable nutrient or other organic impairment. The common cause of organic enrichment across all sub-basins of the study is cattle grazing, and the macroinvertebrate and periphyton communities are exhibiting deleterious effects. Community results from the habitat, fish, periphyton and macroinvertebrate surveys combined to rank the Tenderfoot Creek AQ6 reference site with the highest ecological integrity, Tenderfoot Creek AQ5 second, and three Sheep Creek sites, 2 control and one impact (AQ2, AQ3, AQ4), tied for third highest overall integrity.

Baseline Aquatic Survey and Stream Assessment report for the analysis and interpretation of data from 2014 through 2016 is presented in Appendix G by Montana Biological Survey (2017). The *Baseline Aquatic Survey and Assessment of Streams Report* was reviewed by Montana Fish, Wildlife and Parks, and their proposed revision recommendations dated April 20, 2017 were incorporated into the Baseline report and included in the MOP application (Revision 2) as Appendix G as presented to the DEQ on May 8, 2017.

In addition, Montana Fish, Wildlife and Parks has reviewed *the Draft Plan of Study, Aquatic Monitoring Plan for the Black Butte Copper Project in Upper Sheep Creek Basin in Meagher County Montana* dated April 2017, and provided comments on May 17, 2017. This document has been revised and is included in this Revision 3 of the MOP Application, as a draft plan of study in Appendix G-1.

2.8 Vegetation Resources

Vegetation within the Project area was categorized according to published classifications of vegetation types developed state-wide for Montana. Map Sheet 5 is a Vegetation Habitat Map. Table 2-28 lists habitat and community types for each physiognomic class sampled in the vegetation study area in 2015. Appendix H (Westech, 2017b) presents a list of vascular plant species identified for the Project baseline vegetation inventory.

2.8.1 Vegetation Habitat Types

The baseline vegetation inventory identified four native Grassland habitat types in two series including the *Festuca idahoensis* (Idaho fescue) and *Festuca campestris* (rough fescue) series (Table 2-28). The study also identified an Upland Altered Grassland community type dominated by non-native perennial grasses *Poa pratensis* (Kentucky bluegrass) and *Phleum pratense* (common timothy).

The study sampled six Upland Shrubland types, dominated by *Artemisia tridentata* (big sagebrush) and/or *Dasiphora fruticosa* (shrubby cinquefoil). *Festuca idahoensis, Festuca campestris,* and *Poa pratensis* dominated or variously distinguished the understories.

Of seven Conifer Forest and Woodland habitat types identified, six were in the *Pseudotsuga menziesii* (Douglas-fir) series, and one in the *Picea engelmannii* (Engelmann spruce) series. *Festuca idahoensis, Festuca campestris, Juniperus communis* (common juniper), *Calamagrostis rubescens* (pinegrass), *Symphoricarpos albus* (common snowberry), and *Linnaea borealis* (twinflower) dominate the understories.

The survey sampled a Lowland Altered Grassland or Hay Meadow type at 16 sites, primarily on the Sheep Creek floodplain.

The survey classified, according to physiognomic type, three primary Riparian-Wetland types including Herbaceous, Shrub, and Deciduous Tree. The Herbaceous Riparian-Wetland types were sampled in mesophytic/ hydrophytic habitat types or community types dominated by various associations of *Juncus balticus* (Baltic rush), *Carex nebrascensis* (Nebraska sedge), and *Carex utriculata* (southern beaked sedge). The Shrub Riparian-Wetland types include three mesophytic or hydrophytic low shrub community types in the *Dasiphora fruticosa* series, and two hydrophytic tall shrub community types dominated by *Salix bebbiana* (Bebb willow) or *Salix geyeriana* (Geyer willow). The Deciduous Tree Riparian-Wetland type was comprised of one community type and one habitat type in the *Populus tremuloides* (quaking aspen) series.

The diversity of community types in the inventory area is largely representative of other, lower to middle elevation study areas in central Montana, as listed in the literature review table in Appendix H, Sub-Appendix G (Westech, 2017b). All vegetation types identified in this study have been documented in previous studies in the region under the same or similar type names, as reviewed and summarized from published literature and unpublished technical reports.

Table 2-28. Vegetation Types Identified in the Black Butte Project Baseline Study Area

VEGETATION TYPE[1]	PLOT NUMBERS	n
UPLAND GRASSLAND		**28**
Upland Altered Grassland c.t.	44, 45, 46, 47, 50, 52, 67, 78, 85	9
Festuca idahoensis/Agropyron spicatum h.t.	63, 68, 69	3
Festuca idahoensis /Stipa richardsonii h.t.	61, 107	2
Festuca campestris/Agropyron spicatum h.t.	48	1
Festuca campestris/Festuca idahoensis h.t.	56, 62, 64, 65, 66, 70, 71, 72, 73, 74, 75, 93, 108	13
UPLAND SHRUBLAND		**44**
Artemisia tridentata/Poa pratensis c.t.	51, 53, 54, 57, 77, 83, 84, 88, 92, 95, 97, 100, 101	13
Artemisia tridentata/Festuca idahoensis h.t.	99, 105, 111	3
Artemisia tridentata/Festuca campestris h.t.	49, 55, 58, 59, 60, 76, 79, 81, 90, 91, 94, 98, 102, 103, 104, 114, 115	17
Artemisia tridentata-Dasiphora fruticosa/Poa pratensis c.t.	89, 96, 109, 110, 112, 116	6
Dasiphora fruticosa-Artemisia tridentata/Festuca campestris c.t.	80, 106, 113	3
Mixed Shrub-Shale Outcrop c.t.	86, 87	2
CONIFER FOREST AND WOODLAND		**40**
Pseudotsuga menziesii/Festuca idahoensis h.t.	13	1
Pseudotsuga menziesii/Festuca campestris h.t.	11, 12, 15, 17, 19, 20, 23, 28, 34, 38, 42, 43	12
Pseudotsuga menziesii/Juniperus communis h.t.	14, 24, 25, 26, 29, 32, 33, 40	8
Pseudotsuga menziesii/Calamagrostis rubescens h.t.	31, 35	2
Pseudotsuga menziesii/Symphoricarpos albus h.t.	1, 4, 5, 7, 16, 18, 27, 30, 36, 37, 39	11
Pseudotsuga menziesii/Linnaea borealis h.t.	10, 21, 22, 41	4
Picea engelmannii/Linnaea borealis h.t.	6, 9	2
LOWLAND ALTERED GRASSLAND		**17**
Noxious Weed tailings c.t. (2014/2015)	162	1
Lowland Altered Grassland (Hay Meadow) c.t.	117, 133, 134, 135, 138, 139, 140, 141, 143, 144, 145, 148, 151, 152, 153, 165	16
RIPARIAN AND WETLAND (RW)[3]		**56**
Herbaceous RW types		(15)
Juncus balticus c.t.	129, 149, 163, 164, 176	5
Carex nebrascensis c.t.	127, 166	2
Carex utriculata h.t.	126, 146, 167, 168, 172, 174, 178, 179	8
Shrub RW types		(37)
Dasiphora fruticosa/Poa pratensis c.t.	82, 118, 160, 169, 170, 177	6
Dasiphora fruticosa/Deschampsia cespitosa c.t.	175, 180, 182, 185	4
Dasiphora fruticosa/Carex utriculata c.t.	155, 173	2
Salix bebbiana series	120, 122, 123, 125, 156, 157, 158, 159, 161, 171, 181, 183, 184	13
Salix geyeriana series	119, 121, 128, 130, 131, 132, 136, 137, 142, 147, 150, 154	12
Deciduous Forest RW types		(4)
Populus tremuloides/Osmorhiza occidentalis h.t.	8	1
Populus tremuloides/Poa pratensis c.t.	2, 3, 124	3
	TOTAL SAMPLE SITES	**185**

[1]Grassland and shrubland habitat types were identified following Mueggler and Stewart (1980); Forest habitat types follow Pfister *et al.* (1977), and Wetland/ Riparian types follow Hansen *et al.* (1995), with minor modifications. In these classifications, vegetation types are named according to the following:
A slash (/) indicates a separation of species dominating one or more strata, namely the herbaceous, shrub and/or tree layers; c.t. = community type, h.t. = habitat type n = sample size (number of 0.01-acre canopy cover plots.

2.8.2 Vegetation Productivity and Utility

The primary land uses in the vegetation study area are livestock grazing (rangeland) and hay production (Lowland Altered Grassland). The NRCS (2003) presents recommended stocking rates for the applicable soils in Meagher County, relative to good-excellent condition in the perceived “Historic Climax Plant Community”. Additionally, NRCS (2003) gives long-term irrigated and non-irrigated hay yields by soils mapping unit that can be expected under a high level of management. (Appendix H) (Westech, 2017b) summarizes information pertinent to the vegetation study area.

2.8.3 Vegetation Species List / Montana Natural Heritage Program- Listed Species

The 2015 inventory of the vegetation study area identified a total of 398 vascular plant taxa during, with forbs (278 species) comprising the majority (70%). Forbs included 235 perennial taxa (213 native, 16 introduced, and 6 fern allies), and 43 annual/biennial taxa (31 native and 12 introduced). The 82 grasses and grass-like plants identified (21% of the total plant taxa), included 78 perennial taxa (66 native and 12 introduced), and 4 annual taxa (2 native and 2 introduced). The 38 woody plant taxa (9% of the total plant taxa) recorded in the study area included 31 shrubs and vines, and 7 tree species.

No federally listed or proposed endangered or threatened plant species are known to occur in the vicinity of the Project area, and the 2015 baseline vegetation inventory recorded none. A search of the MTNHP (2015) website for plant SOCs in Meagher County found that one had previously been identified in the vegetation study area, *Cirsium longistylum* (long-styled thistle).

2.8.4 Weeds

State-listed noxious weeds are given on the “Montana Noxious Weed List, Effective December, 2015” (Montana Department of Agriculture, 2015). The baseline vegetation inventory encountered four State-listed weed species (all Priority 2B), and one Priority 3 regulated plant species (*Bromus tectorum*, cheatgrass) in the study area. Noxious weeds in the vegetation study area included *Centaurea maculosa* (spotted knapweed), *Cirsium arvense* (Canada thistle), *Cynoglossum officinale* (common houndstongue) and *Leucanthemum vulgare* (oxeye daisy).

Another potentially problematic weed species recorded (but not listed as noxious), *Carduus nutans* (musk thistle), was more common than the listed noxious weed species, occurring in almost every vegetation physiognomic type present in the study area, occasionally in dense patches.

2.9 Cultural Resources

2.9.1 Cultural Resources Introduction and Methods

Prior to submitting an application to the Montana DEQ for an amendment to its Montana Exploration License in 2011, DEQ encouraged Tintina to conduct cultural resource inventories of areas targeted for mine disturbance. Even though cultural resource inventories are not required on private property, Tintina contracted Tetra Tech, Inc. (Tetra Tech) to conduct these inventories in support of Tintina’s Mine Operating Permit Application (this document). Appendix I (Tetra Tech, 2015a) presents a complete technical baseline Cultural Resource Inventory report to this Application. Previous cultural assessment data from work associated with a nearby road improvement project (Wood, 1994) and a Central Montana Communications buried cable project (Brumley, 2010 and 2011) also support the current studies.

Project archaeologists used a Trimble GeoXT to ensure they accurately followed inventory boundaries. The Trimble also recorded locations of cultural resources and Tetra Tech staff differentially corrected this data with Pathfinder Office software at the Tetra Tech office. All cultural properties identified were recorded on Montana Cultural Resources Information (CRIS) forms. The surveyors collected no artifacts in the field.

2.9.2 Cultural Resources Inventoried and Study Area

Cultural resource inventories examined a total of 1,500 acres (607 ha) in the Project area and documented 14 prehistoric and 6 historic sites (Figure 2.27 and Table 2-29). Prehistoric sites consist of 13 lithic scatters (a surface scatter of cultural artifacts and debris that consists entirely of lithic (i.e., stone) tools and chipped stone debris). The proposed mine facilities will likely impact three lithic scatters (24ME164, 24ME165, and 24ME1109). Additionally, disturbance may occur at four lithic scatters (24ME162; 24ME1105; 24ME1107; 24ME1110), as these sites occur 25 to 65 feet (8 to 20 m) from proposed mine facilities.

In 2012, lithic scatter at site 24ME163 was tested by archaeological excavation prior to the proposed construction of an exploration road project. This testing identified the existence of an intact, subsurface cultural deposit, and 24ME163 archaeologists recommended this site as eligible to the National Register of Historic Places (NRHP) (Tetra Tech, 2015a). However, they did not excavate or further study this site since road modification work within the site boundary consisted of laying down a layer of fill material, thus avoiding any project impacts.

In addition, one of the lithic scatters previously identified as being potentially impacted, Site 24ME1108, occurs on a terrace along Brush Creek and was bisected by the proposed mine access road. The 2015 cultural resource report recommended Site 24ME1108 be tested for National Register eligibility if access road construction would disturb this site. However, as a result of the USACE tribal consultation process and site visits, Tintina voluntarily moved the access road crossing location on Brush Creek and the nearby buried alluvial conveyance pipeline to avoid this cultural site (Addendum to Appendix I, Tetra Tech 2017). This revised crossing location slightly decreased the amount of fill within wetlands (<0.01 acres: <0.004 ha) at Brush Creek. Tintina Resources has subsequently realigned the proposed access road which now passes 100 feet south of Site 24ME1108 (see Figure 1.3 and Figure 2.27). This distance should protect the integrity of Site 24ME1108 and testing is no longer recommended as the site will be avoided by the proposed access road (Addendum to Appendix I; Tetra Tech, 2017).

Historic properties identified in the Project area include a log structure, a mining site, two roads, a homestead, and a sheepherder's rock cairn. With the exception of the sheepherder's cairn, this study recommends historic sites (24ME158, 24ME159, 24ME925, 24ME936, and 24ME940) as not eligible for NRHP listing, and recommends no further work. This study recommends the sheepherder's cairn, 24ME1104, as eligible for NRHP listing under Criterion C. This feature lies approximately ¼-mile (400 m) from the nearest proposed mine feature, suggesting avoidance of this cairn is possible. SHPO response letters are included at the end of Appendix I.

2.9.3 Cultural Resource Recommendations

Mining construction should avoid any site determined NHRP eligible, or if this is not possible, site impacts should be mitigated through archaeological excavation and the recovery of cultural material that will broaden the understanding of prehistoric lifeways along Sheep Creek. (Figure 2.27) shows the locations of the cultural resources in relation to the proposed facility construction areas. Tintina has indicated some mine features may be moved to avoid cultural sites. If avoidance is not possible, sites not previously tested, should receive evaluation for NRHP eligibility, and if recommended eligible, impacts should be mitigated through archaeological excavation and recovery of cultural material. To date, only sites 24ME163 and 24ME1104 were tested and found NRHP eligible.

Table 2-29. Cultural Resources in the Black Butte Copper Project Area

Site Number	Site Type	Possible Mine Feature/Facility Disturbance	NRHP Recommendations
24ME158	Historic Log Structure	None	Not eligible under Criteria A-D.
24ME159	Historic Mining	None	Not eligible under Criteria A-D.
24ME160	Lithic Scatter	None	Archaeological testing to determine eligibility under Criterion D.
24ME161	Lithic Scatter	None	Archaeological testing to determine eligibility for Criterion D.
24ME162	Lithic Scatter	A vent raise (16-ft. in diameter) is planned for the vicinity of 24ME162. Site avoidance is possible.	Archaeological testing to determine eligibility under Criterion D.
24ME163	Lithic Scatter	No mine features are proposed to date. If this changes, 24ME163 needs to be avoided or mitigated.	Site tested and recommended eligible to the NRHP.
24ME164	Lithic Scatter	Located within the Process Water Pond boundary.	Archaeological testing to determine eligibility/ Criterion D.
24ME165	Lithic Scatter	Located within the Process Water Pond boundary.	Archaeological testing to determine eligibility/ Criterion D.
24ME166	Lithic Scatter	None; site occurs 50 meters (164 ft.) from Access Road and 75 meters (246 ft.) from Process Water Pond boundary.	Archaeological testing to determine eligibility under Criterion D.
24ME925	Historic Road- Sheep Creek	None	Not eligible under Criteria A-D.
24ME936	Historic Road- Butte Creek	None	Not eligible under Criteria A-D.
24ME940	Historic Homestead	None	Not eligible under Criteria A-D.
24ME1104	Historic Sheepherder's Cairn	None; Diversion Channel and Cemented tailings Facility approximately ¼ mile to the east.	Eligible under Criterion C.
24ME1105	Lithic Scatter	Disturbance is possible as 24ME1105 lies 20 meters (66 feet) from the Process Water Pond Diversion channel. Tintina may relocate channel to avoid this site.	Archaeological testing to determine eligibility under Criterion D.
24ME1106	Lithic Scatter	None; 300 meters (984 ft.) from Cemented tailings Facility.	Archaeological testing to determine eligibility under Criterion D.

Site Number	Site Type	Possible Mine Feature/Facility Disturbance	NRHP Recommendations
24ME1107	Lithic Scatter	Disturbance is possible as Main Access Road lies 10 meters south of 24ME1107. Tintina may alter road alignment to avoid this site.	Archaeological testing to determine eligibility under Criterion D.
24ME1108	Lithic Scatter	Main Access Road moved to avoid 24ME1108.	Archaeological testing to determine eligibility under Criterion D.
24ME1109	Lithic Scatter	An Access Road bisects this site. Additionally, the Mill Pad and Temporary Storage of Waste Rock will likely disturb 24ME1109.	Archaeological testing to determine eligibility under Criterion D.
24ME1110	Lithic Scatter	Disturbance is likely as Access Road occurs eight meters (26.3 ft.) south of 24ME1110.	Archaeological testing to determine eligibility under Criterion D.
24ME1111	Sheep Creek Surface Stone District	District area will be disturbed with construction of the Adit, Mill Pad, Temporary Waste Rock Storage, Portal Pad, Ventilation Raises, Cemented tailings Facility, Contact Water Pond, Process Water Pond, and Access Roads.	Presence of intact, subsurface cultural deposit at 24ME163 suggests NRHP eligibility under Criterion D.

2.10 Socio-economic Resources

2.10.1 Population

Meagher County is sparsely populated by both Montana and US standards. The land area is 2,391.82 square miles and the population density is 0.8 people per square mile, while the average for Montana in 2010 was 7.0 people per square mile. Table 2-30 shows the 2010, 2014, and 2010 – 2014 trends in population, along with the population density (people per square mile) for Meagher County, the State of Montana, and the US. The population in Meagher County has decreased slightly since 2010. The US Census Bureau reports that migration out of the county is greater than migration into the county, and the number of births has also decreased. These are the causes of the decline in population in the county.

Table 2-30. Meagher County, Montana, and US Population

Year	Meagher County	Montana	US
2014	1,853	1,023,579	318,857,056
2010	1,891	989,415	308,745,538
2010 to 2014	-2.0%	3.5%	13.3%

Source: US Census 2015a, 2015b

Table 2-31 lists the population of White Sulphur Springs and other nearby towns and their distance from the Project site. Figure 1.1 shows locations of towns. More than 142,000 people live less than 100 miles from the Project site.

Table 2-31. Population of Towns and Distance from Project Site

Town or City	Population	Distance from White Sulphur Springs
White Sulphur Springs	925	0
Billings	108,869	164
Great Falls	56,690	64
Bozeman	41,660	95
Helena	29,943	91
Livingston	7,245	87
Lewistown	5,867	130
Townsend	1,942	57
Three Forks	1,903	92
Harlowton	974	82
Belt	604	35
Martinsdale	530	51
Ringling	45	36

2.10.2 Demographics

Demographics is a characterization of the population. Table 2-32 shows the populations of Meagher County, Montana, and the US by age group in 2009. Meagher County has a significantly higher proportion of its population over the age of 65 compared to Montana and the US average.

Table 2-32. Age Groups in Meagher County, Montana, and US Population

Age Group	Meagher County	Montana	US
Under 5 years old, percent, 2013	5.9%	6.0%	6.3%
Under 18 years old, percent, 2009	18.7%	22.1%	23.3%
65 years old and over, percent, 2009	25.0%	16.2%	14.1%

Data from US Census 2015a, 2015b

2.10.3 Employment by Industry

Meagher County is rural and the main industry is farming and ranching. Table 2-33 shows the industries in the county and trends in employment between 2001 and 2011. In the census, this information is provided by the proprietor. The total number of people employed in Meagher County in 2011 was 697.

Table 2-33. Meagher County Employment by Industry, 2001-2011

Total Employment (Number of Jobs)	2001	2011	Change 2001-2011
Farm	227	179	-48
Retail trade	76	107	31
Real estate and rental and leasing	8	37	29
Administrative and waste services	24	na	na
Educational services	5	11	6
Arts, entertainment, and recreation	52	78	23
Accommodation and food services	109	84	-13
Other services, except public admin.	68	59	-9
Government	180	145	-35
Total Employment (%)			
Farm	19.5%	13.5%	-21.1%
Retail trade	6.5%	9.5%	34.2%
Real estate and rental and leasing	0.7%	8.1%	40.8%
Administrative and waste services	2.1%	na	na
Educational services	0.4%	0.8%	373.2%
Arts, entertainment, and recreation	4.4%	5.9%	42.9%
Accommodation and food services	9.4%	6.4%	-13.7%
Other services, except public admin.	5.8%	4.5%	-13.2%
Government	15.5%	14.1%	-16.1%

Data from: US Department of Commerce. 2014.

2.10.4 Employment Rate

The unemployment rate is an indication of the potential available employees. Both Meagher County and Montana reported lower than average unemployment rates for June 2015, compared to the US unemployment rate of 5.3%. Table 2-34 indicates the unemployment rates for Meagher County and the State of Montana.

Table 2-34. June 2015 Labor Force Non-Seasonally Adjusted Preliminary

Area	Labor Force	Employed	Unemployed	Unemployment Rate
Meagher County	944	911	33	3.5%
Montana	531,429	510,347	21,082	4.0%

Data from Montana Department of Labor & Industry 2015

2.10.5 Income

Income is reported by the US Census as "per capita" and household. The per capita takes the total income for the county, State, or country and divides it by the total population for an indication of the income per person. The household income is reported as the median household income, which is where half the households earn more and half the households earn less. Table 2-35 reports these numbers for Meagher County, Montana, and the US, along with the percent of the population that is considered below the poverty level. The US Census definition of poverty (http://www.census.gov/hhes/www/poverty/about/overview/measure.html) is complex. For example, one person living alone over the age of 65 is considered in poverty if their income was less than $10,458 in 2010, as is a family of 4 (two children under 18) who earned less than $22,113 in 2010.

Table 2-35. Per Capita and Household Income

Income Level	Meagher County	Montana	US
5-year (2009-2013) average per capita income in past 12 months (2013 dollars)	$20,288	$25,373	$28,155
Median household income, 2009-2013	$38,182	$46,230	$53,046
Persons below poverty level, percent, 2009 - 2013	13.6%	15.2%	15.4%

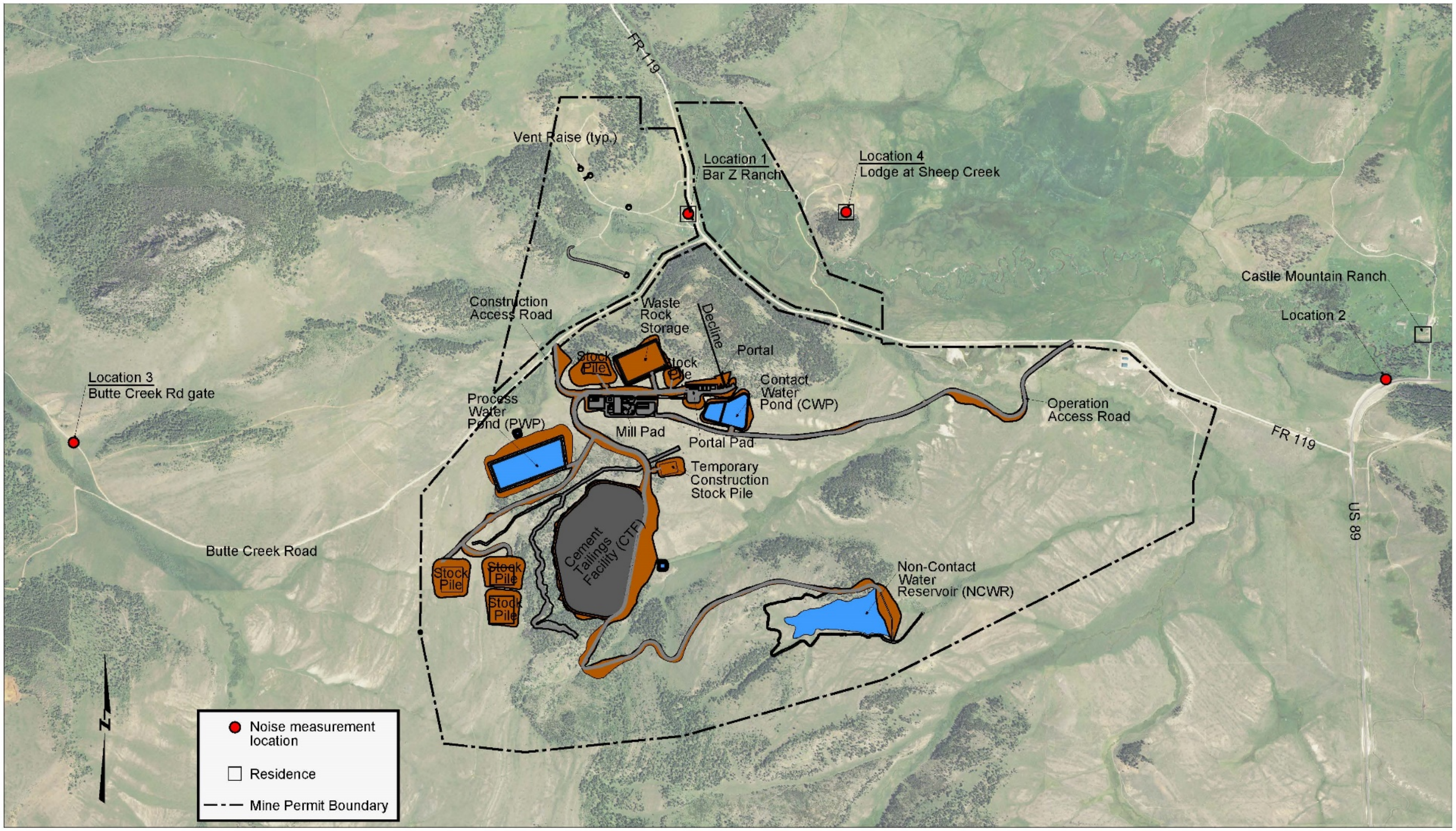
US Census 2015a, 2015b

2.11 Noise

Baseline ambient noise monitoring was conducted on September 10 and 11, 2013 in general accordance with the American National Standards Institute (ANSI) S12.18-1994, *Procedures for Outdoor Measurement of Sound Pressure Level* (ANSI, 1994). Details of the test apparatus, methods, and quantification of noise data are provided in Appendix J (Big Sky Acoustics, 2013).

Noise measurements were taken at four locations ranging from 0.5 to 2 miles from the proposed mine portal location (Figure 2.28). A 24-hour noise level measurement was completed at Location 1, the most proximal monitoring site (i.e. the Bar Z Ranch). One 1-hour "daytime" (7 a.m. to 7 p.m.) noise level measurement and one 15-minute "nighttime" (7 p.m. to 7 a.m.) noise level measurement were completed at the remaining three locations (i.e. Castle Mountain Ranch, Strawberry Butte, and a location along Butte Creek Road).

Noise levels at each of the four locations were typical for sparsely-populated rural areas (Harris, 1998). Dominant noise sources during the daytime consisted of vehicles, haul trucks from the Black Butte Iron Mine, ATVs, and occasional air traffic. Dominant nighttime noise sources included flowing water in Sheep Creek, breezes, and traffic along U.S. 89. Average noise levels ranged from 22 to 48 dBA.



Prepared by: Big Sky Acoustics, LLC (2017)

Figure 2.28

Baseline Ambient Noise Measurement Locations with Project Facilities

Mine Operating Permit Application

Meagher County, Montana

TINTINA RESOURCES

2.12 Transportation Resources

2.12.1 Transportation Study Area and Methods

This section provides information on the means of transportation in the vicinity of the Project area, as well as the city of White Sulphur Springs and major routes within Meagher County (Figure 2.29). The following information sources were consulted for the baseline transportation study:

- Montana Department of Transportation (MDT) traffic maps and count data
- Montana State Rail Plan
- Montana Rail Link (MRL) and MDT railroad route maps
- Federal Aviation Administration (FAA) airport information
- Montana State Library (MSL) transportation framework
- Aerial photography
- U.S. Geological Survey (USGS) topographic maps

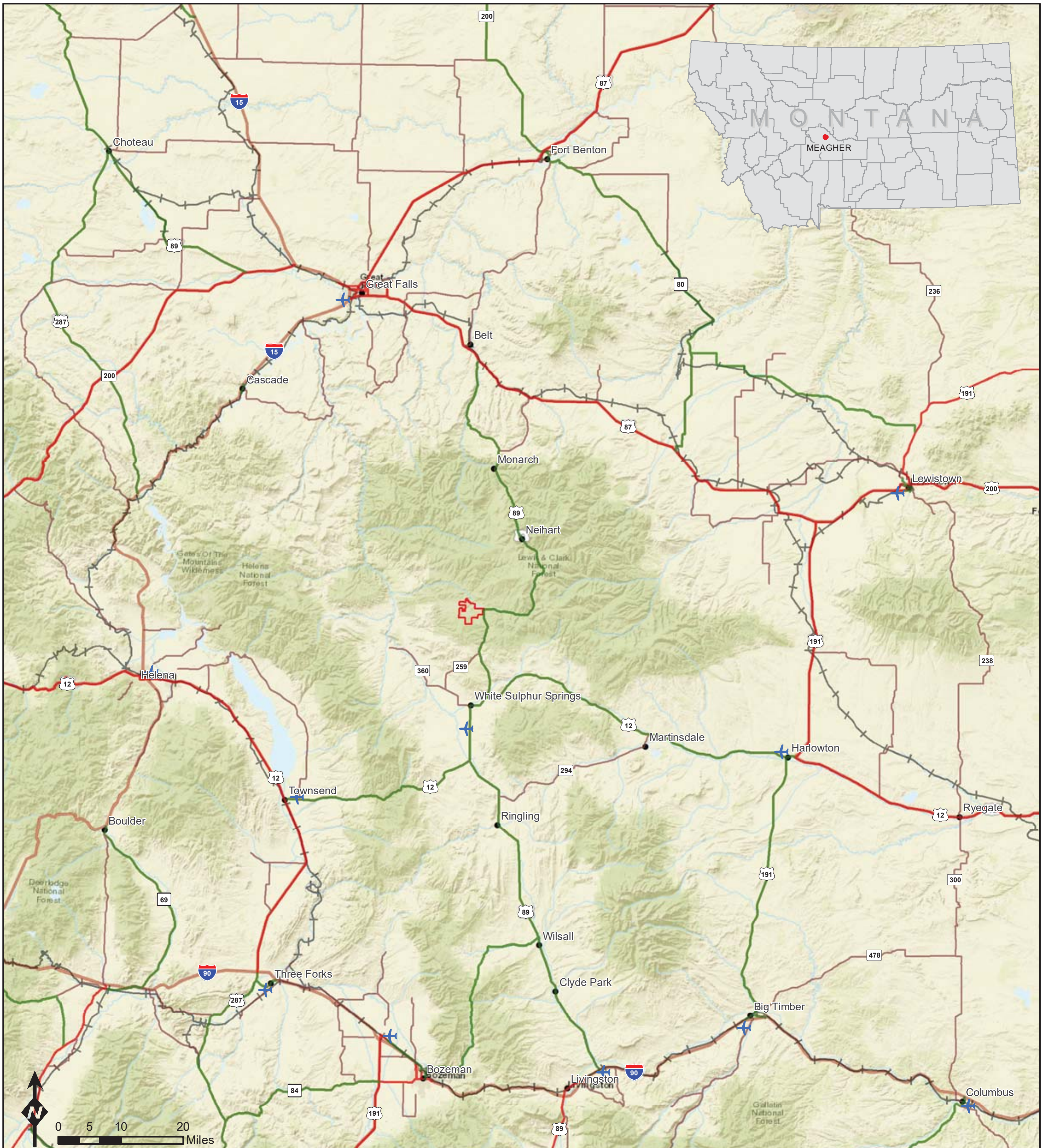
2.12.2 Roads

For the purposes of allocating government funds, Montana categorizes public highways and streets according to a highway functional classification system (Table 2-36). Montana has both Federal- and State-designated classification systems. Federally designated highway systems are the National Highway System (NHS), which includes Interstates, and the Non-Interstate NHS, which are principal arterial roadways other than Interstate highways. State-designated highway systems in Montana include the Primary Highway System (roads that have been functionally classified as principal or minor arterials), the Secondary Highway System (minor arterials or major collectors), the Urban Highway System (arterials or collectors in cities with a population greater than 5,000 selected by MDT and the municipality to be placed within the Urban Highway System), and the State Highway System (roads maintained by MDT that are not part of the Primary, Secondary, or Urban systems (MDT, 2010)).

Table 2-36. Highway Functional Classification System

Functional Class	Definition and Characteristics	Example
Arterials	Highest level of mobility at the greatest speed, with longest uninterrupted travel. Arterials are additionally categorized as either principal or minor depending on the nature of the area they serve (rural versus urban).	Interstate, US Highways
Collectors	Lower degree of mobility at lower speeds for shorter distances. Collectors are typically two-lane roads that gather and distribute traffic from the arterial routes. In rural areas, collectors are defined as major or minor.	State Highway, County Road
Local	Lowest degree of mobility at slower speeds with highest degree of access. Local roads connect residential and commercial properties and funnel traffic to higher order roadways.	City Streets

Source: MDT 2010



TINTINA RESOURCES

Figure 2.29

Project Location and Transportation Network
Black Butte Copper Project
Meagher County, Montana

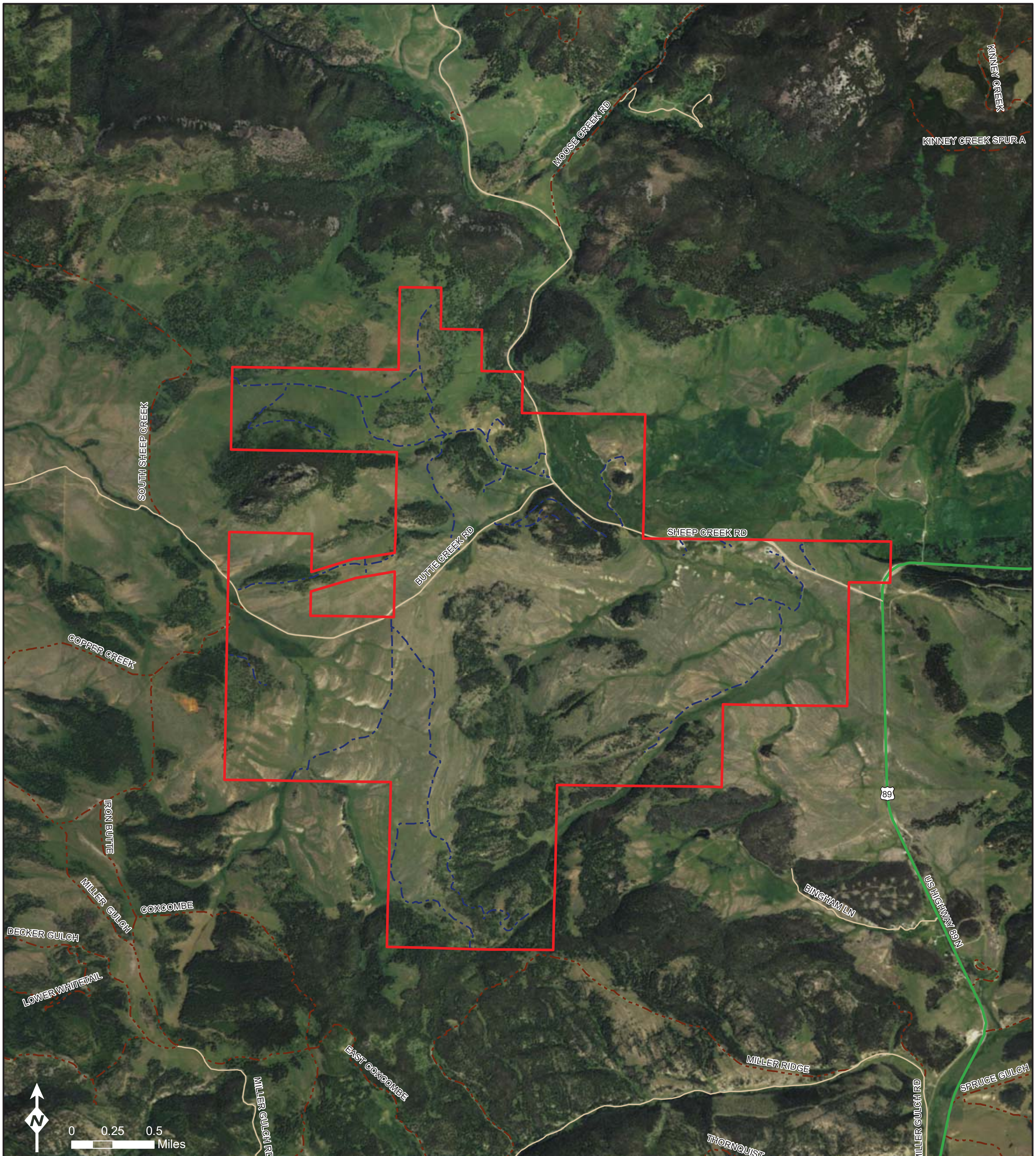
U.S. Highway 89 (US-89) and county roads provide the primary access to the Project area approximately 15 miles (24 km) north of White Sulphur Springs (Figure 2.30). US-89 lies east of the Project area and is the only paved road in the vicinity and County or U.S. Forest Service roads bound and traverse the Project area. A small number of private roads, primarily in the form of two-track ranch access roads, are present within the Project area (Figure 2.30). A more detailed description of these road networks is provided below.

Within the Project area, approximately 22 miles (35 km) of unpaved roads traverse the property (Figure 2.30; as determined and digitized from aerial photography). The roads are a mix of established gravel roads and less-frequented dirt or grass two-track roads. The established county gravel roads are located in the north half of the Project area and include Sheep Creek Road, a northwest-southeast route, and Butte Creek Road, which splits off of Sheep Creek Road to the southwest. There are two unnamed gravel roads provide access to residential buildings in the northern portion of the Project site. The dirt and grass two-track roads are fairly well distributed across the Project property; the central portion of the Project area has fewer two-tracks than other areas.

U.S. Highway 12 (US-12) and US-89, both of which are classified as primary State highways (MSL 2013) serve White Sulphur Springs (Figure 2.30). A secondary highway, Montana Highway 360 (MT-360), heads west-northwest from White Sulphur Springs to Fort Logan. The town of White Sulphur Springs has approximately 24 miles (39 km) of local (city-county) roads (MSL, 2015).

Highways US-89, US-12, and MT-360, along with secondary Montana Highway 294 (MT-294) comprise the main highways in Meagher County (Figure 2.30). MT-294, a two-lane paved highway, connects US-89 with US-12 and passes through the towns of Lennup and Martinsdale, MT. US-12, an east-west two lane paved highway, connects from east to west the towns of Roundup, Harlowton, White Sulphur Springs, and Townsend, MT. Within Meagher County, US-12 has one east bound lane and one west bound lane, and has occasional passing lanes on steep grades. Highway US-89, a paved two-lane highway (one lane for each direction of travel), connects from north to south the towns of Great Falls, Belt, Neihart, White Sulphur Springs, Ringling, Wilsall, Clyde Park, and Livingston, MT. From Great Falls, MT Highway US-89 enters Meagher County 30 miles (48 km) northeast of White Sulphur Springs and exits approximately seven miles (11 km) south of Ringling, MT before continuing on to Livingston, MT. Highways US-89 and US-12 overlap for approximately 12 miles (19 km) in the vicinity of White Sulphur Springs.

The study used route maps and traffic count data from the MDT (MDT, 2015). The MDT collects traffic data through short-term and permanent traffic count stations, which consist of automatic traffic recorder (ATR) and weigh-in-motion (WIM) sites. Proportionally, the short-term traffic count stations provide the bulk of traffic counts. The ATR and WIM stations mainly provide traffic volume data, but several also provide information on vehicle length, classification, weight, and speed. The short-term stations provide data on traffic volume only, and are deployed for a 36- to 48-hour period between April and September. As a result, a seasonal adjustment factor is applied to the short-term counts to better represent traffic conditions on an average day (MDT, 2015). Annual Average Daily Traffic (AADT) counts attained from MDT's interactive web map service and referenced below have received application of the adjustment factor.



Legend

Leased area boundary

Highway system

- Primary
- City-County
- Private
- U.S. Forest Service
- U.S. Bureau of Land Management

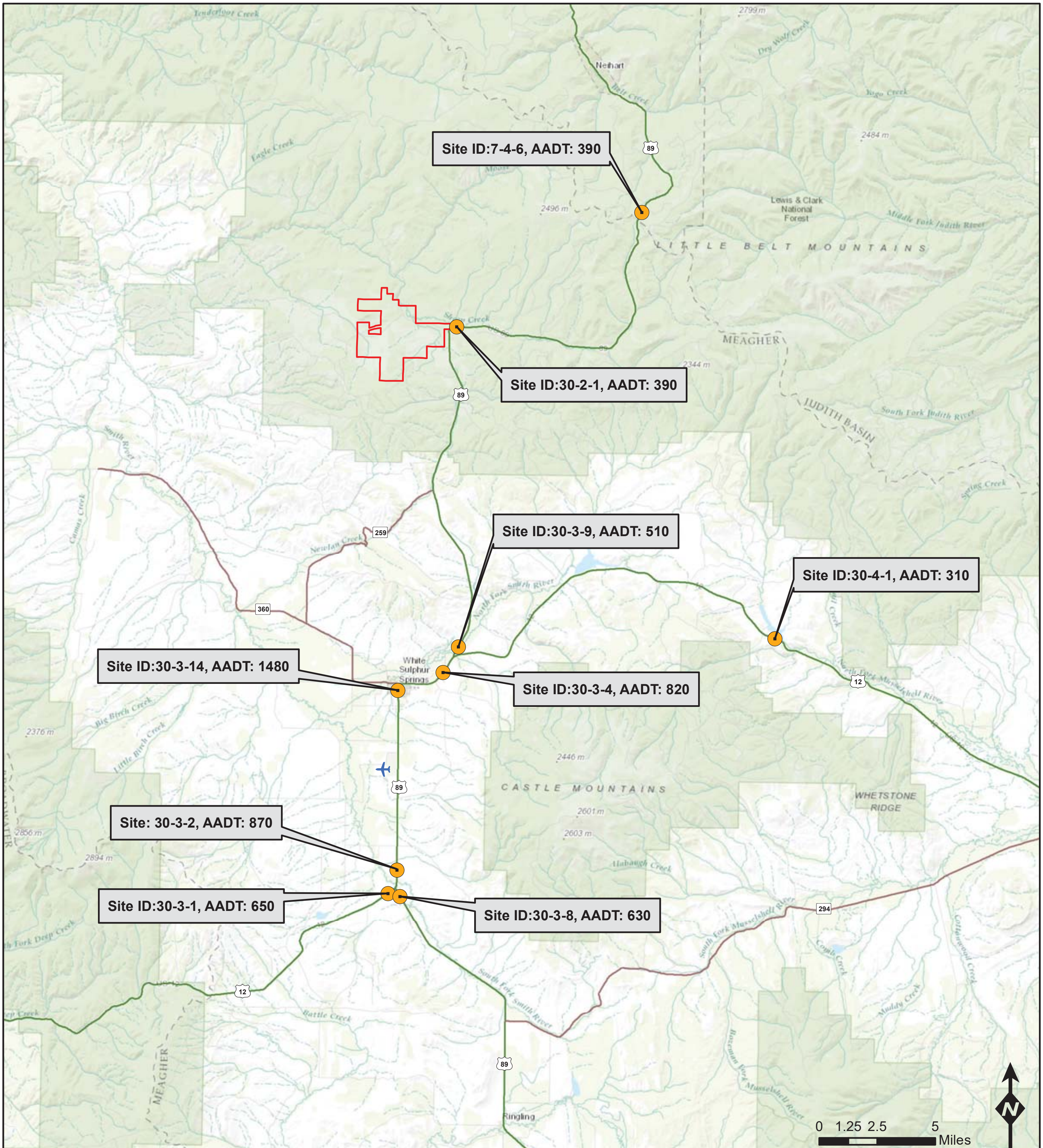
TINTINA RESOURCES

Figure 2.30

Project Area Road Detail

Black Butte Copper Project

Meagher County, Montana



Legend

- Leased area boundary
- Airport
- MDT Traffic Station*

Highway Classification System

- NHS Non-Interstate
- Primary
- Secondary

* All stations are short term traffic counting stations.

TINTINA RESOURCES

Figure 2.31
MDT Transportation Count Stations
Black Butte Copper Project
Meagher County, Montana

There are no permanent ATR or WIM traffic monitoring sites in Meagher County. An ATR site is proposed for installation east of White Sulphur Springs on US-12 near Checkerboard, MT and a WIM station is proposed for US-12/US-89 approximately seven miles south of White Sulphur Springs (MDT, 2015). Traffic data for the county is provided by several short-term traffic counting sites. Table 2-37 and Figure 2.31 provide the reported AADT value for select short-term traffic count stations in Meagher County in the vicinity of the Project (MDT, 2015).

Table 2-37. Average Annual Daily Traffic (AADT) Counts in the Vicinity of the Project

MDT Traffic Site ID	AADT	Highway	Year	Distance, Direction from Project	Comment
30-2-1	390	US-89	2014	<1 mile, East	Located at sharp bend east on US-89
30-3-9	510	US-89	2014	14.5 miles, South	At split from US-12
30-3-4	820	US-12/US-89	2014	16 miles, South	East edge of town
30-3-14	1480	US-12/US-89	2014	18 miles, South	South edge of town
30-3-2	870	US-12/US-89	2014	27 miles, South	North of junction between US-12 & US-89
30-3-1	650	US-12	2014	30 miles, South	Before junction with US-89
30-3-8	630	US-89	2014	30 miles, South	Before junction with US-12
30-4-1	310	US-12	2014	32 miles, Southeast	East of White Sulphur Springs
7-4-6	390	US-89	2014	13.5 miles, Northeast	Near county line

2.12.3 Railroads

This study reviewed various sources for railroad routes and carrier information, including the Montana State Rail Plan (Cambridge Systematics, 2010), the Montana Rail Link (MRL) and Burlington Northern Santa Fe (BNSF) websites and route maps, and Montana Department of Transportation railroad route maps. Meagher County (MDT, 2015a) has lost the Milwaukee line and the WSS & YP line, and no longer has any currently operating railroad lines. The nearest active railroad line to the Project area is a MRL line 40 miles (64 km) west-southwest of White Sulphur Springs (via US-12) at Townsend, MT; locally this north-south line connects the towns of Three Forks with Helena, MT (Figure 2.29). This segment of MRL line is part of a longer southeast-northwest line that connects Huntley, MT and Sandpoint, Idaho (MRL, 2015) and also passes through the town of Livingston approximately 87 miles (140 km) south (along US-89) of the Project area. In addition, a BNSF line lays 57 miles (92 km) (east of White Sulphur Springs near Harlowton, MT. This BNSF line runs north-northwest from east of Laurel to Great Falls, MT (BNSF 2014). Great Falls is approximately 83 miles (134 km) north of the Project area along US-89. The town of Armington Junction (just south of Belt) also lies along this route and is approximately 57 miles north of the Project site along US 89. BNSF is a Class I railroad, that as of 2006, operated 1,942 miles (3,125 km) of track in Montana. MRL is a Class II regional railroad that operates 875 miles (1,408 km) of track within Montana (Cambridge Systematics, 2010).

2.12.4 Airports

This study acquired airport information from FAA records (FAA, 2015) from AirNav, LLC (2015), a private enterprise which provides airport and navigation information to pilots via the internet, and from aerial photography. One public airport is located three miles south of White Sulphur Springs on the west side of MT Hwy 12/89, approximately 19 miles (31 km) due south of the Project area (Figure 2.29). The City of White Sulphur Springs and Meagher County (FAA, 2015) jointly own the airport. Facilities at the airport consist of one asphalt runway and one turf runway, measuring 6,100 feet (1,860 m) and 3,200 feet (975 m) (respectively) and a single hangar. Transient general aviation contributes sixty-two percent of operations at the White Sulphur Springs airport between August 2013 and August 2014 and local air traffic contributes 38% to (AirNav, 2015). Great Falls, Helena, Bozeman, and Billings, MT all have regional airports with scheduled passenger services suitable for travel to the Project area.

2.13 Land Use

Private citizens own all the property in the Project area which contains the Johnny Lee copper resource and which Tintina needs to use for mine development (Figure 1.4 and Section 1.3). Land uses are predominantly agricultural and include primarily livestock grazing and hay production. In addition, fishing and big game outfitters use the Sheep Creek drainage for hunting and fishing.

The Bar Z Ranch and Short Ranch own 100% of the surface and mineral rights of the lands containing the proposed mine and related facilities. Tintina has lease agreements with each of these owners (Figure 1.4) (Section 1.3) (Resource Modeling, Inc. 2010). The lease agreements allow only underground mining, interfere with current uses as little as possible, and stipulate that after mining the owners can resume, as much as possible, any interrupted land uses such as cattle grazing and hay production.

Vegetation resource investigations in the study area identified seven Conifer Forest and Woodland habitat types (Table 2-28; Section 2.8.1). They are Douglas-fir, with less frequent occurrences of common juniper and infrequent Engelmann spruce. Mature conifer stands occupy 502 acres (200 ha) or 15% of the vegetation study area. Areas with previous logging activities or areas with encroachment by conifers into grassland or shrub land, exhibit stands of immature conifers and comprise 235 acres (95 ha) or 7% of the study area.

Rangeland productivity varies considerably among vegetation types in the study area, depending on current conditions and the ecological sites involved. Hypothetical grazing capacity estimates calculated for historic rangeland is 4,350 animal unit months (AUMs) (annually) for the entire baseline study area.

Hay, the only crop grown in the study area, covers 69 acres (28 ha) (2 % of the study area) and hay cropland in the study area can produce approximately 3 to 5 AUMs per acre, depending on the soil. Based on long term production data compiled by the NRCS (2015) the predicted yield of grass hay in the study area can produce 3 to 5 AUMs per acre. In recent practice, ranchers' cut grass hay and grass-legume hay on the Sheep Creek floodplain once a year within the study area, and produce approximately 3 tons per acre annually on average (ranch manager, personal communication, 2015).

3 OPERATING PLAN

3.1 Introduction

Section 3.0 describes the components, facilities and processes comprising the mine operations in detail. Table 3-1 lists sections of this report that have supporting technical reports as appendices.

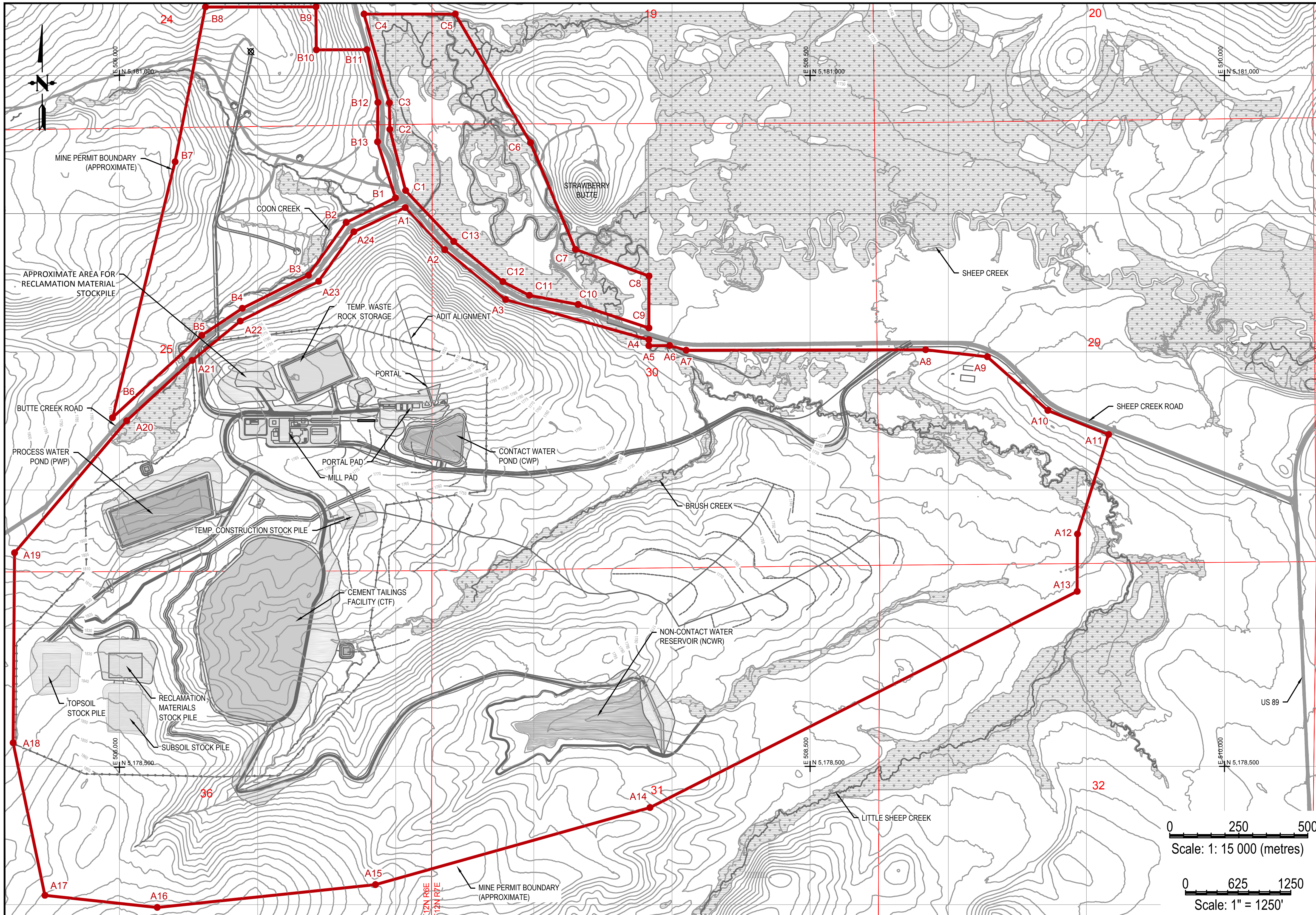
Table 3-1. Reference Sections for Operating Plan

Document Section	Section This Report	Detailed Technical Report as Appendix
Engineering Evaluation	3.5	K, and K-1
Waste and Water Management Facilities	3.6	K, and K-1
Water Management during Construction and Operations	3.4.2	K-2
Water Treatment	3.7.3	V
Treated Water Disposition	3.7.4	E-1
Storm Water Management	3.7.5; Map Sheet 6	_
Erosion Control Methods and BMPs	3.7.6; Figures 3.51 and 3.52	–
Water Balance	3.7.2	L

3.1.1 Mine Permit Boundary

The proposed mine permit boundary for the Project (Figure 1.2) encloses a total area of 1,887.7 acres (763.9 ha) of private property, all within three tributaries of the upper Sheep Creek drainage. The proposed mine permit area is located in Sections 24, 25 and 36 in Township 12N, Range 6E, and in Sections 19, 29, 30, 31, and 32 in Township 12N, Range 7E (Figure 3.1). It encompasses all proposed facilities (Figure 1.3) and surface disturbances associated with the Project. The permit boundary (Figure 3.1) specifically excludes the existing county road and follows topographic divides between tributary drainages of Sheep Creek on the south, and the divide between Sheep Creek and Butte Creek to the west. The south and west portions of the permit boundary include drainage sub-basins for surface water run-on and run-off control, while remaining as close as possible to major facilities.

A county road (Sheep Creek Road) accesses the permit area approximately 1.5 miles (2.4 km) west of its intersection with US Highway 89 (Figure 1.2). The permit boundary area consists of three separate subareas (Figure 1.3). The main Project area to the south and west of the county road contains almost all of the proposed major facilities and surface disturbances. A smaller area north of the county road and Coon Creek encloses the collar areas of the four proposed underground ventilation raises, the potable water supply well, and their respective largely existing and proposed access roads, several existing Bar-Z owned structures and several existing monitoring wells. The third northeastern subarea lies to the east of the county road along Sheep and Little Sheep Creeks. A four-strand barbed-wire fence will surround a small portion of the mine permit boundary area south of the county roadways and enclose most of the facilities. An additional barbed wire fence will enclose both sides of the main access road to avoid conflicts between mine traffic and cattle. Other smaller fenced areas include the individual vent raises, water well, and pumping station. However, these will allow unencumbered existing ranch road access. Eight-foot-tall wildlife chain-link fencing will surround all water-bearing lined ponds.



LEGEND

- MINE PERMIT BOUNDARY (APPROX.)
- A12 BOUNDARY CORNER NUMBER
- SECTION LINE
- 32 SECTION NUMBER
- E 1,000 N 1,000 UTM Z12N NAD83 COORDINATES

South Area UTM Zone 12N / NAD83 Boundary Corner Coordinates				
Boundary Corner	Easting (m)	Northing (m)	Longitude (D M S.S)	Latitude (D M S.S)
A1	507,034.00	5,180,521.50	W110° 54' 28.29"	N046° 46' 41.54"
A2	507,177.00	5,180,369.00	W110° 54' 21.56"	N046° 46' 36.59"
A3	507,397.50	5,180,189.00	W110° 54' 11.17"	N046° 46' 30.75"
A4	507,916.00	5,180,043.50	W110° 53' 46.73"	N046° 46' 26.02"
A5	507,916.00	5,180,022.00	W110° 53' 46.73"	N046° 46' 25.32"
A6	507,991.50	5,180,022.50	W110° 53' 43.17"	N046° 46' 25.34"
A7	508,051.00	5,180,005.50	W110° 53' 40.37"	N046° 46' 24.78"
A8	508,918.00	5,180,007.50	W110° 52' 59.48"	N046° 46' 24.81"
A9	509,141.50	5,179,982.00	W110° 52' 48.95"	N046° 46' 23.97"
A10	509,360.50	5,179,788.00	W110° 52' 38.63"	N046° 46' 17.67"
A11	509,580.00	5,179,701.00	W110° 52' 28.29"	N046° 46' 14.84"
A12	509,467.50	5,179,340.50	W110° 52' 33.62"	N046° 46' 03.17"
A13	509,466.50	5,179,133.00	W110° 52' 33.69"	N046° 45' 56.45"
A14	507,920.00	5,178,351.00	W110° 53' 46.65"	N046° 45' 31.19"
A15	506,926.50	5,178,072.00	W110° 54' 33.50"	N046° 45' 22.19"
A16	506,136.50	5,177,990.00	W110° 55' 10.74"	N046° 45' 19.56"
A17	505,730.00	5,178,033.50	W110° 55' 29.90"	N046° 45' 20.98"
A18	505,615.00	5,178,585.50	W110° 55' 35.29"	N046° 45' 38.87"
A19	505,620.00	5,179,273.00	W110° 55' 35.03"	N046° 46' 01.14"
A20	506,026.00	5,179,750.50	W110° 55' 15.86"	N046° 46' 16.60"
A21	506,263.00	5,179,969.00	W110° 55' 04.68"	N046° 46' 23.67"
A22	506,437.00	5,180,111.00	W110° 54' 56.47"	N046° 46' 28.26"
A23	506,720.50	5,180,255.00	W110° 54' 43.09"	N046° 46' 32.92"
A24	506,848.00	5,180,434.00	W110° 54' 37.07"	N046° 46' 38.71"

Northwest Area UTM Zone 12N / NAD83 Boundary Corner Coordinates				
Boundary Corner	Easting (m)	Northing (m)	Longitude (D M S.S)	Latitude (D M S.S)
B1	506,999.00	5,180,557.00	W110° 54' 29.94"	N046° 46' 42.69"
B2	506,820.50	5,180,467.50	W110° 54' 38.36"	N046° 46' 39.80"
B3	506,684.00	5,180,277.00	W110° 54' 44.81"	N046° 46' 33.63"
B4	506,444.50	5,180,157.50	W110° 54' 56.11"	N046° 46' 29.77"
B5	506,341.00	5,180,088.50	W110° 55' 00.99"	N046° 46' 27.54"
B6	506,297.84	5,180,059.72	W110° 55' 03.03"	N46° 46' 26.61"
B7	505,974.28	5,179,761.43	W110° 55' 18.30"	N46° 46' 16.95"
B8	506,311.00	5,181,247.50	W110° 55' 02.35"	N046° 47' 05.09"
B9	506,711.33	5,181,247.88	W110° 54' 43.47"	N046° 47' 05.08"
B10	506,712.59	5,181,092.29	W110° 54' 43.42"	N046° 47' 00.04"
B11	506,895.52	5,181,092.99	W110° 54' 34.79"	N046° 47' 00.06"
B12	506,935.00	5,180,902.00	W110° 54' 32.94"	N046° 46' 53.87"
B13	506,934.00	5,180,759.50	W110° 54' 33.00"	N046° 46' 49.25"

Northeast Area UTM Zone 12N / NAD83 Boundary Corner Coordinates				
Boundary Corner	Easting (m)	Northing (m)	Longitude (D M S.S)	Latitude (D M S.S)
C1	507,035.50	5,180,583.50	W110° 54' 28.22"	N046° 46' 43.55"
C2	506,978.50	5,180,805.00	W110° 54' 30.89"	N046° 46' 50.73"
C3	506,977.00	5,180,901.00	W110° 54' 30.96"	N046° 46' 53.84"
C4	506,885.00	5,181,222.00	W110° 54' 35.28"	N046° 47' 04.24"
C5	507,215.50	5,181,222.00	W110° 54' 19.69"	N046° 47' 04.23"
C6	507,487.50	5,180,756.50	W110° 54' 06.89"	N046° 46' 49.14"
C7	507,650.00	5,180,370.50	W110° 53' 59.25"	N046° 46' 36.62"
C8	507,916.50	5,180,274.00	W110° 53' 46.69"	N046° 46' 33.49"
C9	507,916.50	5,180,086.00	W110° 53' 46.70"	N046° 46' 27.40"
C10	507,659.50	5,180,171.00	W110° 53' 58.82"	N046° 46' 30.16"
C11	507,483.50	5,180,204.50	W110° 54' 07.11"	N046° 46' 31.25"
C12	507,387.50	5,180,254.00	W110° 54' 11.64"	N046° 46' 32.86"
C13	507,209.50	5,180,399.00	W110° 54' 20.02"	N046° 46' 37.56"

Topographic base map from 2011 aerial LiDAR survey.
Map Projection: UTM Zone 12N
Map Datum: NAD83
Contour Interval: 5m

Prepared by Tetra Tech Inc. (Revised July 2017)

FIGURE 3.1

Mine Permit Boundary Plan
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

TINTINA RESOURCES

3.1.2 List of Facilities with Surface Disturbance Acres

Table 3-2 lists the Project's facilities, features, and access roads (which are discussed below) and presents the measured acres of disturbance associated with each facility. An additional 10% (or 26.9 acres; 10.87 ha) of the subtotal Surface Disturbance acres has been added to the final Total Disturbance Acres (Table 3-2) to account for a Construction Buffer Zone or miscellaneous disturbances. The total amount of proposed surface disturbance for the project is approximately 295.9 acres (119.7 ha). A more detailed accounting of surface disturbance acres is presented in Table 3-13.

Table 3-2. Acres of Surface Disturbance Consolidated by Major Facility

Facility or Activity	Surface Disturbance (Acres)
New Access Roads	57.7
Direct Underground Mine Support	7.9
Temporary Waste Rock Storage (WRS) and copper-enriched rock stockpile	12.1
Contact Water Pond (CWP)	9.0
Mill / Plant Site	9.8
Process Water Pond (PWP)	28.7
Cemented Tailings Facility (CTF)	82.5
Non-Contact Water Reservoir (NCWR)	7.6
Water Supply	6.3
Underground Infiltration Galleries	14.4
Material Stockpiles	32.4
Other / Miscellaneous	0.6
Subtotal	**269.0**
Construction Buffer Zone / Misc. (10%)	26.9
Total Disturbance Acres	**295.9**

3.2 Underground Mine Operations and Mining Methods

3.2.1 Introduction

Underground mining requires the removal of both the metal resource (valuable copper-bearing rock) and waste (non-mineralized and sub-economic mineralized rock). The two basic stages of underground mining required for access to and/or mining of an underground copper deposit are development mining and production mining. *Development Mining* typically involves excavation of uneconomic waste rock in order to gain access to the valuable mineral deposit. Development mining is also referred to throughout this document as *pre-production mining*. The pre-production time period refers to the activities and time before the mill becomes operational. *Production Mining* involves mining of the actual copper-bearing stopes or drifts to remove the profitable rock for subsequent mineral processing. Approximately 14,497,146 tons (13,151,590 tonnes) of copper enriched rock and 778,810 tons (706,525 tonnes) of waste will be mined from both pre-production development and production mining over the operational life of the mine (15 years).

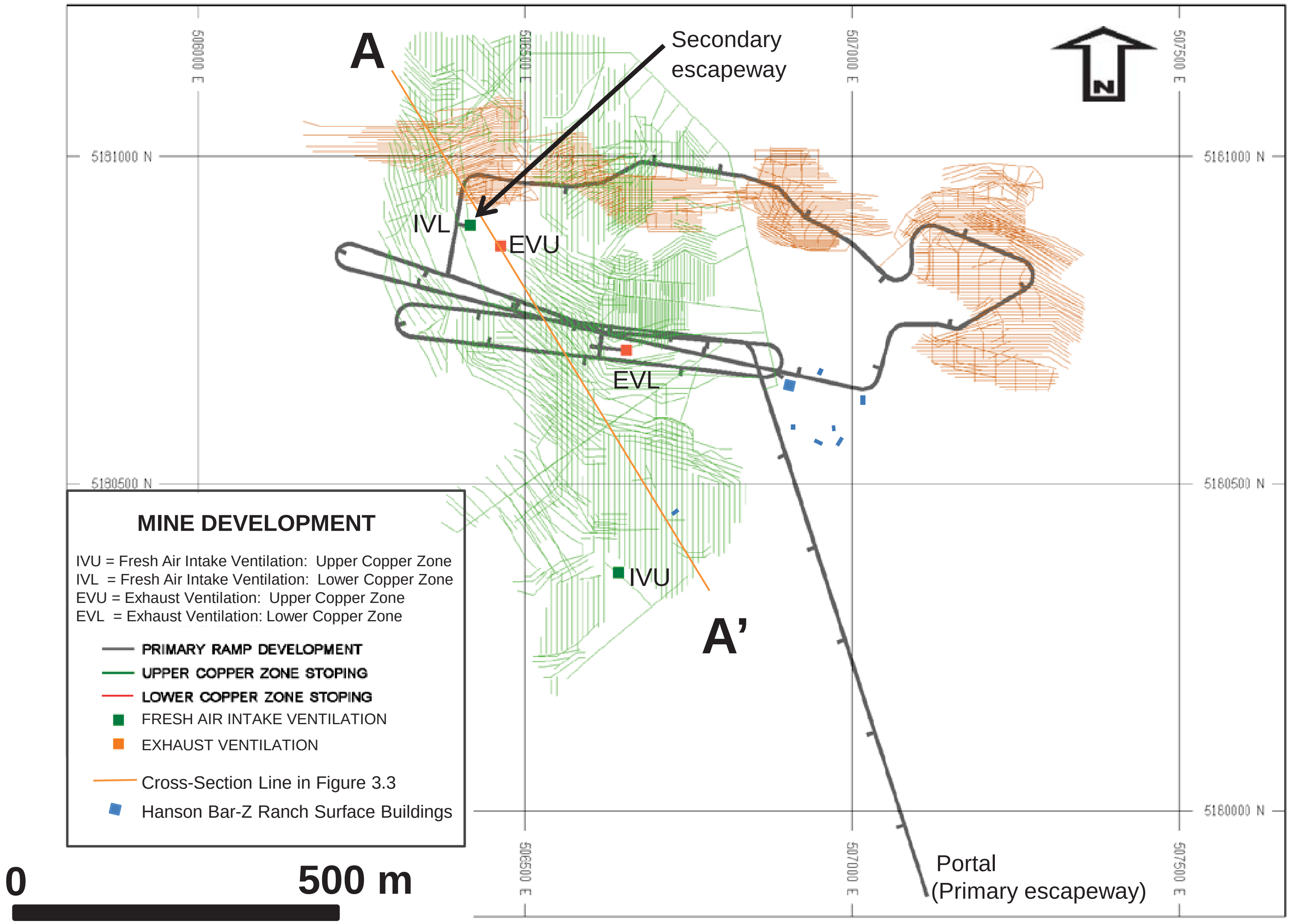
3.2.2 Tintina's Underground Mine Plan

3.2.2.1 Johnny Lee Development Workings

Early pre-production development mining will take approximately 2 to 2.5 years to complete and construction of surface support facilities will occur at the same time. Tintina plans to access the upper and lower Johnny Lee deposit zones through a single 17-foot wide by 17-foot (5m x 5m) tall mine portal (opening) at the surface. Approximately 18,800-feet (5,730 m) of declines (downward sloping access tunnels) and access drifts (tunnels driven in non-ore-grade rock to access mining stopes) (Figure 3.2 and Figure 3.3 will be developed beyond the surface portal for mining. A 5,398 foot long (1,645 m) 17-feet wide by 17-feet tall decline with a slope of -15% will provide the access from surface to the upper copper zone (Figure 1.7). The initial UTM Z12N NAD83 starting point coordinates of the approximate post-portal excavation decline sill centerline are about E 507,114.6, N 5,179,868.4, Z 1,785.6 (all coordinates in meters). The intersection of the bottom of the decline and the bottom of the upper copper zone lies at a depth from surface of approximately 460 feet (140 m). From there the decline extends an additional 4,954 feet (1,510 m) (to reach the top of the lower Johnny Lee deposit zone, at a depth of 985 feet (300 m) below the surface. The 8,448 long (2,575 m) lower copper zone access loop will provide access for resource extraction, and drop in depth from approximately 985 feet (300 m) feet below surface to approximately 1,640 feet (500 m) below the surface (the depth of the base of the lower copper zone).

The decline and ramps provide access for all personnel and materials to the working areas. Underground trucks will carry all waste rock and copper-enriched rock up the decline to separate storage pads immediately west of the portal pad (Figure 1.3). The temporary WRS pad will store waste rock for approximately 2 years, which is equivalent to 453,642 tons (411,537 tonnes). The temporary waste rock storage pad could hold as much as 551,156 tons (500,000 tonnes) of pre-production waste rock while awaiting completion of the CTF. The completed CTF will receive all the waste rock from the temporary waste rock storage pad as well as any new waste rock for co-disposal with the cemented tailings. Prior to reclamation of the temporary WRS pad, a newly constructed 1.9 acre (0.8 ha) lined, copper-enriched mill feed storage pad will be constructed immediately southeast of the WRS pad off the northwest corner of the portal pad. This location was selected so that it would be closer to the jaw crusher that would be used to feed copper-enriched rock to the mill. The copper-enriched mill feed stockpile pad will have storage capacity for as much as 82,600 tons (75,000 tonnes) of mill feed. Any seepage from the temporary waste and resource mill feed storage pads, and contact water from the portal pad and mill facility will report via pipeline and HDPE-lined ditch to the CWP for subsequent treatment and discharge (Figure 1.3) (described in Section 3.6.5.1) or alternatively used as make-up water in the mill. Underground drill stations may be cut if infill development targeting is warranted.

There will also be four ventilation raises constructed from the underground mine workings and one will be developed as a secondary escape way (Figure 1.3). The raises and escape way are discussed in greater detail in Section 3.6.4.

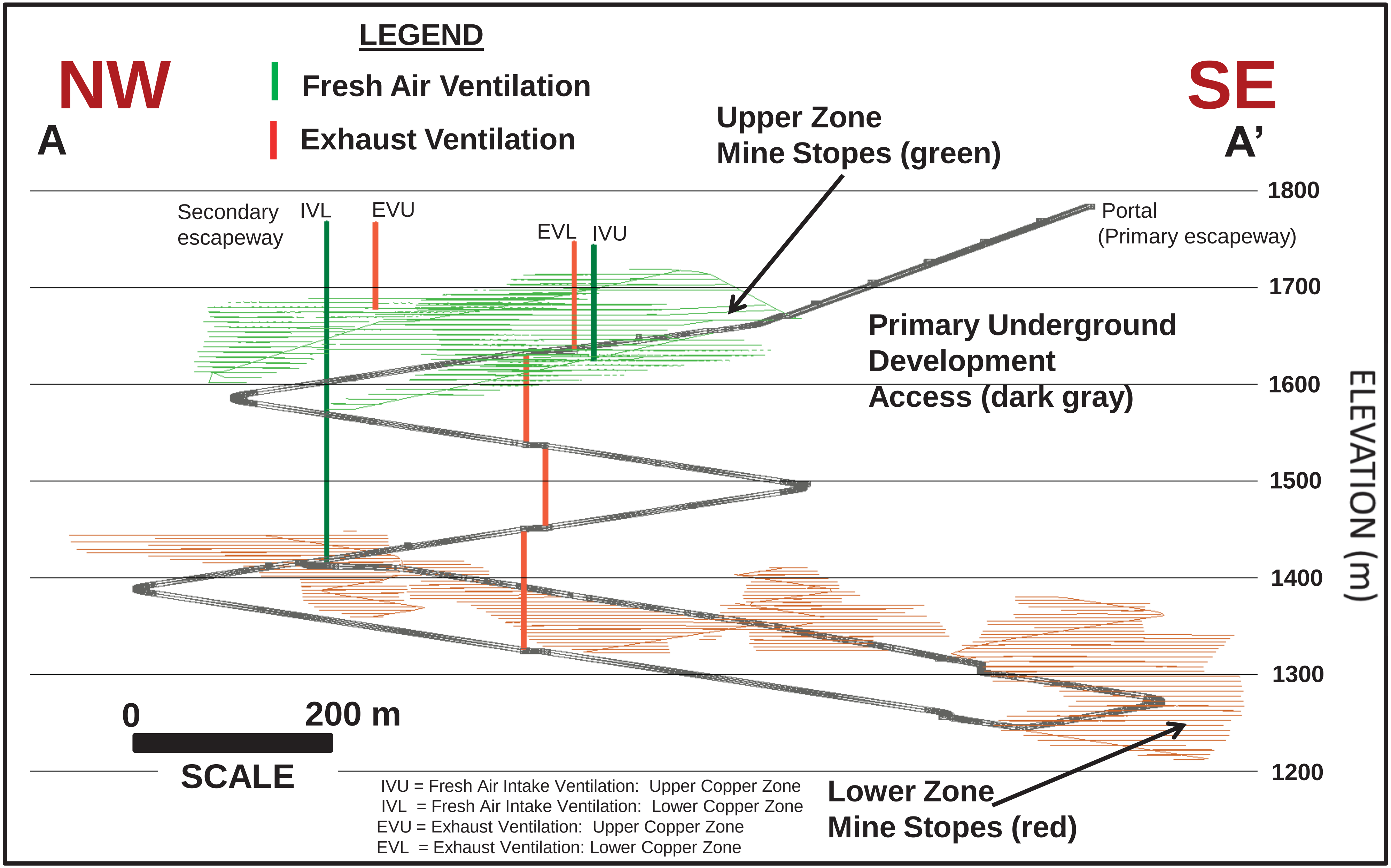


Map projection and datum: UTM 12N WGS84

Prepared by AMEC FW and Tintina Resources (2017)

TINTINA RESOURCES

Figure 3.2
Plan Map of Underground Workings and Mining Stopes



Prepared by: AMEC (2015) and Tintina Resources

TINTINA RESOURCES

Figure 3.3
Cross-Section of Underground Workings and Mining Stopes
Mine Operating Permit Application
Meagher County, Montana

3.2.2.2 Johnny Lee Production Workings

Production mining will occur after the bulk of the development (pre-production) mining has taken place. During production mining, Tintina will use a "drift and fill" mining method. Drift and fill mining has many advantages:

1) Drift and fill operations are an expensive yet very selective method in which the copper-enriched rock can be mined with minimal loss and dilution (mixing of the copper-enriched rock with adjacent low-grade or barren rock, thereby lowering the overall grade mined).

2) The entire deposit can be mined (i.e., does not require leaving copper-enriched ground supporting pillars).

3) The mined out opening is completely backfilled and supported with cemented tailings, therefore there is no risk of future ground subsidence at the surface.

4) Incremental backfilling of the mine workings will replace the mined out voids with a very fine-grained cemented tailings paste that has very low effective porosity and hydraulic conductivity (1 x 10^{-8} cm/s or 2.8x10^{-5} ft./day) (Amec Foster Wheeler, 2015a). The permeability of the surrounding host rock in the UCZ is at least three orders of magnitude higher than the paste backfill and the LCZ is one to two orders of magnitude higher than the paste backfill. The large difference in permeability will result in the majority of the water moving through this area traveling through the host rock because groundwater generally takes the path of least resistance (Cedergen, 1997). The little water that does move through the backfill material will travel at a very low rate.

5) The open space created by active working headings (where sulfide-bearing rock is exposed along the walls) are of a limited volume, estimated at about 1% of the total mineral deposit at any one time, before being backfilled with cemented paste tailings. Therefore only a small amount of surface area is available to atmospheric oxygen at any time, and the location of these areas are constantly changing.

6) Prior to backfilling the stopes or access drifts, a shotcrete wall will be built at the stope / access drift entrance as a retaining wall against which to pump and confine backfill. The wall will remain in place indefinitely, and will eliminate direct exposure of the cemented paste backfill to the open mine workings operationally and to flooded workings in closure. These walls will prevent also prevent direct in situ erosion and degradation of the cemented paste backfill by providing lateral support and a chemical isolation across the wall.

7) Backfilling of the drifts and stopes also provides a safe underground working environment for the miners.

Figure 3.4 and Figure 3.5 illustrate individual stopes (i.e., drifts in the resource) which are tunnels driven into the mineral deposit. The resource stopes are typically inclined (maximum 1 to 2% grade), narrow but long slices. The stopes in the upper copper zone will measure either 17 feet (5 m) wide by 17 feet (5 m) high or 26 feet (8 m) wide by 17 feet (5 m) high, depending upon ground conditions and mineralization. The 3,000 foot (920 m) by 1,500 foot (460 m) resource area will accommodate multiple active mining stopes during mining of the entire deposit. The production drifts in the upper portion of the lower zone will generally measure 11.5 feet (3.5 m) wide by 11.5 feet (3.5 m) high. However, production drifts in the lowest portion of the lower copper zone will again reach dimensions of 17 feet (5 m) wide by 17 feet (5 m) high.

The drift and fill mining proceeds as illustrated in Figure 3.4 and Figure 3.5. A drift driven from the ramp to the opposite side of the mineralized zone allows access. Miners can then drive the stope along the length of the mineralized zone. Cemented tailings fed to the underground mine via pipeline from a paste plant on the surface (see Section 3.6.11 and Figure 3.43) will subsequently backfill this drift. Miners simultaneously drive several other drifts parallel to the first drift (but spaced out some distance away), and all sequentially receive cemented paste backfill. Once mining in an individual drift is complete and the cement backfill has cured and reached its full strength (usually about a month), a new drift immediately adjacent to the cemented paste backfilled drift is mined. Mining proceeds in this fashion until the copper deposit at this drift level is completely mined out laterally. Miners subsequently develop a second cut series of drifts on top of the underlying mined out backfilled area if the resource is thicker than the 17-foot (5 m) tall mining drift. This process of mining drifts above previous backfilled drifts is called overhand mining. This pattern of drifting and backfilling continues both laterally and vertically until the entire resource is mined out.

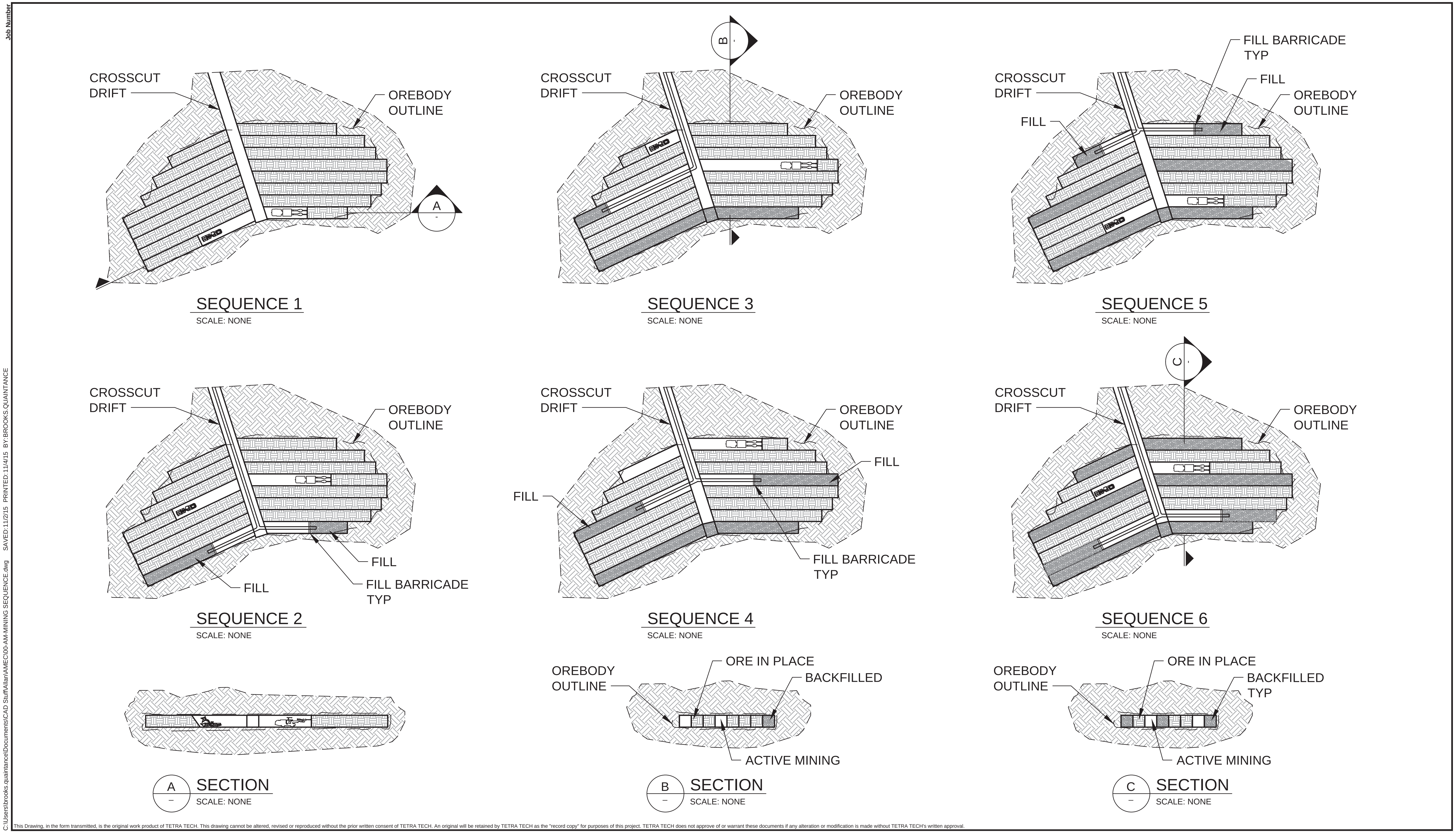


Figure 3.4
Typical Drift and Fill Mining Method
Sequence 1 Through 6
Black Butte Copper Project
Meagher County, Montana

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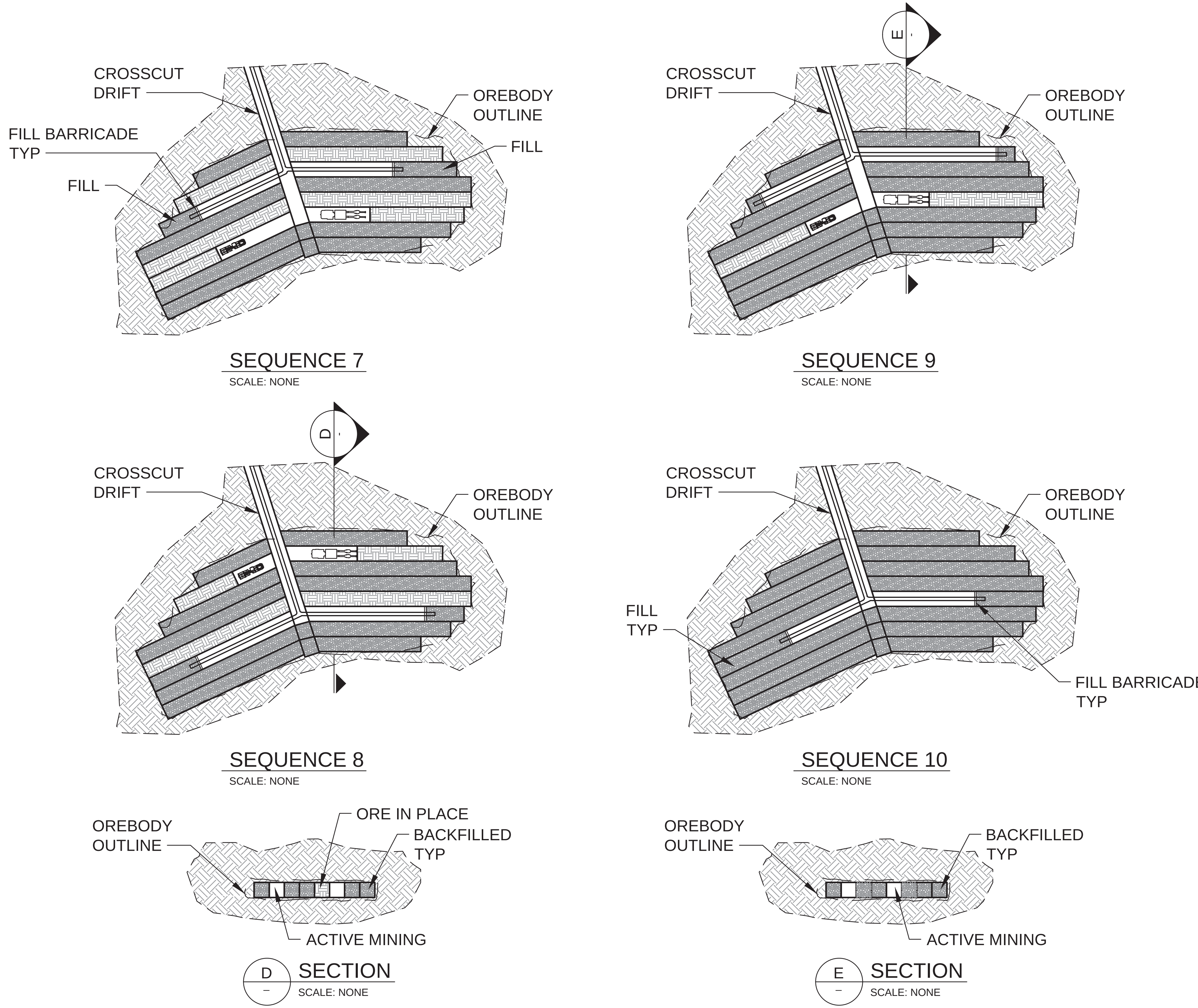

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Figure 3.5
Typical Drift and Fill Mining Method
Sequence 7 Through 10
Black Butte Copper Project
Meagher County, Montana

3.2.2.3 Geotechnical and Crown Pillar Stability of Underground Workings

Tintina is committed to developing an appropriate underground geostability monitoring program that satisfies MSHA standards will be designed based on a geotechnical engineer's assessment of the underground conditions as they are exposed.

Mine Design Engineering, Inc. was retained by Tintina Resources to conduct a geotechnical and crown pillar stability assessment for the Black Butte Copper Project (Appendix S, of this report). A crown pillar is any rock mass that remains between an underground mining excavation and surface. Risk considerations for crown pillar stability including remediation requirements are presented by Hutchinson et al. (2002).

The rock mass quality (Q) is considered to be poor to fair for most mining units at the Black Butte Copper Project using the classification scheme developed by Barton and others (1974). Adverse ground conditions are expected in and around the Volcano Valley Fault (VVF), which generally exhibits very poor rock mass quality.

Estimates of the modified Rock Mass Quality (Q') for the geotechnical domains (by lithologic unit) relevant to crown pillar stability are provided in Table 3-3 (see Appendix S). Geotechnical data indicates that the *USZ* has slightly better rock mass quality than *LSZ* rock. As described earlier in Section 1.4.2, the *UCZ* lies at a depth of approximately 90 to 625 feet (30 to 190 m) below ground surface. The *LCZ* occurs 985 to 1,640 feet (300 to 500 m) below the ground surface.

For assessment of crown pillar stability, the lower bound 30th percentile Q' has been applied for thin pillars <130 feet (<40 m) bedrock cover) as it is reasonably expected that meteoric ground water has contributed to some deterioration of the rock mass quality. For crown pillars > 130 feet (40 m) thick the lower bound 50th percentile Q' is utilized for analysis. It is assumed that the crown pillars will be predominantly composed of Newland Shale.

Table 3-3. Modified Rock Mass Quality (Q') Classification by Lithologic Unit

Lithologic Unit	Q' mean	Q' 30th Percentile
LSZ	3.4-6.8	2.0-4.0
USZ	3.9-5.2	3.2-4.3
VVF	0.7-0.8	0.5-0.6
Ynl above the VVF	5.7-7.6	3.6-4.8
Ynl below the VVF	3.7-4.9	2.2-2.9

Notes: (1) Q' is the modified Rock Quality Index value as classified by Barton et al. (1974) which utilizes the low and high (range) joint set number (Jn) values;
(2) lithologic unit abbreviations: *LSZ* = Lower Sulfide Zone; *USZ* = Upper Sulfide Zone; *Ynl* = Lower Newland Shale; *VVF* = Volcano Valley fault;

The majority of the mine area is generally expected to have a shallowly dipping joint set parallel to bedding and two mutually perpendicular sub-vertical joint sets, as well as random jointing (this random jointing becomes more prevalent below the *VVF*).

The bulk of the crown pillars in the mine will be developed in the USZ and LSZ units. For the crown pillar stability analysis, it is assumed that stopes will be backfilled to within roughly 1.6 feet (0.5 m) of the back which is a conservative assumption since the cemented tailings paste fill is expected to be typically placed with much less void. A second assumption assigns the bulking ratio of any material which caves from stope backs to be 30%. The stability analyses use standard equations and empirical design methods presented in Appendix S of this report and estimate that the depth of the potential cave over the mined out and backfilled LSZ and USZ orebodies could propagate a maximum of 5.6 feet (1.7 m) (vertically) into the back (roof) before becoming choked off. This equates to less than 1% of the total crown pillar thickness which is very small. It is assumed that cemented paste tailings backfill will have negligible long-term consolidation. The only material that could be subject to consolidation from possible roof collapse would be the zone immediately adjacent to the small 1.6 foot (0.5 m) thick void volume. A 1.6-foot (0.5 m) void is considered to be a very conservative worst case as it is reasonable to expect that operations can easily achieve the timely placement of tighter fill with a well-managed backfill program.

The stability estimates for the long term risk of crown pillar failure in the LSZ unit to the surface is almost completely negated by the placement of paste backfill. Therefore, Mine Design Engineering (2016) recommends that no rehabilitation measures in the LSZ unit will be necessary.

The Upper Sulfide Zone (USZ) is very shallow with minimum depths from the topographic surface to the top of the zone as small as 72 feet (22 m), and therefore has more potential stability issues relative to the LSZ unit. The copper-enriched rock within the USZ is intended to be extracted by the drift and fill mining method and so maximum open spans of 16 feet (5 m) and 26 feet (8 m) have been empirically evaluated in the stability analysis for this unit assuming 328 feet (100 m) panel lengths to estimate critical bedrock thickness over open stopes (excluding overburden cover).

The design guidelines for pillar acceptability/service life of crown pillars (see Appendix S) indicate that a 20% probability of failure is an acceptable standard for service life in the order of 1 year. A 20% probability of failure is achieved for the following span to bedrock thickness ratios:

- 16 foot span: 50 feet bedrock thickness (5 m span:15 m)
- 26 foot span: 114 feet bedrock thickness (8 m span:35 m)

The risk of failure associated with this 20% probability criterion is mitigated by:

1) Ground support installed in stope backs (rock bolts, screen, mattes and shotcrete)
2) Rapid cycle time to minimize the necessary stand up time for critical crown pillar areas (60 day maximum open time for mining stopes)
3) Continuous monitoring/instrumentation to provide safety factor for miners working in stopes

Items 1 and 2 above are the most significant means to controlling stability while stopes are open, and both are included in the mine plan. Since ground support is designed to maintain excavation stability during mine operations, it is very unlikely that a sinkhole or collapse to the surface will occur. However, ground support and crown pillar design will have to be reviewed during the detailed project feasibility study and monitored for effectiveness during early underground construction as additional geotechnical data becomes available. Once paste backfill is placed in the mining stopes the probability of crown pillar collapse (i.e., sinkhole development) is minimized to negligible (effectively zero) as there will be very limited open volume for material to collapse into, and propagation of a collapse to the topographic surface is unlikely.

3.2.2.4 Mine Dewatering

Based on hydrologic data, the first 1,700 feet (518 m) of decline will lie above the regional groundwater table and will encounter very little or no water. Therefore, during underground development mining, two 6,000 gallon (22,700 liter) water tanks (Figure 3.20) will be constructed at the east end of the portal pad for use in storing and supplying water required by underground mining methods or equipment. Any excess groundwater produced from the underground mine will be pumped to temporary storage in the Contact Water Pond (CWP) and from there to the construction phase RO WTP (Section 3.7.3) for treatment and discharge to underground infiltration galleries. As a safeguard, the underground infiltration galleries (UIG) and the WTP will be available for use at the outset of development.

Once mining encounters the regional groundwater table (approximately 1,700 feet [518 m] in from the portal, and about 220 feet (67m) below the ground surface), pumping will move excess water from the underground workings and working faces to underground settling sumps, and from there to temporary storage in the segmented CWP or directly to the water treatment plant. As mine development progresses and thereafter during operations, the mine will be dewatered through a series of pumps and three to four sumps located adjacent to the main access ramp decline or along underground working levels of the mine. Their precise location will depend on where larger inflows of water into the mine are encountered during mine development. Flocculants may be added to the sumps to assist in settling sediment if necessary. If needed, hydrocarbon booms or oil skimming capability will remove any hydrocarbon contamination from the underground settling ponds. Pumping will push water from the settling ponds through a buried 6-inch (15.2 cm) HDPE pipeline either directly to the PWP as make-up water or to the WTP located during construction on the mill pad for treatment to compliance with non-degradation criteria and discharged to shallow permeable bedrock via the underground infiltration gallery system.

Numerical groundwater modeling efforts predict maximum groundwater flows into the mine in the range of 420 to 500 gallons per minute (1,590 Lpm to 1,983 Lpm) during active mining. This assumes no inflow controls have been constructed. Occasional short-term higher flows generated by rapid dewatering of fracture systems encountered by mining could be as high as 1,000 gallons per minute. However, Tintina plans to grout major water bearing fractures or faults as they are encountered. When mining encounters significant inflows of water from water-bearing faults and/or fractured zones (>20 gpm; 75 Lpm), pressure grouting techniques may be used to control the inflow of water into the mine. Pressure grouting is a widely accepted standard practice in the mining industry. It involves injecting a grout material into fractured rock to seal off waterways, and divert the water around the underground mine openings. Appendix T describes common standard grouting methods likely to be used.

Each of the three or four underground sump pumps is capable of handling flows as large as 1,100 gpm (3,785 Lpm). The pumping system from underground sumps does not run constantly, but rather cycles on and off based on actual mine inflows and water levels in individual sumps. If the increased flows are intermittent, then the pumps cycle on and off more frequently, which is fairly common. If there is a large unexpected flow increase then the pumps will run longer or almost continuously until the inflow decreases as fractures are dewatered (usually over a period of a day or less). During the initial construction period mine inflow for years 0 to 1 is predicted at 0 gpm, year 1 to 2 will have gradually increasing flows to about 230 gpm (870 Lpm), and by year 2.5 (just prior to the completion of the PWP) the flow should be at about 300 gpm (1,136 Lpm). Should the volume of water produced from underground exceed the capacity of the construction RO water treatment plant (which it should not), excess storage for water prior to treatment exists in the CWP (9.8 million gallons; 37,000 m^3, about 23 days at 300 gpm). Once the PWP is completed (at about year 2.5), untreated water can be stored in the PWP that has an operational range of storage capacity of 156,954 to 261,590 cubic yards (120,000 to 200,000 m^3, about 125 days at 300 gpm, 1,136 Lpm) of water.

Dewatering of the underground mine workings will produce all water needed for consumptive use by mining operations (about 210 gallons (790 Lpm) per minute or 0.47 cubic feet per second). A table of estimated values for consumptive use of groundwater by component is provided as an inset to Figure

3.44. This water will be pumped from the mine to the PWP for use as make-up water. Water pumped from the mine in excess of the PWP maximum design operating capacity (approximately 261,600 cubic yards, 58,843,410 gallons, or 200,000 m^3) will receive treatment to non-degradation standards in the water treatment system and be discharged to the underground infiltration gallery system. Tintina plans to control the flow of water into the mine to a maximum of about 500 gallons per minute (1,893 Lpm). The water treatment system design is optimized in the range of 500 gallons per minute (1,893 Lpm) of continuous flow, with maximum annual average inflow rates of about 588 gallons (2,226 Lpm) per minute. The water treatment system will have a backup 250 gpm module which will allow for a maximum capacity of 750 gpm (2,839 L/min.), which is 1.27 times the average inflow rate. It is estimated that a small quantity of water, approximately 15 to 30 gpm (57 to 114 Lpm) will be required for the actual mine operations, which includes mobile equipment fleet water usage and delineation drilling needs.

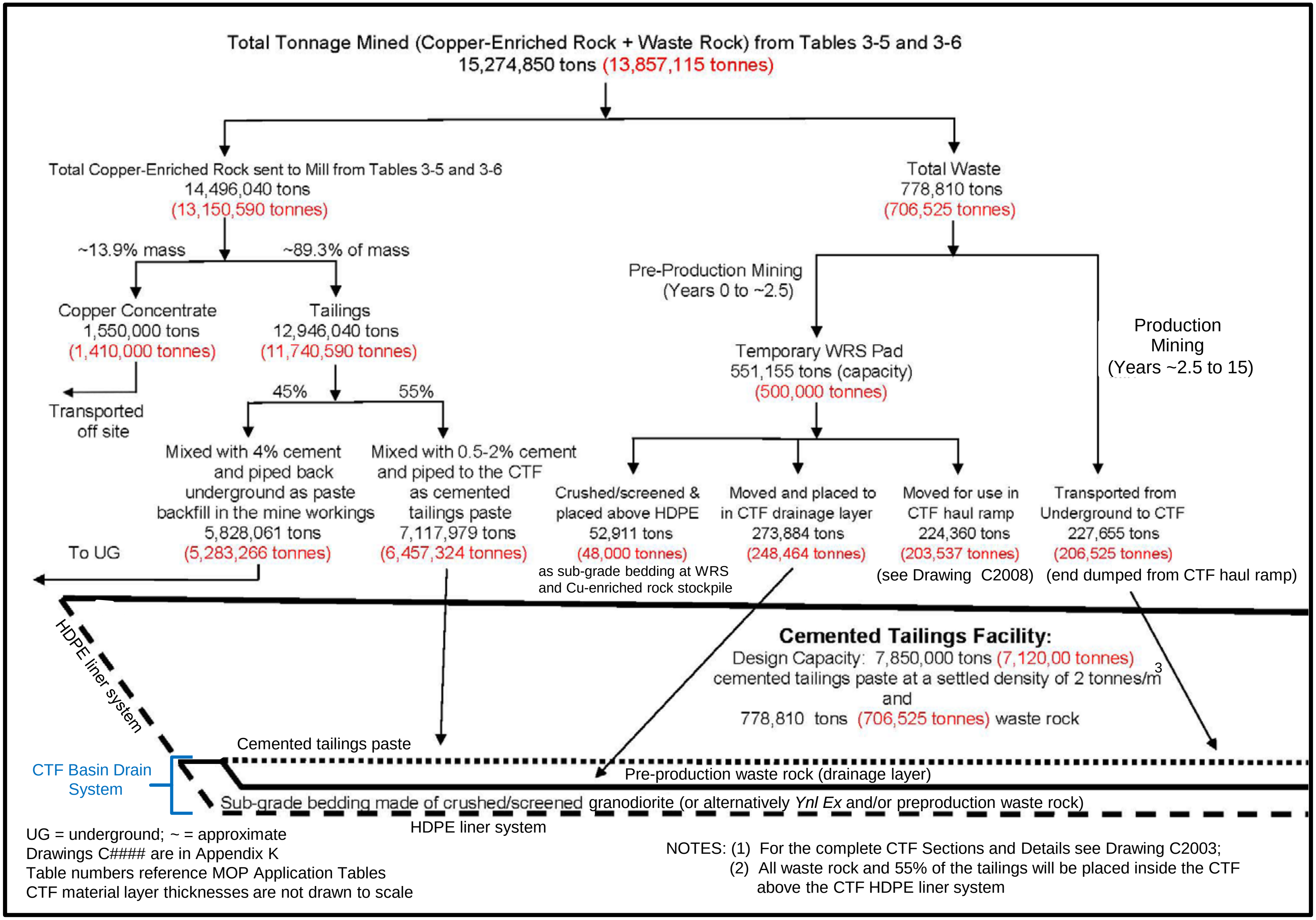
3.2.2.5 Mining Rates and Schedules

The underground mine will begin development after four to six months of basic site preparation and construction of an access road, portal pad, underground mine utilities, surface support facilities, temporary WRS area, and the CWP. These activities will run concurrently with major surface facilities construction activities. It is anticipated that major site preparation and support facility construction for overall operations will require 24 to 36 months to complete. These facilities are discussed in the surface support facility section (Section 3.6).

During the first four years of mining (including the first approximately 2 to 2.5 years of pre-production mining), a mining contractor will drive primary development ramps and development cross-cuts or access drifts (these are tunnels typically driven in waste rock) to access the mining stopes. After approximately 2.5 years of development mining, Tintina mining crews will start mining larger amounts of copper-enriched rock from upper Johnny Lee deposit production drifts. Copper-enriched rock mined prior to year 2.5 and the projected completion of the copper-enriched rock stockpile, will be stored either underground in access stopes or stockpiled in a segregated area on the WRS pad. In all, the total main access ramp length will be approximately 18,800 feet (3.6 miles) (5,730 m), the access drifts total approximately 47,900 feet (9 miles) (14,600 m), the mining drift length in copper-enriched rock would be approximately 366,400 feet (69 miles) (43 km) and the total ventilation raise shaft length would be approximately 2,263 feet (690 m).

Figure 3.6 presents a detailed mineralized rock / waste rock / tailings material balance over the life of the mine. Approximately 14.5 million tons (13.2 Mt) of copper-enriched rock and 0.77 million tons (0.7 Mt) of waste rock and 12.9 million tons (11.7 tonnes) of tailings will be produced. The overall mine production rate will approximate 1.3 million tons (1.2 million tonnes) per year during the peak years of active mining, with about three quarters of that yield from the upper copper zone of the Johnny Lee deposit (2,760 tons per day; (2,500 tonnes/day) and about one quarter (880 tons per day; 800 tonnes/day) from the lower copper zone of the Johnny Lee deposit. The design production rate of 3,640 tons per day (3,300 tonnes per day) requires approximately 18 active mining stopes (headings) (Table 3-4).

Figure 3.6 also shows that the CTF has been engineered / designed to accommodate all of the life of mine waste rock and 55% of the total tailings (equivalent to 7,117,979 tons or 6,457,324 tonnes). Approximately 45% of the total tailings or 5,828,061 tons (5,283,266 tonnes) generated from the mill will be returned back underground as paste backfill in the mine workings.



Prepared by: Tintina Resources (revised July 2017)

TINTINA RESOURCES

Figure 3.6

Schematic Chart Showing Copper-enriched Rock, Waste Rock, and Tailings Quantities

Mine Operating Permit Application

Meagher County, Montana

Stope lengths in the Johnny Lee upper copper zone average approximately 230 feet (70 m), and in the lower copper zone average approximately 165 feet (50 m). Four crews will mine two headings each to maintain production and minimize the quantity (42,475 m^3) of sulfide-bearing rock exposed to atmospheric oxygen at any one time. A maximum of 1.5M cubic feet of production headings will be open at any given time. The entire mine plan for the two copper zones calls for a total of approximately 118M cubic feet (3,341,388 m^3) of production drifts within the deposit zones. Therefore, only about 1% of the mining stopes will be exposed to atmospheric oxygen and underground weathering conditions for about 60 to 90 days each at any given time in the entire mine life.

Table 3-4. Number of Open Active Mining Headings by Type, at Any One Time.

Heading Type	Upper Copper Zone Number of Headings	Lower Copper Zone Number of Headings
Development	2	2
Production	6	3
Paste Backfill	3	2
Sub-total	11	7
TOTAL	**18**	

In the first two years of underground mining, the mine will produce approximately 453,642 tons (411,537 tonnes) of waste rock. The design capacity of the WRS pad is 551,155 tons (500,000 tonnes). This material will be placed upon the temporary WRS pad. The development plan schedules completion of the Cemented Tailings Facility (CTF) by the end of the second year of construction. At that time a portion of the mine waste rock from the temporary stockpile will be transferred to the CTF. Approximately 52,911 tons (48,000 tonnes) of pre-production waste rock will be crushed and placed on top of the HDPE liner system of the WRS pad and the copper-enriched rock stockpile to form a protective layer (sub-grade bedding layer). The remaining 400,731 tons (363,537 tonnes) of potential pre-production waste rock stored on the temporary WRS pad will subsequently (about two years later, once the CTF HDPE liner is in place) be placed over the protective layer overlying the CTF HDPE liner system to make up the drainage layer of the CTF basin drain system and to help construct the haul ramp access into the CTF. Reclamation of the WRS pad will commence after transfer of all remaining waste rock to the CTF. A smaller 82,600-ton (75,000-tonne) pad will then be constructed off of the northwest corner of the portal pad and will serve as a mill feed resource stockpile pad for the remaining life of the mine. The CTF will receive any future mined waste rock, and this will be covered by and co-deposited with cemented paste backfill. The volume of all waste rock comprises approximately 10% of the total material (waste and tailings) that will be deposited in the tailings impoundment, and almost 70% of material (waste and tailings) that will be placed in the tailings impoundment during the first year of its operation. Table 3-5 presents the projected production schedule for the life of the mine in tons and Table 3-6 in tonnes. Figure 3.6 is a schematic chart showing copper-enriched rock, waste, and tailings quantities over the life of the mine.

Table 3-5. Copper-rich Rock and Waste Rock Mine Production Schedule (in tons)

Year	Copper-enriched Rock Tons	Waste Tons	Total Tons
1	0	103,656	103,656
2	11,429	349,986	361,415
3	433,542	214,560	648,102
4	1,018,607	93,745	1,112,352
5	1,294,347		1,294,347
6	1,276,871		1,276,871
7	1,307,971		1,307,971
8	1,277,480		1,277,480
9	1,311,726	16,863	1,328,589
10	1,298,461		1,298,461
11	1,349,008		1,349,008
12	1,318,149		1,318,149
13	1,297,095		1,297,095
14	1,039,008		1,039,008
15	262,347		262,347
Total (tons)	**14,496,040**	**778,810**	**15,274,850**

NOTES:
(1) The life of mine plan includes both development (pre-production mining) and production mining;
(2) The individual tonnage values (in tons) do not specifically add up to the total based on minor conversion rounding errors.

Table 3-6. Copper-rich Rock and Waste Rock Mine Production Schedule (in tonnes)

Year	Copper-enriched Rock Tonnes	Waste Tonnes	Total Tonnes
1	0	94,035	94,035
2	10,368	317,502	327,870
3	393,303	194,646	587,948
4	924,065	85,044	1,009,109
5	1,174,212		1,174,212
6	1,158,358		1,158,358
7	1,186,572		1,186,572
8	1,158,911		1,158,911
9	1,189,978	15,298	1,205,276
10	1,177,944		1,177,944
11	1,223,800		1,223,800
12	1,195,805		1,195,805
13	1,176,705		1,176,705
14	942,573		942,573
15	237,997		237,997
Total (tonnes)	**13,150,590**	**706,525**	**13,857,115**

NOTE: This table includes development (pre-production) and production mining.

3.2.2.6 Mining Equipment

Rubber tired, diesel-powered equipment (including three 7 cubic yard Load-Haul-Dumps [LHDs] and two 5 cubic yard LHDs) will haul all rock mined from the Johnny Lee copper zones to the main underground haulage ways. From there, six, 44- to 66-ton (40- to 60-tonne) diesel trucks will haul all rock to the surface. This equipment will be fueled and serviced at the repair shop/maintenance facility on surface. This facility will also house offices for engineering, geology, and supervisory personnel. Diesel-powered mobile underground equipment will use low-emission engines that comply with Mine Safety and Health Administration (MSHA) underground air quality regulations. A shop with simple service bays will be constructed underground. Dedicated maintenance and fuel/lube trucks will provide maintenance and fueling underground for all drills, bolters, scissors trucks, an ammonium nitrate / fuel oil (ANFO)- loader, a grader, fork-lifts, LHDs, and other underground-only equipment. Section 3.6.3 discuss the requirements and design of all surface shops, their associated equipment, and their utilization by equipment operators. Section 3.6.5 and 3.3.2 discuss re-handling of rock from the temporary waste rock storage facility and shipping from the concentrator respectively.

Table 3-7 lists the equipment anticipated for use in mine development and production during year 6 of mining (the largest fleet size year) and the utilities required to advance underground mining. Table 3-8 lists mobile equipment to be used on surface in support of underground mining and for activities at other surface facilities.

Table 3-7. Underground Equipment Fleet

Equipment Upper Zone	
2 Boom Jumbo	2
Mechanized Bolter	3
7 yd^3 LHD	2
Scissor Truck	3
44-ton Haul Truck	4
ANFO Loader	1
Total Upper Zone	**15**
Equipment Lower Zone	
2 Boom Jumbo	1
Mechanized Bolter	2
7 yd^3 LHD	1
5 yd^3 LHD	2
Scissor Truck	2
40-tonne Haul Truck	2
ANFO Loader	1
Total Lower Zone	**11**
Shared Upper/Lower Zone Equipment	
Raise Bore, Alimak	1
Forklift	1
Boom Truck	2
Grader	1
Transmixer	2
Shotcrete Sprayer	2
Pressure Grouting Equipment	1
Fuel/Lube Truck	1
Underground Light Truck	4
Maintenance/Elec Trucks	4
Supervisor Vehicles	4
Engineering/Geology	3
Total Shared	**26**
Total Mine Equipment Fleet	**52**

Mining operations will require various types of surface construction equipment. Table 3-8 lists the types and numbers of this equipment. The year-round operational schedule requires snow plowing during the winter. A snowplow/sanding truck assisted by a road grader, dozer, and truck-mounted snow blower (if necessary) will be used.

Table 3-8. Surface Equipment in Support of Underground Mining.

Equipment	Number
Excavator	1
Dozer	1
Grader	1
Loader	3
Haul/Service Trucks	4
Dust Suppression Truck	1
Forklifts	4
Boom Truck -20T	2
Man Lifts	2
Passenger/Crew Van	1
Pickup Trucks	15
Air Compressor (1100 cfs)	1
Vacuum Truck	1
HDPE Fusion Machines	1
Light Plants	4
Fuel & Lube Truck	1
Maintenance Trucks	3
Snowplow/Sander	1
Cranes (90T)	2
Ambulance	1
Fire Truck	1
TOTAL	**60**

3.2.2.7 Operational Underground / Surface Support Mine Workforce and Work Schedule

Underground mining will follow a schedule of two 12-hour shifts per day, seven days per week, and 365 days per year. The personnel required to support and conduct both the surface and underground operation includes a total of 240 Tintina hourly employees and salaried staff. These employees will conduct underground production mining tasks and day-to-day operations. A limited staff will be needed beginning in year 2 of the 15 year construction and production schedule of the proposed mine life. Table 3-9 presents the various positions and number of employees from various internal company support groups, as well as mining and milling personnel. Note that while Table 3-9 includes a total Tintina work force of 243, there will normally be 104 people on-site during day shifts, 41 onsite during night shifts, and the remaining 98 employees will be on days off during the normal operations schedule in years 4 through 15.

Table 3-9. Total Number of Tintina Employees

Total Employees		On-site per Shift		Off-site
Department	**Employees**	**Dayshift**	**Nightshift**	**On Days Off**
General and Administration	22	18	2	2
Maintenance and Surface	48	20	6	22
Mill	51	20	10	21
Mine	122	46	23	53
Total	**243**	**104**	**41**	**98**

3.2.2.8 Other Major Components of Underground Mining

Other major components or elements of underground mining include the following.

Ground Control: The underground workings will be rock bolted to provide basic ground support and shotcrete, steel mats, and wire screen mesh will be used as necessary to assist with support in areas with more intense fracturing or poor ground conditions.

Underground Mine Power Supply: The maximum estimated operating electrical load for mining and milling of the Johnny Lee deposit is approximately 9 to 12 MVA (Mega Volt Ampere, a measure of the amount of power estimated for project needs). Site substations located on the mill pad will carry power to an underground substation located in an excavation off the lower extent of the decline (approximately 3,250 feet (1 km) from the portal). Back-up generators will provide power to essential equipment during power outages. These diesel generators will be located near the mill building, and consist of two one-megawatt generators.

Grouting and Groundwater Inflow Control: Pilot holes drilled ahead of the advancing mined face will test for likely water inflow rates in the vicinity of anticipated water-bearing geologic structures. Large amounts of water encountered in a pilot hole will require installation of a packer to seal the hole followed by directional grouting prior to advancing the decline. Pressure grouting will be the primary means of minimizing and controlling the amount of water flowing from water-bearing faults and/or fractures into the mine workings. It involves injecting a grout material into fractured rock. The grout is a cement-based or a solution-based chemical mixture. It could extend under pressure into the wall rock as much as 100 feet (30.4 m) depending on fracturing. Grouting can both strengthen rock and reduce water flow through rock, and is a widely accepted standard practice in the mining industry. Grout and shotcrete will be mixed in a small portable batch plant near underground locations where underground grouting or shotcrete is needed. Should a temporary shotcrete plant be needed it would likely be during the underground development stage of mining and would be located near the temporary cement mix batch plant at the west end of the construction laydown area, west of the Mill facility (Figure 3.9).

The initial mine access decline will pass approximately 90 feet (27.4 m) below the Coon Creek tributary of Sheep Creek, approximately 2,312 feet (705 m) map distance in from the portal (Figure 1.3). This is the closest proximity of the decline to the surface once beyond the portal. Shallow bedrock at test well PW-3 (located along the decline trend adjacent to Coon Creek (Figure 2.3), encountered minimal groundwater in its upper 75 feet (23 m), suggesting that dewatering of the deeper decline will have minimal impact on Coon Creek flow. Pumping tests of PW-3 and PW-4 showed no impacts to Coon Creek, or in piezometers installed in associated wetlands (Figure 2.3). Water producing fracture zones encountered at the decline level in the area underlying Coon Creek will be subject to inflow control measures (i.e., grouting). The objective will be to eliminate all significant fracture-controlled inflow to the decline within a distance of approximately 200 feet (61 m) on either side of the creek.

Blasting Agents: If mining encounters no substantial groundwater inflow to the workings (as indicated by inflow modeling), ammonium nitrate / fuel oil (ANFO) will be the primary blasting agent. Miners will load blast holes with ANFO from an explosives truck. To minimize the effects of nitrate and ammonia explosive residues on water quality, blasters will make a concerted effort to limit the use of blasting agents to only those necessary for rock breakage, and to minimize spillage. Exceptional "good housekeeping" efforts can significantly reduce on-going water treatment costs. If wet conditions are encountered, miners will use an emulsion-based powder or other less water-soluble explosives. Emulsion-based powder is available in both stick form and pumpable forms, and many mines use this to control the release of nitrogen by-products produced by explosive residues. In addition to minimizing nitrogen input at the source, Tintina will remove nitrogen to below non-degradation standard with the water treatment system.

During the drive of the main decline Tintina will monitor ground vibration or shaking when the underground workings are within 300 feet (90 m) of any landowners' structure. Tintina mining engineers will coordinate with its explosives supplier to develop a plan to ensure ground vibrations are at safe levels for public structures, which could include modifying blasting practices.

Presently the only structures proximal to the trace of the main decline are those on the Hanson Bar-Z ranch property located west of the intersection of Butte Creek Road with Sheep Creek Road. The structures currently in place include a ranch house, bunk house, an A-framed cabin, and five out buildings (see Figure 3.2). Only the bunk-house and one outbuilding of the existing eight structures fall within a 300 foot radius of the decline, which occurs at a depth of about 140 feet below the surface and about 225 lineal feet to the west of the nearest building. However, Tintina mining engineers have committed to working with the explosives supply company and the landowner to ensure that ground vibrations or shaking is monitored, and controlled appropriately to safe levels for all of these ranch structures. It is in this area that Tintina will monitor for ground vibrations or shaking during the main decline drive.

Powder Magazines: A temporary powder magazine will initially be located on surface (Figure 1.3). It will subsequently be moved underground (Figure 1.3) to a safe working distance from the portal after the decline advances a sufficient distance. Development mining will establish appropriate sites for powder magazines further underground as the decline and development workings advance towards the resource areas. Explosive storage magazines and practices will comply with all MSHA rules and regulations. A forklift will deliver explosive filled totes from surface to underground storage areas. Tintina will educate and train employees and subcontractors on nitrogen by-product issues, proper housekeeping, spill cleanup, and explosives management practices to minimize the potential release of nitrogen by-product to waste rock and mine water.

Underground Sumps: Underground settling ponds (sumps) initially constructed approximately 500 feet (152 m) from the portal will service the mine prior to intersection of the regional groundwater table. Pumping will lift accumulated water from deeper mine sumps to these pond(s) where booms will skim any oil and fuel residue from the water. In addition, sufficient retention time in these sumps, with or without the use of flocculants, will allow partial removal of suspended sediment from underground mine waters prior to pumping to the WTP clarifiers located in the mill.

Additional underground settling ponds (sumps) locations include one at the bottom of the upper copper zone, one midway through the lower copper zone, and one at the bottom of the lower copper zone. All will be connected in series. Smaller sumps and pumps will transfer water from any additional low areas in the mine to the main dewatering piping. Accumulated mine water will gravity feed from one sump to another typically via a pipe or ditch (less frequently using a borehole) before final pumping from the lowest elevation sumps to the near-surface sumps.

3.3 Mineral Production

3.3.1 Processing Method

The mill design is based upon industry standard processing methods that will separate and concentrate the copper minerals. Both a copper concentrate and a tailings or waste stream will be produced from the milling process. The tailings will be managed on site by storing a portion underground as cemented backfill to provide ground stability, and the remainder as cemented paste tailings in a tailings storage facility(i.e., the CTF).

The approximate copper production tonnages contained in the Project's Johnny Lee mineral deposit come from both an Upper Copper Zone and a Lower Copper Zone. These tonnages are summarized in Table 3-10**.**

Table 3-10. Summary of Proposed Production Tonnage

Metric tonnes	US Customary Tons	Copper Content Cu - %
13,150,590	14,496,040	3.04

A "flotation" process will liberate fine-grained copper minerals from the bulk of the mined rock to form the copper concentrate. The water-based flotation processes rely upon the chemical interaction between fine-grained mineral particles and hydrocarbon-based reagents to separate specific minerals into concentrates. Copper minerals adhere to bubbles formed during agitation of the slurry of water and finely ground rock in a flotation cell, and the bubbles carry the copper minerals to the fluid surface, forming a copper mineral-rich surface froth. Skimming the froth effectively separates the copper minerals away from the slurry, and the skimmed froth routes to a thickening and filtering circuit to remove the water.

Figure 3.7 is a photograph of copper flotation concentrate produced in a laboratory-scale flotation cell using Black Butte Copper Project materials. The copper minerals concentrate in the froth formed on the fluid surface of the flotation cell. This separation forms the basis of the flotation process. This fine-grained high-grade concentrate is suitable for sale in the world market.

Figure 3.7. Photograph of Copper Concentrate Bench Scale Flotation Cell

The flotation process uses suspension of finely ground rock in water, typically at water to solids weight ratios of about 2:1. Mixing and agitating this slurry in flotation cells maintains suspension of the solids in the mixture. During flotation the slurried solids pass through a number of cleaning stages that are required to optimize recovery of copper minerals into a final saleable concentrate. Multiple stages of flotation require sizing of flotation cells depending upon their role in the various stages of cleaning. The Project process plant flotation cells will range from 65 cubic yards (50 m^3) in size to approximately 6.5 cubic yards (5 m^3), depending upon which stage of the process the cell is employed.

The flotation process requires addition of trace amounts of reagents (measured in ounces per ton or grams per tonne, to alter the surface chemistry of copper minerals, and allow the copper minerals to 'float' to the surface froth of the flotation cell. The ability to attach a mineral particle to an air bubble forms the basis of the mineral separation used to produce a copper concentrate. Oils or hydrocarbons form the basis of copper flotation reagents, and typically work best if added to the water and rock slurry at rates of 0.7 to 3.5 ounces per ton (20 to 100 grams per tonne (g/t)) of solids being processed. A typical copper flotation process uses lime to maintain a high pH which significantly improves the effectiveness of the separation of copper minerals from the slurry.

The operation will dispose of solids that do not report to the copper concentrate (i.e., tailings) back to the underground mine workings as cemented backfill in mined out stopes, or as cemented paste tailings to the CTF.

Copper concentrates produced from the Project will contain approximately 20 to 28% copper, depending upon the mineralized zone producing the concentrate. These concentrates will represent 10 to 15% of the total mass of the mined material. Table 3-11 shows a typical metallurgical balance for the lower copper zone resource based upon recent metallurgical test work.

Table 3-11. Metallurgical Balance for Lower Zone Copper Concentrate Production

Process Stream	Percentage of Mass %	Copper Content %
Flotation Feed	100	4.59
Flotation Concentrate	13.9	30.8
Flotation tailings	86.1	0.36

The flotation milling facility is designed to process up to 3,640 tons of copper-enriched rock per day (3,300 tonnes/day) during two 12-hour shifts. It will operate 365 days per year. This results in a calculated annual process rate of 1,327,734 tons/year (1,204,500 tonnes/year).

Figure 3.8 is a flow sheet showing the major components of the mineral processing required to produce the copper concentrate from the Project resource. The following sections provide more comprehensive descriptions of the mill facility, milling and flotation process, and the equipment, ancillary facilities, and reagents required.

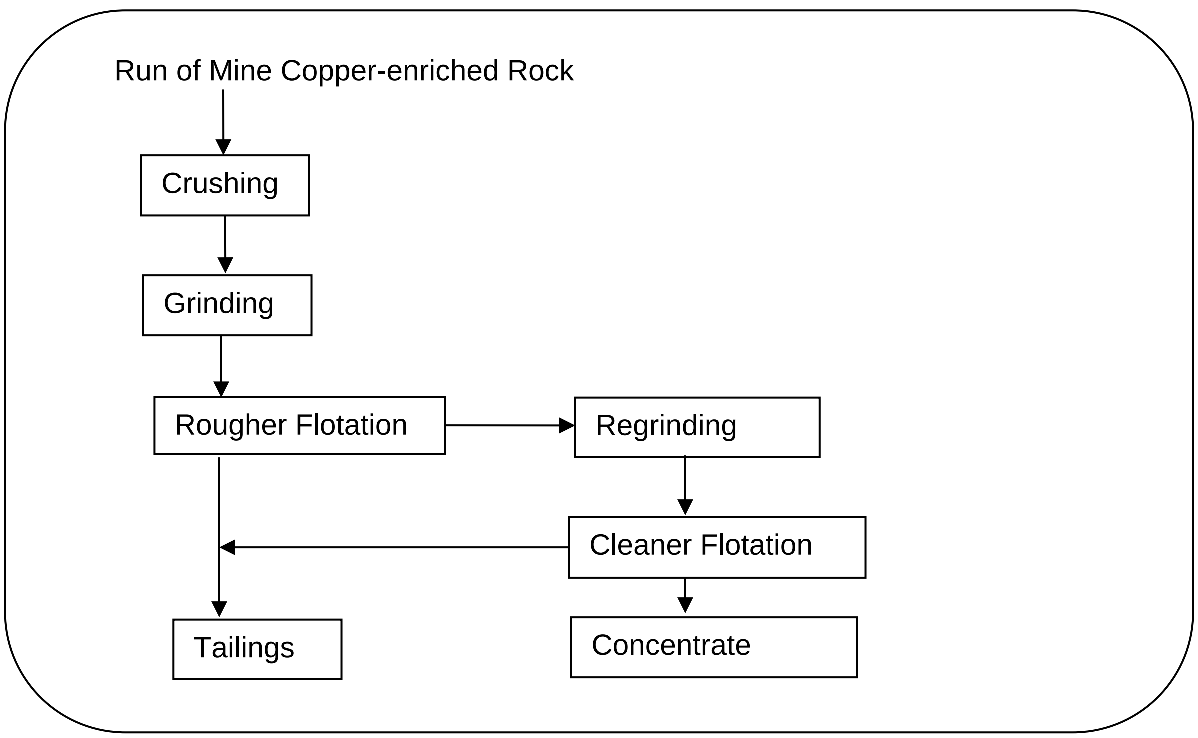


Figure 3.8. Simplified Process Flowsheet Showing Key Unit Operations

3.3.2 Processing Facility

3.3.2.1 Mill Facility Footprint

Figure 3.9 illustrates the major structural features and components of the mill facility. The facility will require a footprint of approximately 9.8 acres (4.0 ha) which will include about 1.7 acres (0.7 ha) for a mill laydown area east of the mill facility, and an additional 3.9 acres (1.58 ha) for a construction laydown area (Figure 3.9) at the west end of the mill facility area. The ground at this higher elevation provides a sound bedrock foundation upon which to build. The depth to the groundwater table in this area is approximately 34 feet (10 m) below the mill pad elevation based on Figure 1.3, Figure 2.8, and Figure 3.21 and monitoring well number SC15-198, which lies inside the mill pad footprint.

Facility preparation will include removing topsoil and subsoil where necessary and transporting it to storage areas. The facility area will have sheet-flow drainage to its outside edges, where storm water will drain into perimeter ditches. During the construction stage and prior to any milling, any storm water that falls on this area will be treated as non-contact water. Ditches and piping will redirect storm water to infiltration basins associated with natural drainage systems. Surface water management will use BMPs to mitigate sediment and run-off controls. As construction on the mill area facilities advances, and when the CWP and water treatment system reach completion, and during the entire mining operations period, operations will treat any water from the mill pad as contact water. This water will be routed in perimeter ditches which convey it to the CWP for pumping to the water treatment system. The contact water ditches and culverts will convey the 200 year 24-hour rain event on top of the 200-year snow melt peak flow event without overtopping. A HDPE geomembrane will line the contact water ditches.

The mill pad will contain an internal network of roads and a surface parking area sized for approximately 100 vehicles. The areas within the mill facility footprint adjacent to concrete foundations of buildings and other structures will have a gravel surface. During operations, the mill pad, surface area drainage will collect in drain ditches and perimeter ditches which direct it into the CWP.

Employee vehicles and all supply deliveries including fuel, and lubricants, cement, slag, replacement parts and trucks with ore concentrate (in sealed containers), access the mine / mill site along the main access road and all pick-up and delivery traffic accesses the mill site along the south side of the mill pad as shown on Figure 3.9. Clean, over-the-road ore concentrate trucks will pick up concentrate in sealed containers from the construction laydown area located on the west end of the mill pad, using the access road along the south side of the mill pad. Employee parking is located south and east of the mill. These designated parking areas and access routes are designed to separate clean on-road traffic (confined to south, southeast and west ends of the mill) from potential PAG contaminated haul routes located north of the mill. Therefore any possible tracking of PAG materials into clean traffic areas is eliminated. Drainage from the access road will route this non-contact water to nearby sediment traps and into storm water infiltration basins.

3.3.2.2 Mill Building

The pre-engineered steel-sided process plant (or mill building) will measure approximately 275 feet (84 m) long by 120 feet (36 m) wide by 66 feet (20 m) high. It will be taller and larger than any other building in the mill area (Figure 3.9). A dust collection system will capture fugitive dust from various areas inside the process plant, but for the most part, the treatment system is a wet process and requires little dust collection. The building will have insulation for heat retention and noise dampening. The mill and mill area will contain areas for the following processes, described in greater detail in Sections 3.3.2.3 through 3.3.2.6:

- Grinding
- Flotation
- Regrinding
- Concentrate dewatering and handling

- Reagent handling
- Paste backfill (separate building to east of mill building)
- Tailings thickening (adjacent to the paste plant and mill building)

The mill building will contain the assay and metallurgical laboratories which will have all the laboratory equipment necessary for metallurgical grade testing and control. The laboratories will have all appropriate heating, ventilation, and chemical disposal equipment as needed. Reinforcement of the facility floor will accommodate specialized equipment.

3.3.2.3 Crushing and Grinding

The crushing and grinding stages of the milling process liberates copper minerals to allow for their effective separation during the flotation process, which forms the copper concentrates. Typically a number of stages of size reduction optimize the energy inputs to efficiently liberate the copper minerals.

Resource material trucked from the underground mining operations will be dumped directly onto stationary and vibrating grizzlies (screen) with steel gratings that allow the smaller material to bypass the jaw crusher. Rock captured by the grizzlies proceeds into the jaw crusher which will reduce the largest size of rock contained in the discharge from the jaw crusher to approximately 5 inches (12.7 cm) (Figure 3.9 and Figure 3.10). Alternatively, rock can be placed onto the 82,600 ton (75,000 tonne) surface stockpile for later crushing and milling. From the jaw crusher, a conveyor will move the crushed material to a surge bin (Figure 3.9 and Figure 3.10) in preparation for further size reduction in the grinding mills. The surge bin will have a capacity of approximately 2,755 tons (2,500 tonnes). A dust control system (including a dust collector) will control fugitive dust emissions from the crushing operation. Sound-insulating material and baffles will control noise, as well as enclosing the crushing and grinding facilities inside of a largely closed building.

Crushed material will be conveyed to the grinding circuit from the surge bin (Figure 3.9 and Figure 3.10). Effective liberation of copper minerals from the host rock requires grinding to the point where 80% measures smaller than 30 microns in diameter (<0.001 inches). The grinding plant will employ three stages of grinding, which crush and grind copper-enriched rock sequentially to complete the grinding process (Figure 3.10). The first stage of grinding is semi-autogenous grinding (SAG), followed by ball mill grinding, and finally stirred milling in a tower mill. Each of the mills will operate with a cyclone classification circuit to manage particle sizes of the ground material between mills, and ultimately to control the particle size sent to the flotation process.

Process water added at the SAG mill and at other points within the processing plant will maintain slurry densities of approximately 65% to 75% solids, consistent with the requirements of the grinding and flotation processes. Steel balls will be added as necessary to the SAG and ball mills to maintain optimum grinding efficiency, and will serve as the grinding media in the grinding circuit. The equipment location inside a sound and temperature insulated steel (mill) building will reduce noise from the grinding circuit.

3.3.2.4 Flotation Circuits

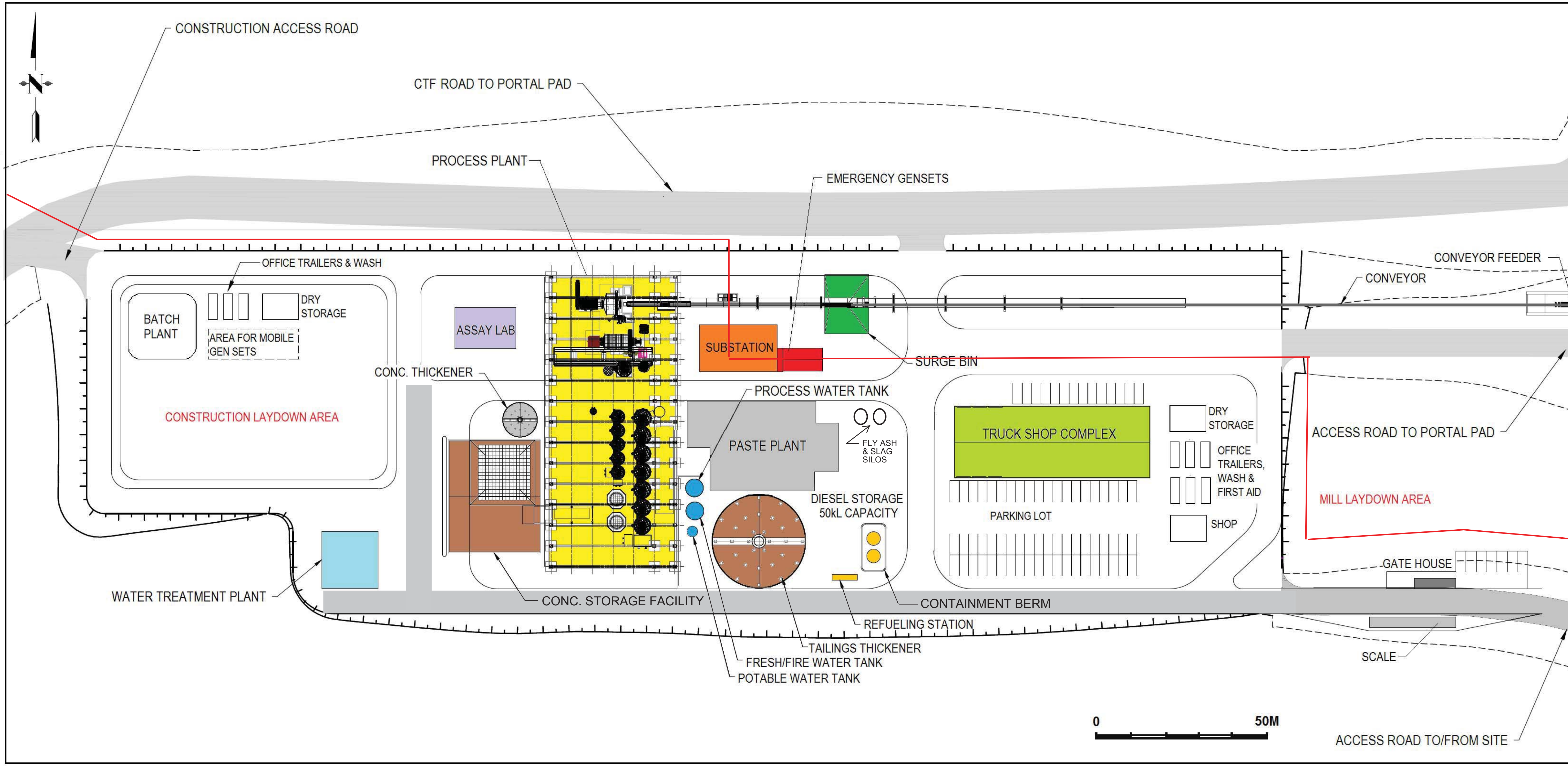
The Project will use a flotation process (Figure 3.10) to recover and upgrade copper values in order to produce a saleable copper concentrate. Material from the grinding circuit will be very fine (less than 0.001 inches, <30 microns).

Ground material from the crushing and grinding circuit will flow by gravity into the rougher flotation circuit comprised of 65 cubic yard (50 m^3) flotation cells. Copper will be recovered in a froth, and transferred to subsequent upgrading stages within the processing plant. The tailings will be sent to a paste plant thickener where it will be dewatered and cement will be added, and then to either the CTF, or underground, as cemented backfill. Liquid residue will be pumped to the PWP.

Concentrate from the first cleaner flotation circuit will be routed to two stirred mills to be reground) before being sent to the second cleaner flotation stage. The final cleaner concentrate produced by the third and fourth cleaner circuit will be sent to a thickener for dewatering. Liquid residue will be sent back to the milling circuit.

The reagents proposed for use in this process are common for copper flotation. They include sodium isopropyl xanthate (SIPX) and Aerophine 3418A as copper mineral collectors and methyl isobutyl carbinol (MIBC) as a frothing agent. The pH will be managed by the use of lime, added at various points in the process, with the flotation pH typically in the range of 10 to 11.5 s.u. This reagent list may be modified operationally to optimize copper recovery.

Tailings from the rougher circuit and the first and second cleaner circuits will be sent directly to a tailings thickener (Figure 3.10). Tailings from the third and fourth cleaner circuits will be recycled through the preceding cleaner circuit, before being routed to the tailings thickener. Water and flotation solutions separated during the thickening process will be stored in the PWP and recycled for use in the mill in future flotation operations.



Prepared by Tetra Tech Inc. 2016

Proposed Powerline

CONC. = Concentrate

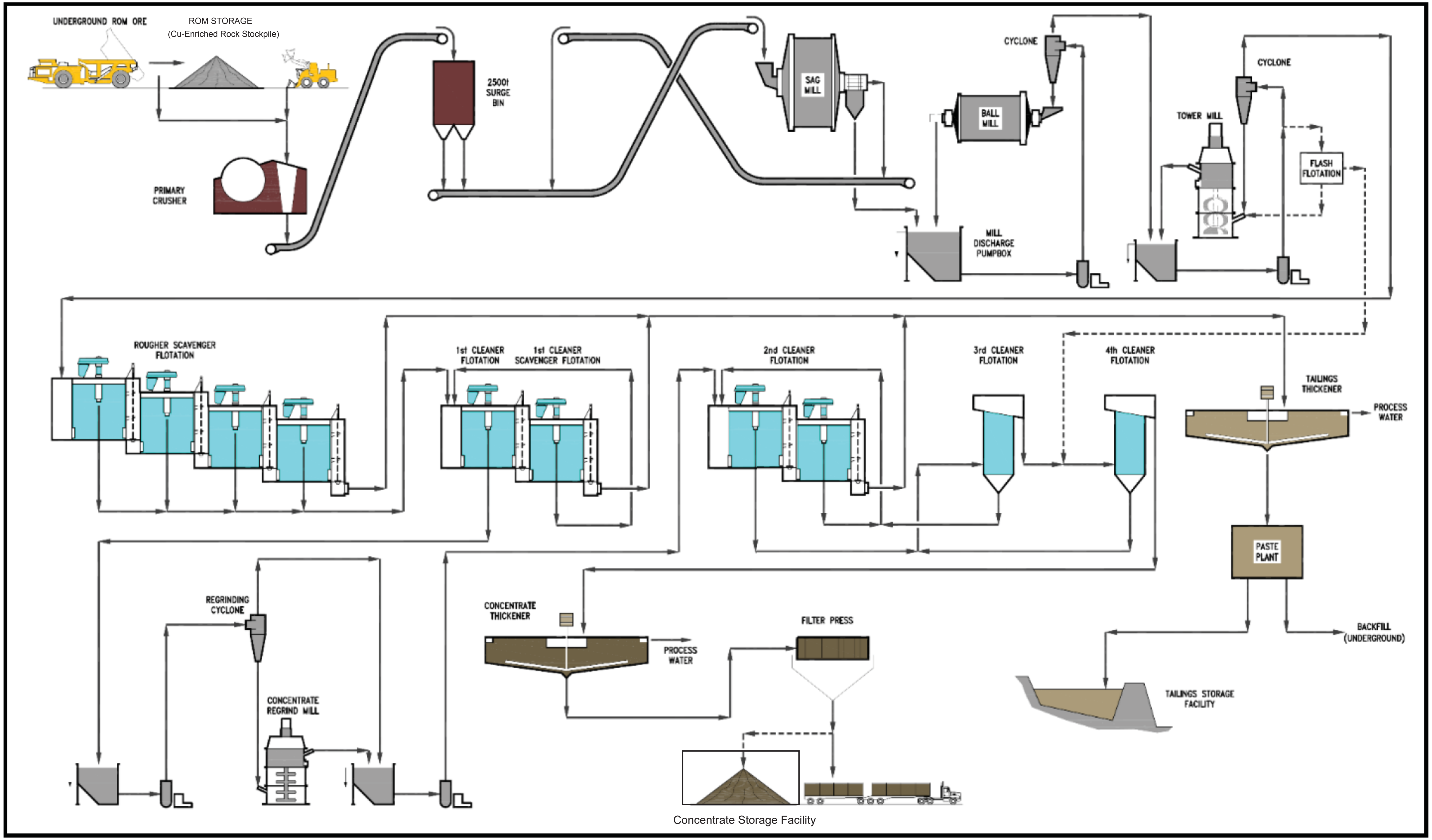
TINTINA RESOURCES

Figure 3.9

Plan Map Showing Mill Facilities

Black Butte Copper Project

Meagher County, Montana



Revised February 7, 2017 (Tetra Tech)

TINTINA RESOURCES

Figure 3.10
Detailed Process Flow Sheet
Black Butte Copper Project
Meagher County, Montana

3.3.2.5 Copper Concentrate Dewatering and Handling

The final copper cleaner flotation concentrate will be thickened in a high-rate thickener (Figure 3.10) where a flocculent (a chemical that causes colloids to form, and other suspended particles in liquids to aggregate, forming a floc) will be added to improve the settling rate of the copper concentrate. Additional dewatering by a pressure filter will reduce the moisture content to approximately 10%. The dewatered copper concentrate will be conveyed and stored in the covered and enclosed concentrate storage facility (Figure 3.9) prior to being loaded into sealed concentrate shipping containers. The containers will be sealed and mechanically locked. The sealed containers will be transported by truck to a nearby railhead in Montana, and then by rail and / or possibly by ship to a smelter. The sealed containers eliminate dust issues during concentrate transport and also eliminate multiple stages of handling normally associated with concentrate shipping. In addition, the containers are strong and rugged enough that they are unlikely to release concentrate during shipping accidents or mishandling. The concentrate will be packaged and transported in full compliance with all applicable Federal and State regulations. The concentrate handling area will be equipped with a dust collection and control system. Tailings Dewatering and Paste Handling Methods

Tailings from the milling process will be dewatered using a separate high-rate thickener and flocculent to initially achieve a solids density of 60%. The tailings will be further dewatered to 70-85% solids using a pressure filter. Thickened tailings will be sent to a paste plant (Figure 3.9 and Figure 3.10) where cement, slag and / or fly ash may be added as binders. Then the cemented paste tailings will either be used for structural backfill in the underground workings or placed in the CTF. The paste tested to date is fully described in Appendix K-5 and in Section 3.5.9 and contains binder that is a 50 / 50% blend of Lafarge grade *100 NewCem* (slag) from Asia and Lafarge Portland type I/II cement (from Missoula, MT). Therefore, the mix with 2% binder has 1% slag plus 1% cement and the mix with 4% total binder has 2% slag plus 2% cement. However, Tintina may seek to optimize performance of the cement and binder additions over time operationally. Other binders and different ratios of binders may be used. Binder content is used to provide strength characteristics in underground applications and to provide a mass with non-flowable characteristics in the surface CTF. Chemical constituents of the materials used remain locked in the rock mass in underground stopes or within a HDPE lined facility and the seepage from both facilities is treated.

RO brine can be added to the tailings thickener as means of brine disposal. This will control the brine addition prior to entering the paste thickener. The effect on concrete properties from high concentrations of chloride, sulfate, and other deleterious ions in the brine would be expected to be minor and will have no effect on the final strength or structure of the cemented tailings. However, the preferred method for brine disposition will be returning it to the PWP for reuse in the mill with ultimate salt disposal with the cemented paste either underground or in the CTF. Experimental laboratory testing of Black Butte Copper tailings material evaluated a range of percent solids in the tailings (approximately 79 to 80% is optimum for the Project tailings), and varying ratios of cement, fly ash, and slag. A pumpable tailings mix, with optimum flow conditions and the best setting properties for both the underground and surface tailings mixes was developed. Paste tailings deposited in the CTF will have a total binder content of 0.5 to 2%, whereas cemented paste used as structural backfill underground will have a binder content of approximately 4% in order to provide the necessary additional strength to stand up as walls in the underground workings. Binder of fly ash and slag are available that meet the chemical requirements of ASTM standards for use in cement (i.e., ASTM C618 for a fly ash for use in concrete). Figure 3.11 and Figure 3.12 show the effects of the addition of binder and cement on the slump testing of tailings (flow/strength characteristics), conducted immediately after mixing and pouring into molds) using 79.5% solids in cylinder with no binder in the example in Figure 3.11, and 2% binder in the example Figure 3.12.

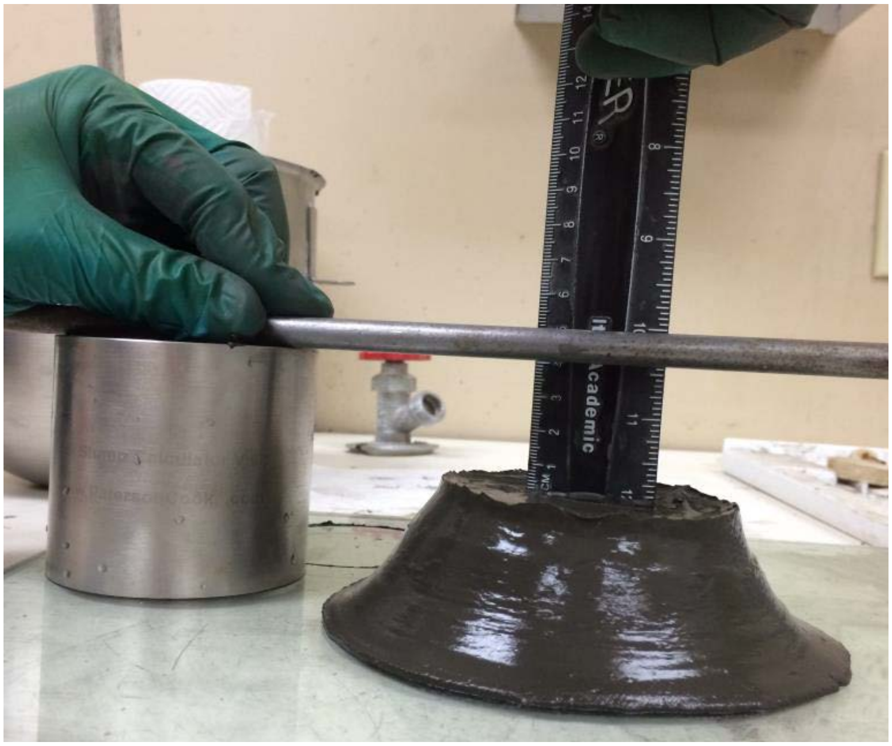


Figure 3.11. Actual Tailings with 79.5% Solids and No Binder
This cylinder of wet tailings has collapsed and flattened with a slump of 1.4 inches (38 mm).

Figure 3.12. Actual Tailings with 79.5% Solids and 2% Binder
This cylinder of wet tailings remains largely intact (little slumping) with a slump of 0.55 inches (14 mm).

The cement and fly ash will be shipped to the Project by self-unloading bulk truck trailers, and uploaded into separate silos located in the mill area (Figure 3.9) by the truck's pneumatic unload system. The silos will be equipped with a dust collecting system to control dust emission.

3.3.2.6 Reagent Use, Handling and Storage

Reagents used for the copper-enriched rock milling process will include hydrated lime as a pH modifier, sodium isopropyl xanthate (SIPX) and Areophine 3418A as copper collectors, and methyl isobutyl carbinol (MIBC) as a frothing agent. Chemicals used may be varied during the optimization process. The collectors will be added to the flotation process slurry streams to modify the chemical and physical characteristics of mineral particle surfaces, and to enhance the floatability of copper minerals. Flocculent will be used as a settling aid during concentrate and tailings thickening. Anti-scalant will be added as required to protect pipelines and process equipment from caking and mineral precipitates.

Table 3-12 summarizes the estimated chemical and reagent usage at the mill. Although many of these chemicals would be removed via precipitation, sorption, or other mechanisms during processing at the mill, some residues could enter the water treatment system or the tailings stream as defined below. The RO system is capable of removing both inorganic and organic constituents; however, hydraulic fluids and fuel must be removed by skimming and adsorption prior to entering the RO circuit as they can clog the RO filters.

Table 3-12. Estimated Milling Reagent Consumption

Reagent	Daily Consumption, tons / day	Annual Consumption, tons / year
Hydrated Lime	11.1	3,758
Sodium Isopropyl Xanthate (SIPX)	0.61	209
Aerophine 3418A	0.13	44
Methyl Isobutyl Carbinol (MIBC)	0.19	66
Flocculent	0.22	77
Anti-Scalant	0.06	22

The major reagents that are anticipated to be used at the mill include those discussed below.

Hydrated Lime ($Ca(OH)_2$) will be used within the mill to help control pH of process solutions at the estimated rate of 11.1 tons per day (1,500 to 2,500 grams per tonne of processed mill feed). Hydrated lime will be residual in the tailings solutions and will report to the tailings stream and maintain the tailings solutions to a pH of 7.0 to 9.0. Additional lime will also be released by the tailings backfill plant into the tailings, as hydrated lime is a significant component of the cement. The cement binder used to make the cemented tailings paste also contains hydrated lime. Quick lime (CaO) is expected to be shipped to the mine site by self-unloading bulk truck trailers. The lime will also be uploaded into a silo by a pneumatic unloading system. The silo will be equipped with a dust collecting system to control dust emission. The quick lime will be slaked (mixed with water) to generate a 15% hydrated lime slurry by weight. The lime slurry will be stored in a holding tank and distributed to various addition points through a closed pressure loop.

Sodium Isopropyl Xanthate (SIPX) is a copper mineral collector used in the flotation of copper minerals and will be used at an approximate rate of 0.61 tons per day (40 to 80 grams per tonne of processed mill feed). SIPX tends to attach to copper minerals and is expected to be concentrated within the copper concentrate that is shipped off site. Some residual SIPX will be present in the tailings solutions, but it is estimated that 99.9% of the added SIPX will be attached to copper minerals or other mineral surfaces. This brings estimates of concentrations of SIPX in tailings solutions into the range of 0.02 mg/L to 0.04 mg/L. SPIX is expected to be shipped to the mine site in solid form in steel drums. A 20% by weight solution will be prepared by dissolving the SIPX with fresh water in a mixing tank prior to storage in a 5-foot (1.50 m) diameter by 5-foot (1.50 m) high holding tank. The solution will be added to the various addition points by metering pumps.

Aerophine 3418A is a copper mineral collector used in the flotation of copper minerals and will be used at an approximate rate of 0.13 tons per day (25 to 50 grams per tonne of processed mill feed). Similar to SIPX, Aerophine 3418A reports to the copper concentrate at very high recovery rates. Residual levels of this reagent are estimated at approximately 0.0125 mg/L to 0.025 mg/L in the tailings solutions.

Methyl Isobutyl Carbinol (MIBC) is a frothing agent used in the flotation process and residual levels will be observed in the tailings solutions. This reagent is an alcohol and is very easily lost to the atmosphere via evaporation or volatilization. It is added to the process at approximately 10 to 30 grams per tonne of processed mill feed and it is expected to be difficult to detect in tailings solutions. Aerophine 3418A and MIBC are expected to be shipped to the plant as liquids in reusable containers of approximately 500 gallon (2,000 liter) capacity. These reagents will be pumped to selected points of addition in the process circuit in undiluted form using metering pumps.

Flocculants are used at an estimated rate of 0.22 tons per day (50 to 70 grams per tonne of processed mill feed) as a settling aid during concentrate and tailings thickening and will be attached to mineral surfaces. Flocculants will be residual in tailings solutions, but are expected to be at very low concentrations and likely below 0.001 mg/L. Flocculants will be prepared in a mixing system to a dilute solution of approximately 0.2%. The solution will be stored in a holding tank prior to being pumped by metering pumps to the thickener feed points.

Anti-scalant will be added to protect pipelines and process equipment from caking and mineral precipitates and will be used at an estimated rate of 0.06 tons per day. Some anti-scalant will remain in the aqueous phase in the tailings but only in very minor quantities since very little of this chemical is used on a daily basis. Anti-scalant will be delivered in undiluted liquid form and added to the process water tank.

A mixing, holding and dosing system will be provided to occasionally test any new reagents that may improve the metallurgical performance and enhance metal recovery.

The reagent preparation and storage facility will be located within a containment area designed to accommodate 110% of the volume of all tanks. This will ensure containment in the event of an accidental spill. The storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during normal operation. Appropriate ventilation, fire protection, fire and mixing safety protection and Safety Data Sheet (SDS) stations will be provided in the area. These reagents will be handled in accordance with SDS requirements and any unused test reagents will be returned to the suppliers for disposal.

The typical decant water chemistry of the tailings filter cake (prior to paste mixing) is reported in Appendix K-5 (K5-B). This water is recycled for future use in the mill and stored in either the PWP or the process water tank in the mill. Any water from the PWP needed to offset consumptive use will be treated in the RO water treatment plant prior to discharge to the underground infiltration galleries.

3.3.2.7 Air Supply System

Two separate air supply systems will service the process plant. Low-pressure air for the flotation cells will be supplied by air blowers. High-pressure air for the overall process plant will be supplied by plant air compressors.

Instrumentation service air will be provided by plant air compressors. Compressed air will be dried and stored in air receivers for distribution to various instruments. Filtration air will also be provided from plant air compressors.

3.3.3 Mill Support Facilities

3.3.3.1 Truck Shop and Administration Building

The mill area will accommodate a number of support facilities within its footprint. These include: a truck shop/administration building; process, potable, and fresh/firewater tanks; a concentrate building; a WTP; a bermed fuel storage and fuelling station area; a substation with emergency back-up generators; a staff parking area and a construction laydown area. A gate house and scale will be constructed on the access road at the southeast corner of the mill pad. A second scale will be constructed in the concentrate building.

The truck shop complex will consist of a 130 feet (40 m) long by 65 feet (20 m) wide pre-engineered steel frame and steel sided building. It is designed to accommodate facilities for repair and maintenance of heavy surface and underground mine equipment and other light vehicles. The facility will also contain warehouse storage space for spare parts and consumables; an emergency vehicle storage area with a first aid station; designated training areas, and offices for the site supervisors, mine engineers, and General and Administrative (G&A) staff. Mine dry (change) facilities will also be provided in this complex.

The truck shop/administration complex will be located east of the process facilities. The service bays inside the truck shop area will consist of:

- Four heavy vehicle repair bays
- One light vehicle service and welding bay, and
- Emergency vehicle bay.

The heavy vehicle repair bays will be designated for service and repair of major equipment. These will include automatic hose reels for dispensing engine oil, transmission fluid, hydraulic oil, air, solvent, diluted coolant, and grease. Hose reels will be supplied by delivery pumps located in the lubrication storage tanks. Waste lubricant recovery systems will pump used oil and coolant to holding tanks located at the lubrication storage building for recycling.

One bay will be used for servicing and maintaining light vehicles. All small equipment required for wheel alignment, balancing and tire repair, automotive testing, and diagnostic purposes will be available in this bay. The light vehicle bay will also be used for welding work. Ventilation fans and flash shields will be provided for personal protection.

A medical/first aid station, ambulance, fire truck, and spill response truck/equipment will be located in a dedicated bay area in the truck shop. Patients requiring evacuation will be transferred to the local hospital in White Sulphur Springs, MT.

3.3.3.2 Fuel Storage and Dispensing

The fuel storage and fueling area will be 100 feet (30 m) long by 50 feet (15 m) wide and located immediately southwest of the staff parking lot in the mill area. A one-week supply of diesel fuel will be kept on site. Freight trucks will transport diesel fuel to the mine. Fuel will be pumped from the trucks into above-ground fuel storage tanks (ASTs). Two 13,000 gallon (approximately 50,000 L) double-walled fuel ASTs will be erected during the construction stage. The fuel tank farm spill containment area will be lined with HDPE liners and protected by safety berms placed along the perimeter. The spill containment capacity will be no less than 110% of the total tank storage. Fueling areas will be on pads adjacent to the fuel storage areas, and a fueling station will be housed in a modular container with automatic shut-off mechanisms to prevent over-fueling and spillage. Manual fire suppressant equipment will be installed at the fueling station.

3.3.3.3 Lube and Oil Storage and Dispensing

The lube and oil storage area will consist of refurbished cargo containers with a gross floor area of 120 square yards (100 m^2). It will be located approximately 40 feet (12 m) from the truck shop. This distance allows fire safety separation between the truck shop and the lube and oil storage area. The lubricant storage facility will house tanks with a two-week supply of lubricants and coolants. Waste oil from the mining and plant support equipment fleet will also be stored in this area. A separate HDPE-lined and bermed exterior storage facility will be provided for waste oil and spent coolants prior to being picked up by a third-party contractor for recycling or disposal. The lubricant storage building will be furnished with loading / unloading arms and pumps. This storage facility will also contain air-operated transfer pumps for supplying lubricants to the dispensing reels located in the truck shop service bays.

3.3.3.4 Construction Laydown Area and Container Storage

A 3.9 acre (1.58 ha) construction laydown area will be provided on the west end of the mill facility. A temporary construction concrete batch plant will be located on the northwest corner of this pad. Sealed concentrate containers may be stored on this pad while awaiting shipment during operations. Spare parts and materials that do not require protection from the elements will also be stored in the laydown area.

3.3.3.5 Water Supply, Storage, and Treatment Locations

Three separate water supply systems consisting of a process water supply, fresh water supply, and potable water supply will be used to meet the water supply needs of the Project. Supply tanks containing these different types of water are located on the east side of the mill building as illustrated on Figure 3.9. Recycled water from the PWP to the process water tank will be the primary water source for the milling operation. Make-up water will be provided directly by dewatering of the mine, or from the WTP. Fresh water (for the fresh / fire water tank) will be obtained from the WTP, and will be used for other milling purposes. Potable water (from the potable water tank) will be derived from a public water supply (PWS) well at or adjacent to Pumping Well 6 (PW-6, Figure 1.3). It will be treated as necessary and supplied for human consumption at various locations throughout the mine site. It could also be used for pump gland lubrication in the mill.

The WTP will be located on the southwest corner of the mill pad. The treatment process will have various components including an oil and grease skimmer, clarifier, and reverse osmosis system (RO) to remove contaminants. Brine from the RO system will be disposed of in the PWP. The Water Management Section (Section 3.7) provides more details on the water supply and treatment system.

3.3.3.6 Staff and Equipment Parking

Approximately 100 staff parking spaces will be located after entry through the security gate south and east of the truck / shop complex. It is assumed that many staff will car pool. The parking area will be graded to positively drain to the contact water ditch system surrounding the mill pad. The surface will be graveled and designed for the anticipated traffic loads which will generally be passenger vehicles, vendor suppliers, and concentrate trucks. Equipment parking for mine and surface support vehicles will be located north of the truck / shop complex.

3.4 Mine Site - General Construction, Erosion Control and Engineering Studies

3.4.1 Overview and Disturbance Acres

The location of on-site facilities and infrastructure were carefully designed to avoid or minimize impacts to wetland, riparian, and forested areas to the extent possible. They were then engineered to reduce the horizontal distances between individual facilities. This reduces the disturbance footprint and the length of haul roads, and pipelines between facility sites. In addition, Tintina commits to marking by flagging and / or staking all disturbance boundary limits for construction of surface facilities to prevent inadvertent disturbance of land surfaces that should not be impacted during project implementation.

A map of surface mine support facilities and a more detailed table of surface disturbance acres for individual facilities are presented in Figure 1.3 and Table 3-13, respectively. All surface facilities are located on privately-owned land. The total amount of proposed surface disturbances associated with the Project is 295.9 acres (119.7ha).

Table 3-13. Complete List of Surface Disturbance Acres

Facility or Activity	Linear Feature	Construction Disturbance Width	Surface Disturbance
	Lineal feet	Feet	Acres
New Access Roads Sub-total			**57.7**
Main Access road to Mill Site	7,973	84	15.4
Contractor Access Road Butte Creek Road to CTF Road	1,178	98	3.5
CTF Road – Portal to CTF	4,223	164	11.8
Power-line Corridor Parallel to main Access Road (overlap with main access road removed)	7,256	20	4.5
Truck road to Waste Rock Storage Pad	305	98	0.7
Service Road - Truck Road to Soil Stockpiles (Includes Road to PWP)	4,490	98	7.7
Service Road – Main Access to CWP	Already disturbed	—	—
Service Road - CTF to NCWR	6,594	98	13.4
Ventilation Raises New Access Roads	1.081	49	0.7
Direct Underground Mine Support Sub-total			**7.9**
Portal Pad, Including Support Facilities	984	410	6.9
Ventilation Raise Collar Areas (4) (100 x 100', 0.3 acres each) 6-foot Chain Link Fence	100	100 *4	0.9
Pumping Lines to Portal to PWP	992 undisturbed	5	0.1
Pumping Lines to Portal to WTP	2300	5	Already disturbed
Temporary Waste Rock Storage (WRS) Sub-total			**12.1**
Temporary Waste Rock Storage	820	591	10.2
Copper-enriched Rock Storage Pad	295	295	1.9
Drainage Piping WRS to CWP	550	20	Already disturbed

Facility or Activity	Linear Feature	Construction Disturbance Width	Surface Disturbance
	Lineal feet	Feet	Acres
Contact Water Pond (CWP) Sub-total			**9.0**
Contact Water Pond (CWP)	656	656	8.9
CWP Pump back Piping to WTP	2,328	5	Already disturbed
CWP Pump-back Piping to PWP	989 undisturbed	5	0.1
CWP 8-foot Wildlife Fence	2600	5	included
Mill / Plant Site Sub-total			**9.8**
Plant Site (includes Mill, Laydown Area, Substation, Truck / Shop / Admin, Paste Backfill Plant, and Water Treatment Facilities, etc.)	1,312	492	9.8
Primary Crusher and Conveyor			included
Process Water Pond (PWP) Sub-total			**28.7**
Process Water Pond (PWP)			23.9
PWP Foundation Drain Pond			0.4
Pump Back Piping to PWP[1]	50	20	0.0
PWP Diversion Channel			3.7
Piping PWP to Mill	1,548	20	0.7
PWP 8-foot Wildlife Fence			included
Cemented Tailings Facility (CTF) Sub-total			**82.5**
Cemented Tailings Facility (CTF)			71.9
CTF Foundation Drain Pond			0.7
CTF Foundation Drain Pond to WTP[1]	420 2,350	20 20	0.2 already disturbed
CTF Pump back Piping to PWP[1]	2,628	20	1.2
Tailings Pumping Supply Mill to CTF	4,423	20	2.0
CTF Diversion Channel	1,002	20	6.5
CTF 8-foot Wildlife Fence			included
Non-Contact Water Reservoir (NCWR) Sub-total			**7.6**
Noncontact Water Reservoir (NCWR**)**			4.7
NCWR Diversion Channel	1,252		2.1
NCWR Spillway Channel	286		0.5
NCWP Piping to Spillway Channel	738	20	0.3
8-foot Wildlife Fence			included
Water Supply Sub-total			**6.3**
Public Water Supply Well and Pipeline (100 x 100’ Pad , 0.3 Acres Includes Water Tank)			0.3
Pipeline Well to WTP	5,913	20	2.7
Powerline Well PW-6 to substation	Same as above		2.7
Water Tanks (Mill) Distribution Lines	1,320	20	0.6
UIG areas Sub-total			**14.4**

Facility or Activity	Linear Feature	Construction Disturbance Width	Surface Disturbance
	Lineal feet	Feet	Acres
Underground Infiltration Gallery	29,800	20	13.7
Underground Infiltration Gallery to Sheep Creek Alluvium	1,500 2,940	20 20	0.7 Already disturbed
Stockpiles Sub-total			**32.4**
Top Soil	492	525	8.0
Subsoil	1,083	558	7.0
Excess Reclamation Stockpile (North)	623	492	7.10
Excess Reclamation Stockpile (South)			7.5
Temporary Construction Stockpile			2.8
Other/ Miscellaneous Sub-total			**0.6**
Septic System			0.2
Temp. Powder Magazine			0.4
8-foot Chain Link Fence			included
Barbed Wire Fencing of Active Mine			included
New Monitor well and Piezometer Sites			included
Subtotal			**269.0**
Construction Buffer Zone / Misc.[2] (10% of subtotal, and includes 25 ft perimeter around all facilities)			26.9
Disturbance Acres Total			**295.9**

1. Much of this pipeline is constructed on ground disturbed by a facility; the amount shown is additional disturbance.
2. Includes: chain link and barbed wire fences, monitor wells and piezometer locations, storm water ponds, storm water ditches outside of disturbed areas, rock roll and erosion control berms, etc.

3.4.2 Construction of Surface Facilities

A number of activities and components are required for all facility construction. These are presented below in the General Construction Section (Section 3.4.2.1). A discussion of construction BMPs can be found in Section 3.7.6. Collaring of the mine portal and decline mining will be initiated and continue throughout this phase of surface construction.

3.4.2.1 General Construction Including Facility Embankments

Earthworks construction will include access roads, borrow area preparation, borrow excavation, foundation preparation, subgrade preparation, embankment fill placement and compaction, liner bedding, transition filter material processing and placement, installation of the geotextiles and HDPE geomembranes throughout the basin footprints of the waste rock or water storage facilities, and installation of instrumentation. Additional construction activities will include installation of pumps and pipelines, surface water diversions, and storm water management structures. Tintina commits to QA / QC and Quality Control testing of construction and materials testing including embankment construction, material compaction and liner installation by third party independent contractors where appropriate, and in particular where specified by requirements adopted by SB-409 (a revision to the Montana metal mining laws having to do with tailings storage facilities adopted by the Legislature in 2015).

Embankments will be constructed with fill material excavated from the facility basins as part of the cut / fill construction and impoundment shaping. The majority of this fill will be shale, with minor amounts of granodiorite (intrusive) rock fill and overburden. Heavy truck roads connecting the facilities will be built early in the construction phase to provide access for the construction fleet. The cemented tailings facility (CTF) basin has been designed such that its cut will provide excess construction material for subsequent supplementary use in the other facility embankments as needed. A site-wide cut / fill balance for major facilities is provided in Section 3.4.2.7 and Table 3-14.

Embankment fill materials will consist of hard, durable, fresh to moderately weathered rock fill with a maximum particle size of 0.98 feet (300 mm) and placed in 1.64 feet (500 mm) thick lifts within the main embankment zone as identified in the Knight Piésold design section drawings (2017a; 2017c) in design drawing C0003 in Appendix K. The material shall be free of clay, loam, tree stumps or other deleterious organic matter. The embankment material will be placed and spread in horizontal lifts by a dozer. Compaction of the embankment material will be to 95% Modified Proctor laboratory density with a smooth drum vibratory roller.

During construction it is anticipated that a contractor will be responsible for foundation preparation, basin shaping, liner bedding placement, geomembrane installation, and the installation of instrumentation, sumps, pumps, and pipelines. Durable, weathered to fresh granodiorite bedrock excavated from the CTF and PWP basins will be used for liner sub-grade bedding material below all of the lined facilities as shown in Table 3-14b. The sub-grade bedding material as identified in the Knight Piésold design section drawings (2017a; 2017c) will have a maximum particle size of 1-inch (2.54 cm) and placed in 0.98 foot (300 mm) thick lifts on the basin surface and upstream side of any embankment. The material shall be free of clay, loam, tree stumps, or other deleterious organic matter. The material will be placed and spread in horizontal lifts by a dozer. Compaction of the sub-grade bedding material will be to 95% Modified Proctor laboratory density with a smooth drum vibratory roller.

During construction, it is anticipated that a contractor will also be responsible for preparing and placing drainage gravel for construction of the CTF and PWP drainage sumps and foundation drains. The drainage gravel material as identified in the Knight Piésold design section drawing C0003 in Appendix K will consist of free draining durable crushed rock with a maximum particle size of 1-inch (2.54 cm) and a minimum size of 3/8-inches (0.95 cm) and will be generally placed in 1.64 foot (500 mm) thick lifts. The material will be spread by a dozer or manually placed using an excavator. The drainage gravel shall be free of clay, tree stumps, or other deleterious or organic matter.

Prepared materials used for drainage gravel in the construction of the CTF and PWP drainage sumps, foundation drains, and sub-grade bedding material used above and below HDPE liners for all facilities will be sourced from granodiorite rock material present in a minable configuration, in tonnages greater than 500,000 tonnes (250,000 m^3) in the CTF and PWP excavation footprints. Tintina has committed for these construction materials to be prepared by selectively crushing and screening the unweathered granodiorite bedrock (see Table 3-14b) to meet the material specifications as stated in Design Drawing C0003 in Appendix K.

The temporary construction material preparation and stockpile area shown on Figure 1.3 and Map 1 will be used to temporarily store (during the two and a half years of facility construction), crush and screen granodiorite excavated from the PWP and the CTF excavation footprints and will be located northeast of the CTF and east of the CTF haul road. It will be approximately 150 m by 75 m, 1.1 ha (492 ft. by 246 ft., 2.8 acres) in size. Prepared construction material stockpiles are expected to be small as materials will be processed as they are needed for use as sub-grade bedding materials and drainage gravel rock for various facility construction. The precise location of the stockpiles and the locations for the mobile crusher and screening plan will be finalized later by the contractor during the detailed design stage.

Construction of the waste and water management facilities will likely begin at the start of site construction. The temporary WRS pad and the CWP will be constructed first to store waste rock produced during excavation of the mine adit and brine generated from the WTP, respectively. The PWP construction will be completed within 12 to 16 months after start of construction in order to store water pumped out of the underground mine workings and the CWP brine beginning in year two. Completion of the basin floor of the CTF will be prioritized so that waste rock from the temporary WRS pad and other required construction materials can be used to construct the basin drain system concurrently with construction of the remainder of the CTF.

A complete set of engineering drawings (layout plans and cross-sections) and construction material specifications (Drawing #C0003) are contained in an engineering report on mine support facilities by Knight Piésold (2017a) (Appendix K). Select drawings are presented in the main text of this document.

As-built drawings of the mine's surface facilities and workings will be provided to DEQ in electronic format as part of the annual report for the Project. A copy of the as-built drawings will be maintained in an up-to-date condition and be available at the Project site.

3.4.2.2 Topsoil, Subsoil and Excess Reclamation Materials Handling (Stockpiles)

Shrubs and other vegetation will be mowed or chipped and harvested with topsoil prior to construction activities in all proposed disturbance areas. Non-merchantable vegetation will be salvaged and stockpiled with topsoil. Merchantable timber will be harvested for use or sold by the landowner.

Salvaged topsoil and sub-soil will be stored in separate stockpiles located south of the PWP and west of the CTF (Figure 1.3). Tintina will have a soils specialist on-site to oversee initial soil salvage activities and establish guidelines for topsoil and subsoil salvage depths on various landforms. The amount of subsoil removed will be limited to that required by excavations for the specific facility. Topsoil and subsoil stockpiles will have appropriate signage regarding the contents of the stockpile, will be surrounded by silt fences at their bases, and will be graded and revegetated using an approved seed mixture (Section 7.3.5). This will reduce soil and moisture loss, minimize erosion from water and wind, and minimize weed invasion. Diversion ditches will be installed uphill from each of the facilities to intercept non-contact water surface drainage, and convey it to existing drainage outlets. Additional silt fences will be installed downstream as required to prevent release of sediment to the environment. Additional soil stockpile information is described in Section 3.6.10 below.

Tintina will salvage (reuse during concurrent construction reclamation, or stockpile) all soils from the diversion ditch footprints associated with facilities, roads and storm water drainage. These soil quantities are minor relative to the other stockpiled salvage soil quantities, and will either be stored adjacent to the diversion ditches during construction, or placed on out-slopes adjacent to ditches as part of the concurrent reclamation program. Salvaged soils and channel excavation materials associated with the PWP and NCWR diversion ditches and most of the other storm water diversion ditches will be placed adjacent to the diversion channels, spread in individual layers, and revegetated a for use in later reclamation of the entire diversion ditch footprint that will be completed as part of mine closure. The salvaged soils from the CTF diversion ditch footprints will be placed on the CTF ditch perimeter slopes (at a slope of 2:1) since these ditches will remain in closure. These berms will be seeded and will remain as a part of the permanent drainage features. Excess soils from diversion ditches may also be placed on the CTF embankment slope. All diversion ditch salvage soils are included in the lower part of Table 7-4 of the MOP Application. Excavated rock fill from the CTF diversion channel will be stored in reclamation materials stockpiles for use in site-wide closure.

Two excess excavation (reclamation) material stockpiles will be constructed: a northern stockpile located to the west of the temporary WRS facility, and a southern stockpile located to the west of the CTF (Figure 1.3). These materials will largely come from the WRS and CTF basin excavations, respectively. The reclamation materials stockpile located west of the WRS will be used in year two or three to mostly reclaim this WRS facility (see Section 3.6.5) but materials from this stockpile will also be used in closure to reclaim the other northern mine facilities. The southern reclamation material stockpile located west of the CTF will be used for various mine closure requirements, but principally for the closure cover on the CTF and closure of the southern mine facilities as described in detail in Table 3-14c and Section 7.3.3.

Contemporaneous reclamation of disturbances will be a priority during the construction period. Maintaining reclaimed areas will be an ongoing Project focus. Surface disturbances related to cut and fill slopes associated with roads, ditches, embankment faces, and the disturbed perimeter of facility footprints will be reclaimed immediately where possible after final grades have been established. Reclamation includes: grading, slope stabilization, drainage control, topsoil and subsoil placement, and seeding. It is expected that these reclaimed areas will be fully revegetated within two to four years following construction.

BMPs will be used to minimize erosion, sedimentation and to control surface and storm water run-off during the construction phase. BMPs and the site-wide water management plan are described further in Section 3.7.6. Removal of vegetation and soil layers will require the use of dozers, excavators, loaders, scrapers and trucks.

3.4.2.3 Foundation Characteristics

Site investigations have been conducted to characterize the subsurface conditions and estimate foundation preparation requirements as described below in Section 3.5.1. Twenty-four geotechnical holes were drilled to evaluate foundation and hydrologic conditions. Forty-four test pits were also dug to determine the types of overburden present, characterize its physical properties, determine depth to bedrock, and measure overburden and shallow bedrock infiltration rates. The Property contains a thin veneer of topsoil overlying subsoil and weathered, rippable bedrock to depths ranging from 6 to 62 feet (2 to 20 m). The topsoil and subsoil layers typically have 1.5 to 3 feet (0.5 to 1 m) combined thickness, with topsoil typically being no more than approximately 8 inches (0.2 m) thick. These units will be stripped and stockpiled separately as described above prior to foundation excavation and grading.

The basins to be excavated for facilities with the excavated material used for embankment construction are underlain by *Ynl A* and locally thick interlayered granodioritic (*Tgd*) intrusive sills (tabular intrusive bodies interleaved with rock and injected along bedding planes). The *Ynl A* and *Tgd* portions of the bedrock has been tested in humidity cells for acid generation and metal mobility and is considered suitable for use as general fill material in embankments. This is true even though the average sulfide content of *Ynl A* was 2.67%, as it is well buffered by calcareous shales and dolomites.

Geotechnical drilling evidence indicates that the upper 20 m of the *Ynl* is highly fractured, oxidized and deeply weathered. As a result, this material has been leached (Section 2.4.4; Figure 2.19). Near surface *Ynl* has average sulfide contents less than 0.28% (by weight) and HCT test results indicate that these materials are unlikely to generate acid (Section 2.4.4; Figure 2.19). *Ynl* rock released only low concentrations of selenium that exceeded surface water standards (but not groundwater) in early weeks of testing. The granodiorite intrusive sills (*Tgd*) contain less than 0.06% sulfides and HCT results indicate that this material is net neutralizing and released no metals above any relevant groundwater or surface water standard (Section 2.4.4).

These near surface bedrock materials will be excavated and used for embankment fill. Granodiorite will be selectively excavated and prepared into sub-grade bedding material for use as protective layers above and below HDPE liners and for drain rock for use in foundation drains and UIG trenches.

3.4.2.4 Basin Excavation, Shaping, and Subgrade Preparation Including Foundation Drain Construction

The CWP, PWP, and CTF facility basins will be graded and shaped in preparation for the installation of the geomembrane. This includes ripping, drilling, and blasting of bedrock (if required), and placement of fill (i.e., crushed weathered bedrock) in areas within the basin. This will achieve the grades and surfaces required for the installation of the geomembrane.

It is anticipated that the CTF cut, and possibly (but not likely) the PWP cut, will locally extend below the groundwater table and care will need to be taken during design, layout, and construction of the foundation drains to control site drainage (Knight Piésold, 2016a and Appendix K-2). Erosion control including surface water diversions and dewatering measures will be implemented on an as needed basis to manage groundwater seepage into the construction site. The CTF and PWP foundation drains that underlie the embankments and the basin floors, need to be constructed first because the embankments (made up of embankment fill) and other construction materials (i.e. sub-grade bedding) comprising the facilities will require the materials to be sourced from the individual facility excavations.

The CTF and PWP foundation drains flow to separate foundation drain collection ponds located adjacent to the facilities. Details of the CTF and PWP foundation drains and drain collection ponds are described in the individual facility discussions below. The topsoil and subsoil from most of the facility excavation sites (other than the stockpile sites themselves) will be salvaged as shown in Table 7-5 with the majority placed in the appropriate topsoil or subsoil stockpiles as shown in Figure 1.3. At the NCWR construction site, only the footprint of the NCWR embankment will be stripped of topsoil/subsoil in preparation for construction of the lined embankment. No basin preparation at the NCWR is required as the basin itself will not be lined. Grading plans for each of the facilities are included in individual facility discussions below.

3.4.2.5 Sub-grade Bedding Placement, and Geomembrane and Geonet Installation

After excavation of the CWP, PWP, and CTF facility basins, after construction of any required foundation drains, after construction of the embankments, and prior to installation of the geomembrane and geonet (i.e. HDPE liner system), sub-grade bedding material will be placed as per the specifications shown in Drawing C0003 in Appendix K over the floor of the basin excavation. The sub-grade bedding material acts as a protective layer for the HDPE liner system. In all of the aforementioned facility basins, the sub-grade bedding material will consist of granodiorite sourced from either the CTF or the PWP excavations.

Two 100-mil HDPE geomembranes will be placed over the entire footprint of the basin and on the upstream embankment and side slopes of the CWP, CTF and the PWP. The HDPE geomembrane panels will be welded together by thermal methods. Non-woven geotextile will be placed below and above the geomembrane to protect it.

A high drainage capacity geonet liner will be placed between the two HDPE geomembrane layers at the PWP, CTF, and brine storage section of the CWP. The geonet liner will collect any seepage through the upper liner and deliver this to a sump for removal. Quality Assurance and Quality Control (QA/QC) procedures implemented during construction will minimize the potential for construction defects.

3.4.2.6 CTF Basin Drain System and CTF Water Reclaim System

After placement of the sub-grade bedding layer above the CTF basin excavation (below the HDPE liner system), and installation of the CTF HDPE liner system within the basin as described in the previous section, an upper layer of sub-grade bedding will be placed above the CTF HDPE liner system and a drainage layer will be constructed above the sub-grade bedding layer that will comprise the internal basin drain system. The drainage layer will be constructed using pre-production waste rock as shown in Section "A" of Drawing C2003 (Figure 3.36 in the MOP Application) and in Section "1" of drawing C2006 of Appendix K. It is assumed that the waste rock will have the same material specifications as the embankment fill material (prior to compaction of the embankment materials, based on its also being drilled and blasted from rocks sourced from the same geologic unit lithologies) as shown in Drawing C0003 in Appendix K, and therefore will act as a free-draining material. The CTF floor will be graded at a minimum of 0.5% towards the CTF wet well sump (i.e., water reclaim system and seepage collection sump) shown in Figure 3.38. The CTF basin drain system will be integrated with the reclaim sump to promote flow to the sump. Excavated granodiorite will be used to construct the sub-grade bedding layer below the CTF HDPE liner system, while excavated granodiorite (Tgd), excavated *Ynl Ex*, and/or preproduction waste rock will be utilized to construct the sub-grade bedding layer above the CTF HDPE liner system. In addition, pre-production waste rock will be used to construct the drainage layer in the basin drain system and to partially construct the CTF haul ramp into the CTF. Additional details of the construction of the CTF basin drain system and the CTF water reclaim system (including the seepage collection sump) will be described in the individual CTF facility discussion below. Volumetric details of the materials used to construct the CTF basin drain system and the other facilities, including the sources of the materials, are described in detail in Table 3-14a and 3-14b below.

3.4.2.7 Cut / Fill Material Quantities

Conceptual cut / fill material balance quantities for construction materials sourced from all of the proposed mine facility excavations are presented in Tables 3-14a and 3-14b. Table 3-14a presents the overall total cut and fill volumes for the construction materials (i.e. bedrock) and excludes pre-production waste rock fill volumes. The cut volumes in Table 3-14a only represent the excavated bedrock volumes from the individual facility excavation footprints; in other words the upper topsoil and subsoil volumes are not included in the listed volumes. The soil volumes salvaged from each facility are listed in a separate table in the MOP Application (Table 7-5). The bedrock "cut" volumes listed in Table 3-14a and Table 3-14b include a 20% bulking factor indicating that the volume represents the material after excavation. The construction "fill" volumes listed in Table 3-14a and 3-14b also include a 20% bulking factor indicating that the volume represents the material after placement and compaction.

Table 3-14a. Project Cut and Fill Quantities

Facility	Bulked Volume Available (m^3)	Bulked Fill Required after Bulking (m^3)	Net (m^3)
Mill Pad	49,000	31,000	18,000
Portal Pad	40,000	70,000	-30,000
Contact Water Pond and Brine Pond	84,700	34,020	50,680
Cemented Tailings Facility	1,903,000	1,545,332	357,668
Process Water Pond	423,000	476,400	-53,400
Non-Contact Water Reservoir	-24,000	141,500	-165,500
Diversion (Channels and Ditches)	17,000	22,000	-5,000
Temporary Waste Rock Pad	138,000	34,000	104,000
Copper-enriched Rock Stockpile	26,000	7,000	19,000
Roads and Ditches	321,000	321,000	0
Underground Infiltration Galleries (UIGs)	5,500	6,000	-500
Total	**2,983,200**	**2,688,252**	**294,948**

Notes:

- This table only includes conceptual cut and fill bedrock material volumes (not pre-production waste rock).
- All cut and fill volumes listed in this table exclude soils; however, Westech Environmental Services (2017a) estimated topsoil and subsoil thicknesses (see Table 7-4 in the MOP) have been subtracted from the initial total excavation volume.
- The CTF construction bulked rock fill includes 77,232 m^3 (43%) of the excavation rock fill required to construct the CTF haul ramp as shown in Table 3-14b. Other volume and material type details are also listed in Table 3-14b.
- This scenario utilizes 411,537 tonnes (205,768 m^3) of pre-production waste rock to construct the following facilities: 24,000 m^3 for the sub-grade bedding layers above the HDPE liner systems at the WRS pad and the copper-enriched rock stockpile; 80,000 m^3 for the drainage layer of the CTF basin drain system, and 101,768 m3 for the CTF haul ramp. Any additional pre-production waste will be placed on top of the drainage layer of the basin drain system.
- Most construction materials <1,000 m^3 are not included in this table.
- Most volumes are rounded to the nearest 1,000 m^3.
- Volumes of cut (after excavation) and fill (after placement and compaction) materials includes a 20% bulking factor.
- The cut and fill volumes from the ventilation raises are included in the waste rock plan presented in Tables 3-5 and 3-6 of the MOP Application. All waste rock ultimately ends up in the CTF above the CTF HDPE liner system.
- The net excess 298,948 m^3 of general rock fill will be placed on the two “reclamation material” stockpiles after construction: 133,268 m^3 is placed on the northern stockpile whereas 161,680 m^3 is placed on the southern stockpile located west of the CTF.

Table 3-14b. Project Cut and Fill Quantities by Material Type and Source [(1)]

Pre-production Waste Rock Use (tonnes)****	Assigned Material Designation or Equation	Construction Material Type/ Cut or Fill Volumes	CTF	PWP	NCWR	Contact Water Pond & Brine Pond	Temporary Waste Rock Storage Pad	Copper-enriched Rock Stockpile	Mill Pad	Portal Pad	Diversion Channels	UIGs	Roads and Ditches	Total
	A	**Total Cut Bulked Volume Available (m^3)**	1,903,000	423,000	-24,000	84,700	138,000	26,000	49,000	40,000	17,000	5,500	321,000	**2,983,200**
	1	Embankment Fill (m^3)	1,337,000	450,000	138,000	26,700	24,000	5,000	31,000	70,000	22,000	1,500		**2,105,200**
48,000	2	Sub-grade Bedding Placed Above the HDPE Liner System (m^3)*	44,000 [(17)]	0	0	0	20,000	4,000	0	0	0	0		**68,000**
	3	Sub-grade Bedding Placed Below the HDPE Liner System (m^3)	78,000	24,000	3,500	7,320	10,000	2,000	0	0	0	0		**124,820**
		Total Subgrade Bedding (m^3)	***122,000***	***24,000***	***3,500***	***7,320***	***30,000***	**6,000**	0	0	0	***0***		***192,820***
	4	Drainage Gravel (m^3)	8,800	2,400	0	0	0	0	0	0	0	4,500		**15,700**
	5	Filter Sand (m^3)	300	0	0	0	0	0	0	0	0	0		**300**
160,000	6	Waste Rock forming the Drainage Layer of the CTF basin drain system (m^3) **	80,000	0	0	0	0	0	0	0	0	0		**80,000**
	7	CTF Haul Ramp (HR) (m^3)	77,232											**77,232**
203,537	8	CTF Haul Ramp Waste Rock (m^3)	101,768											**101,768**
	9	Other (m^3)***	0	0	0	0	0	0	0	0	0	0	**321,000**	**321,000**
	B = 1+3+4+5+7+9	**Total Rock Fill Construction Materials with HR & excluding all Waste Rock (m^3)**	1,545,332	476,400	141,500	34,020	34,000	7,000	31,000	70,000	22,000	6,000	321,000	**2,688,252**
	A - B	**Net (m^3) only materials sourced from excavation cut (not Waste Rock)**	**357,668**	**-53,400**	**-165,500**	**50,680**	**104,000**	**19,000**	**18,000**	**-30,000**	**-5,000**	**-500**	**0**	**294,948**
411,537	**Total WR tonnes**													

Notes:

(1) The sources of the construction materials are listed below and some are indicated by highlighted cells in the table. The primary source of the construction materials will be from fresh unweathered bedrock from each individual facility excavation footprint. Most of the construction materials will be sourced from the facility that they are excavated from (i.e. most of the mill pad will be constructed with materials sourced from the mill pad excavation). If there is a deficit of material listed in a facility (indicated by a negative volume value in the “Net” cells), then some construction material will be required to be sourced from another facility excavation that has excess fill material. For instance, there is excess material fill from the CTF excavation that will likely be used as construction material to construct the PWP, NCWR, UIG, and diversion channel facilities. The excess fill material from the temporary WRS pad will likely be used for some of the construction materials to construct the portal pad. The same notes included in Table 3-14a are applicable to Table 3-14b.

(2) * Most sub-grade bedding and all drainage gravel materials will be sourced from granodiorite (indicated in the table by volumes highlighted in the magenta color) excavated from the CTF and the PWP excavations. Sub-grade bedding material placed above the HDPE liner system at the WRS pad and the copper-enriched rock stockpile will consist of pre-production waste rock (indicated in the table by volumes and tonnages highlighted in the light blue color) that is temporarily stored on the WRS pad. The sub-grade bedding material and the drainage gravel will require crushing and screening of the excavated bedrock. The crusher and screen plant will need to be located on the temporary WRS pad after the HDPE liner and overlying materials to the liner have been placed. After the pre-production waste rock required for the sub-grade bedding required over the HDPE liner system for the WRS pad and the copper-enriched rock stockpile has been constructed, the crusher and screen plant may be moved to either the temporary construction stockpile or to the CTF excavation basin. The contractor will finalize these details prior to construction. Since excess fill materials from the facility construction will be stored on the northern and southern reclamation material stockpiles, some of the sub-grade bedding and drainage gravel materials could be sourced from these two reclamation material stockpiles too.

Table 3-14b notes continued.

(3) ** The minimum volume of pre-production waste rock forming the “drainage layer” in the upper part (minimum 1.0 m thick) of the CTF basin drain system (see Drawing C2003 in Appendix K; Knight Piésold, 2017a) will be sourced from the remaining unused pre-production waste rock stored on the WRS pad (i.e. after some of the pre-production waste rock has been used to help construct the WRS pad, the copper enriched rock stockpile, and the CTF haul ramp as listed in the table). The maximum volume of pre-production waste rock forming the “drainage layer” is calculated by using the maximum design capacity of the WRS pad (which is 500,000 tonnes) and would be approximately 124,232 m^3 (248,464 tonnes) making the layer 1.55 m thick.
(4) *** Other materials refer to road construction materials that will be sourced from the individual road cuts.
(5) **** Pre-production waste rock tonnes are calculated using 1 m^3 = 2 tonnes. All pre-production waste rock utilized for construction of the facilities will be end up at the end of the project (in closure) will be transported and placed in the CTF. The first two years of the mine life will produce 411,537 tonnes as stated in Table 3-6 of this MOP Application which will be stored on the temporary WRS pad.
(6) Filter sand sourced from the CTF excavation cut.
(7) All construction materials needed to construct the NCWR will be sourced from the CTF excavation.
(8) Approximately 53,400 m^3 of the PWP construction materials and 165,500 m^3 of the NCWR construction materials will be sourced from the CTF excavation.
(9) Construction materials<1,000 m^3 are not included in the table.
(10) All cut and fill volumes listed in the table are conceptual and will be refined after a contractor has been awarded the construction project. However, the pre-production waste rock volumes and tonnages correspond to a preliminary mine plan shown in Tables 3-5 and 3-6 of the MOP Application. All gradation specifications (and placement and compaction requirements) for the embankment fill, sub-grade bedding, and drainage gravel are shown in Drawing C0003 in Appendix K. The specifications for the pre-production waste rock will approximate that for the embankment fill. The pre-production waste rock used to construct the drainage layer of the CTF basin drain system will be required to be a free-draining material.
(11) Total rock fill to be stored in the northern and southern reclamation material stockpiles after the end of construction is 294,948 m^3 (same as Table 3-14a). The facility names highlighted in the light green colored fill will have their excess general rock fill (totaling approximately 133,268 m^3) materials stored in the northern reclamation material stockpile whereas the facility names highlighted in the light orange colored cells will have their excess general rock fill (totaling approximately 161,680 m^3) stored on the southern reclamation material stockpile as shown in Figure 1.3 and Map Sheet 1. The excess rock fill volumes stored on the two reclamation material stockpiles in this table are conceptual and will be recalculated by a contractor prior to construction.
(12) Total net rock cut minus rock fill volume excluding materials not sourced from the facility excavation footprints (i.e. pre-production waste rock).
(13) The pre-production underground waste rock schedule for the first two years is 411,537 tonnes; the maximum storage capacity of the temporary WRS pad is 500,000 tonnes which indicates that the WRS pad may be used for more than two years. These tonnages include excavated tonnages from the two development ventilation raises (The waste rock tonnage difference between the first two years and the design capacity is equal to 88,463 tonnes which could be added to the upper part of the drainage layer within the CTF basin drain system during construction).
(14) 184,520 m^3 (or 369,040 tonnes) of combined sub-grade bedding and drainage gravel is required to construct the mine facilities (not including the sub-grade bedding placed above the HDPE liner system at the WRS pad and the copper-enriched rock stockpile). There is ample granodiorite expected from the CTF and PWP excavations to supply these sub-grade bedding and drainage gravel construction materials.
(15) See Table 3-14c for volume of reclamation materials required to close the following facilities: CTF, NCWR, PWP and NCWR diversion channels, the NCWR spillway, and backfilling of the portal (plug), the drift under the Coon Creek (approximately 200 feet length of workings), and the four ventilation raises.
(16) Diversion channels include: CTF (a permanent facility that will exist during construction, operations, closure, and after closure) and the PWP and NCWR which are not permanent facilities (i.e. will not exist after closure).
(17) This 44,000 m^3 of material has been identified as *Tgd*; however, Tinitna may alternatively use *Ynl Ex* and/or preproduction waste rock for sub-grade bedding material to be placed above the double liner in the CTF. Please see Section 3.6.8.7 for additional information on these alternative materials.
(18) Abbreviations as per abbreviations listed in this MOP Application. Others include: HR = CTF haul ramp; WR = pre-production waste rock.

Table 3-14c. Reclamation Material Volumes by Material Type Required to Close the Southern Mine Facilities[1] and Backfill some of the Underground Workings[2].

Facility	CTF (cap)	PWP	NCWR	PWP Diversion Channel	NCWR Diversion Channel and Spillway	Backfilling Ventilation Raises, Portal, and Drift Under Coon Ck. [2]	Total
Embankment Fill (m^3)	198,000 [8]	-170,000	-138,000	3,000	1,000	3,000	**-103,000**
Sub-grade Bedding (m^3)	205,000	0	0	0	**0**		**205,000**
Drainage Gravel (m^3)	0	0	0	0	**0**		**0**
Total by Facility	**403,000**	**-170,000**	**-138,000**	**3,000**	**1,000**	**3,000**	**102,000**

NOTES:

(1) The southern mine facilities include those listed in Table 3-14c.

(2) The underground workings that are planned to be backfilled during closure include: the portal plug, a 200 foot length of drift under Coon Creek, and the ventilation raises. See Figure 7.4 Section 7.3.3.5 of the MOP.

(3) The negative volumes for the PWP and NCWR embankment fill materials indicate that they will be required for reuse to close the CTF.

(4) The 102,000 m^3 of required reclamation material to close the facilities listed in this table is sourced from the estimated 161,680 m^3 of available general rock fill material stored on the southern reclamation material stockpile as identified in note #11 in Table 3-14b. Therefore there will be 161,680 m^3 - 102,000 m^3 = 59,680 m^3 of excess fill for the entire project (after the minimum cap materials are added to the CTF in closure) assuming that all of the reclamation material from the northern stockpile will be used to reclaim the northern mine facilities. See note #5 below for where this excess 59,680 m^3 of fill material will be placed in closure.

(5) A total of 308,000 m^3 of embankment fill from the PWP and the NCWR will be moved (reused) in closure to cap the CTF for this scenario (in this table they are shown as negative volume values). Since all of the 138,000 m^3 of the NCWR embankment fill material must be moved and reused in closure, a total of 170,000 m^3 of embankment fill is estimated to be reused from the PWP in closure in order to close the CTF and still have 59,680 m^3 of excess fill. The excess fill may be added as additional CTF cover material making it thicker than the minimum design thickness of 1.0 m (CTF cover shown in Drawing C8002 in Appendix K and in Figure 7.3); see Note #8 below.

(6) This scenario utilizes 411,537 tonnes of pre-production waste rock as defined in Table 3-14b of MOP.

(7) This scenario sets the volume of reclamation materials to reclaim the PWP at “zero” in order to calculate the volume of PWP embankment fill materials estimated to reuse to close the CTF. This scenario estimates that 450,000 m^3 – 170,000 m^3 = 280,000 m^3 of PWP embankment fill material will be used to reclaim the PWP in closure.

(8) The estimated 198,000 m^3 is the minimum volume of embankment fill required to cap (cover) the CTF at 1.0 m thick as shown in design Drawing C8002 (Detail “A”) in Appendix K. An estimated 257,680 m^3 of embankment fill is the maximum volume resulting in a cap layer of 1.30 m thick.

(9) The estimated 133,268 m^3 of stockpiled reclamation materials stored on the stockpile located west of the WRS pad will be 100% used to reclaim the facility names highlighted in the light green cell color in Table 3-14b.

(10) The UIG buried pipelines to remain buried in place in closure as shown in Figure 7.8 of this MOP.

(11) The CTF diversion channel will remain functional during operations and after closure.

(12) The yellow highlighted volume in this table is the net excess material volume (i.e., reclamation material total) estimated necessary to reclaim the (southern) facilities listed in Table 3-14c. See note #4 above for how the northern mine facilities will be reclaimed.

The cut / fill material balance quantities listed in Tables 3-14a and 3-14b in the MOP Application include many of the same quantities that are listed in Tables 9.1 and 9.2 in Appendix K by Knight Piésold (2017a). However, all of the facilities are represented in Tables 3-14a and 3-14b, whereas not all of the facilities are included in Appendix K. In addition, Knight Piésold (2017a) did not include any pre-production waste rock in their material balance tables 9.1 and 9.2 (Appendix K). As a result of these differences between the two different material balance scenarios, the volumes of reused embankment fill from the PWP in closure are different between the volumes listed in Table 3-14c in the MOP Application and in Table 9.1 of Appendix K. The volume of reused NCWR embankment fill material in closure are the same which will be discussed in detail in Section 7.3.3 (Site specific Facility Closure).

The conceptual construction fill volumes listed in Table 3-14b are categorized by material type and by source. The main material types include embankment fill, sub-grade bedding, drainage gravel, filter sand, and pre-production waste rock. The material specifications, and placement and compaction requirements (if any) for the first three aforementioned material types are described in detail in Section 3.4.2.1 of the MOP Application and in Drawing C0003 in Appendix K. Table 3-14b also includes volumes for pre-production waste rock (volumes highlighted in the light blue cells in Table 3-14b) that will be used to construct portions of the CTF, temporary WRS pad, and the copper-enriched rock stockpile. Pre-production waste rock tonnage equivalents as they relate to cubic meters are also listed in Table 3-14b and correlate to the tonnages listed previously in Table 3-6. Pre-production waste rock is assumed to have the same material specifications as the embankment fill and therefore will act as a free draining material. It is important to note that all of the pre-production waste rock (which could contain sulfide minerals and be potentially acid generating) that will be used to construct portions of the CTF will be placed above the CTF HDPE liner system. The volume of filter sand material to be used in very small and material specifications for this material type will be finalized before construction by Tintina and the construction contractor.

Material used to construct the bedding layers and drainage sumps will be processed by the selected contractor using suitable processed fill provided by Tintina. The source for many of the construction fill materials will be from the CTF and PWP excavations. The sub-grade bedding and drainage gravel materials will be constructed using granodiorite (*Tgd*) from the CTF and PWP excavations. Those materials are highlighted in light magenta in Table 3-14b and total 406,797 tons (369,040 tonnes). Tintina believes that there is ample granodiorite available from the planned CTF and PWP excavations (>551,155 tons or 500,000 tonnes) based on the existing drill holes in the area. The embankment fill materials will consist either of Tgd or Ynl Ex materials that have been previously described in Section 2.4.4.

Tables 3-14a and 3-14b both show that there will be a net excess of approximately 294,948 m^3 of bulked excavation materials to be stored in the two designated reclamation material stockpiles shown in Figure 1.3 for use in closure of the mine facilities. The cut volume for the CTF will generate more fill than is required for the construction of the CTF, PWP, NCWR, and CTF embankments. The PWP will be constructed to an approximate cut-fill balance, and will only require minimal fill from the CTF cut. The NCWR embankment foundation preparation will involve stripping of topsoil/subsoil, but because the NCWR will be unlined, no impoundment shaping will be required. Fill material for the NCWR will be sourced from the CTF cut.

The surplus material excavated from the CTF will be placed in the southern excess material (i.e. reclamation material) stockpile located west of the CTF and be used to reclaim the CTF and other facilities listed in Table 3-14c in closure at the end of the mine life. Other excess excavation materials from the northern mine facilities including the WRS pad will be placed in the northern reclamation material stockpile located west of the WRS pad and be used to reclaim the WRS pad in year three and the other northern mine facilities at the end of the mine life in closure. The excess material (reclamation material) stockpiles will be reclaimed when they are no longer needed to store the suitable fill materials (i.e., when the stockpiles are exhausted in facility closure). Additional details of Table 3-14c and the reclamation material volumes required to fully close the mine at the end of the mine life are discussed in Section 7.3.1 (Post Mining General Construction Measures) in the MOP Application.

3.4.2.8 Instrumentation

Instrumentation will be installed in the CWP, CTF, PWP, and NCWR embankment fill zones and underlying foundations. The instruments will be monitored during construction and ongoing operations to assess performance. The types of instrumentation that will be installed are described below:

- **Vibrating Wire Piezometers** – Little water is expected to accumulate on the basin drain system liner. However, as a precaution, the CTF basin drain system and wet well sump and pump system will be designed to minimize head on the impoundment liner. This will reduce the potential for seepage from the facility. Vibrating wire piezometers will be installed between the 100 mil HDPE liners, as shown on drawings C2011 and C3010 in Appendix K at select locations to measure the pore water pressures within the tailings and monitor the performance of the drainage management systems.
- **Survey Monuments and Vibrating Wire Settlement Cells** - Regular surveying will aid evaluation of the performance of the embankment slopes and crest with respect to movement and settling. Periodic (initially quarterly) surveying of the monument locations will provide early warning of movements.
- **Inclinometers** - Inclinometers installed at the embankments for the CTF, PWP, and NCWR will provide additional tracking of movement.

The instrumentation plans and details are shown on design drawings in Appendix K (Knight Piésold, 2017a).

3.5 Engineering Evaluations

3.5.1 Geotechnical Foundation Evaluations

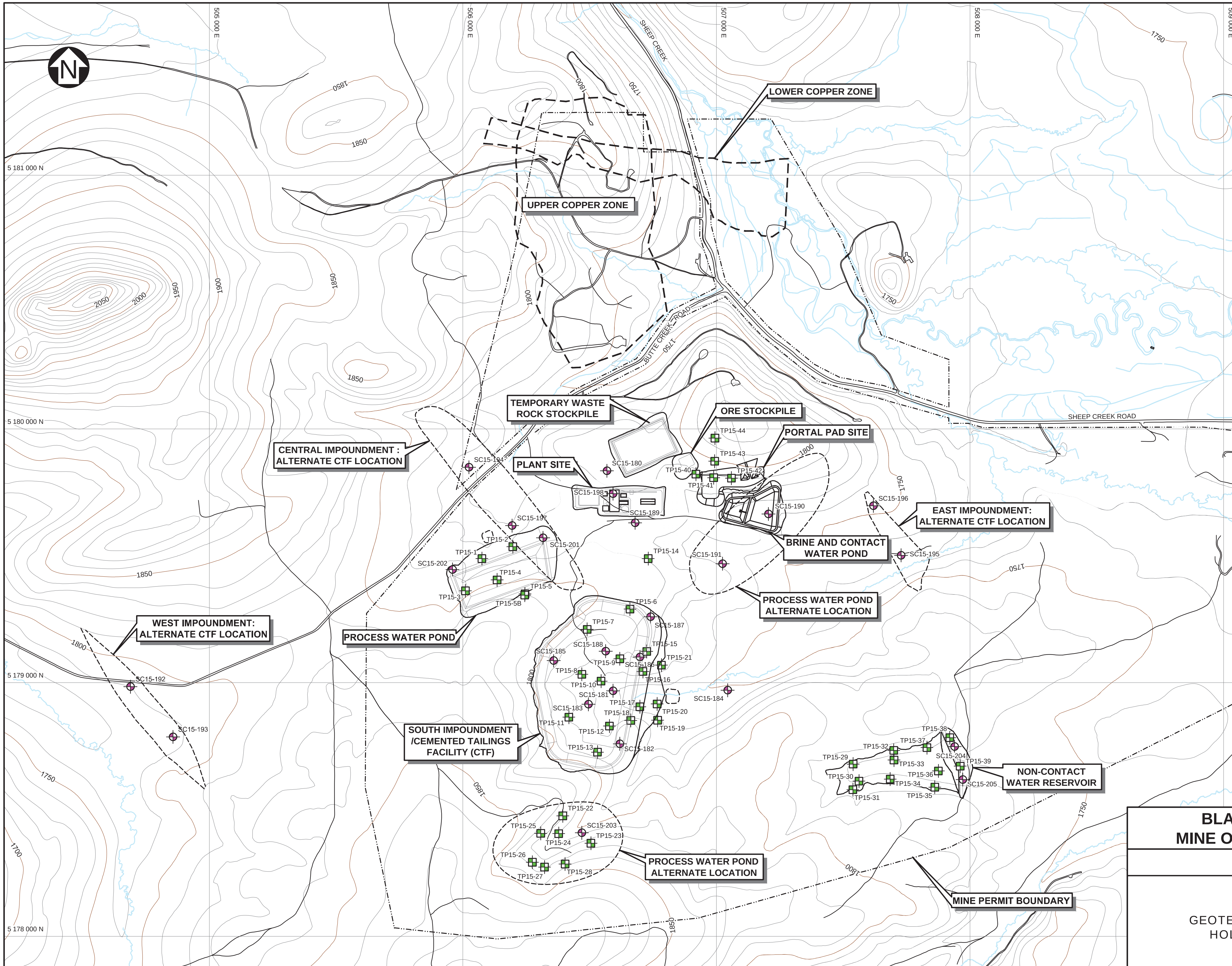
Knight Piésold completed geotechnical and hydrogeological site investigations for the Project in the spring of 2015. The results of the 2015 site investigations are included in Appendix K-4 (Geotechnical Site Investigation Report by Knight Piésold (2017b) and include drill hole logs, test pit logs, geology drill sections, hydrogeological data, laboratory test results for both soil and rock mechanics, and core drill hole and Standard Penetration Testing (SPT) sample photographs. The key objectives of the site investigations were to:

- Collect geotechnical and hydrogeological information to support a feasibility level design for the construction of the CTF, Process Water Pond, and Non-Contact Water Reservoir,
- Collect geotechnical and hydrogeological information to characterize the conditions at the proposed plant site, portal pad, and contact water pond, and
- Complete test pit excavations over the Project area to characterize soil depth to bedrock and suitability as potential for construction material borrow sources.

The site investigation program included the tasks listed below (Figure 3.13 and Table 3-15):

- Drilling with standard penetration testing (SPT) in overburden, packer testing in bedrock, and detailed geotechnical logging of core or characterization of drill-cuttings. The drill hole location and total depth information by facility and/or alternative site are listed in Table 3-15.
- Installation of PVC casing for long-term monitoring of water quality and groundwater elevations. The monitoring well location information has been previously presented in Table 2-7 and the groundwater table elevation data are presented in Appendix B-A.
- Excavation of test pits through overburden until contact with (weathered) bedrock; and,
- Sample collection of soil for particle size analysis and sample collection of bedrock for strength testing. A summary of the rock strength test results are included in Table 3-19.

The 2015 site investigations were conducted between March and May, and were split into two phases. The first phase was carried out in March, 2015, during which 19 geotechnical holes were drilled. Four of those 19 holes, were selected to have standpipe piezometers installed for the purposes of long term water quality testing and groundwater elevation monitoring. The second phase was carried out in May, 2015 and consisted of 5 geotechnical drill holes and 44 test pits.



LEGEND:

- DRILL HOLE
- TEST PIT
- ALTERNATE CTF AND PWP LOCATION
- MINE PERMIT BOUNDARY

NOTES:

1. TOPOGRAPHIC BASE MAP FROM 2011 AERIAL LIDAR SURVEY WITH MAP PROJECTION: UTM ZONE 12N AND MAP DATUM: NAD83.
2. CONTOUR INTERVAL IS 10 METERS.
3. ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.13
GEOTECHNICAL SITE INVESTIGATION DRILL HOLE AND TEST-PIT LOCATIONS WITH FACILITIES

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REVISED DATE: MAY 2016

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-1 Rev 2

SOURCE FIGURE NUMBERS: FIGURE D1.1_r2

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 2.18 & 3.13 Geotechnical Site Investigation Drill Hole and Test-Pit Locations with Facilities(D1.1_r2), PRINTED: 4/26/2017 2:44:38 PM

Table 3-15. Summary of 2015 Geotechnical Drill holes

Drill hole	Drill hole Location	Coordinates [1]			Total Depth	Depth to Bedrock
		Northing	Easting	Elevation		
		(m)	(m)	(m)	(m)	(m)
SC15-180	Plant Site and WRS	5,179,835	506,568	1,788	30.2	0.6
SC15-181	South Impoundment Embankment	5,178,968	506,592	1,770	30.1	6.7
SC15-182	South Impoundment Embankment	5,178,759	506,619	1,794	30.2	0.2
SC15-183	South Impoundment Embankment	5,178,913	506,510	1,779	30.2	0.6
SC15-184	Seepage Collection Pond	5,178,970	507,044	1,756	30.0	4.6
SC15-185	South Impoundment Embankment	5,179,087	506,358	1,806	30.2	0.3
SC15-186	South Impoundment Embankment	5,179,101	506,698	1,786	30.2	0.3
SC15-187	South Impoundment Embankment	5,179,260	506,740	1,786	30.2	0.3
SC15-188	South Impoundment Embankment	5,179,124	506,563	1,792	30.2	0.2
SC15-189	Plant Site	5,179,630	506,679	1,782	30.2	0.3
SC15-190	CWP and Process Water Storage Pond Alternate	5,179,665	507,205	1,761	30.2	0.5
SC15-191	Process Water Storage Pond Alternate	5,179,469	507,024	1,768	30.2	0.5
SC15-192	West Impoundment Embankment	5,178,984	504,689	1,792	30.5	2.1
SC15-193	West Impoundment Embankment	5,178,786	504,857	1,787	30.2	2.1
SC15-194	Central Impoundment Embankment	5,179,849	506,024	1,774	30.1	0.5
SC15-195	East Impoundment Embankment	5,179,502	507,728	1,736	30.1	0.2
SC15-196	East Impoundment Embankment	5,179,697	507,619	1,751	30.5	1.5
SC15-197	Central Impoundment Embankment	5,179,619	506,194	1,775	29.9	0.2
SC15-198	SAG Mill	5,179,745	506,592	1,787	30.0	1.4
SC15-201	Process Water Storage Pond	5,179,571	506,316	1,783	30.3	0.6
SC15-202	Process Water Storage Pond	5,179,446	505,959	1,795	29.8	1.4
SC15-203	Process Water Pond (Alternate)	5,178,408	506,469	1,794	30.2	1.2
SC15-204	Non-Contact Water Reservoir	5,178,748	507,939	1,761	30.2	0.3
SC15-205	Non-Contact Water Reservoir	5,178,618	507,971	1,773	29.9	0.7

NOTES:

1. Coordinates are based on final collar survey data using the NAD 83 UTM Zone 12N coordinate system.

Rock core was logged using the Rock Mass Rating classification system using Bieniawski (1989). The Rock Mass Rating system characterizes a rock mass based on the intact rock strength, the degree of fracturing, discontinuity spacing, and discontinuity conditions. Falling head response tests were conducted in bedrock throughout both drilling phases in order to determine the hydraulic conductivity of the bedrock throughout the Project area. Soil samples were collected throughout both phases of the program and sent to Knight Piésold's soil testing facility in Denver, Colorado for index testing (particle size distribution, moisture content, and Atterberg limits). Rock core samples were collected during the first phase drilling program and sent to Mine Design Engineering in Kingston, Ontario for unconfined compressive strength testing. Information obtained from the site investigation was used in feasibility design of the tailings and water management facilities.

3.5.2 Design Standards

The design criteria for the waste rock and water management facilities have been developed to satisfy both US and international standards. Design standards are based on the relevant State and Federal guidelines for the construction and operation of a dam in Montana. A detailed Project design basis summary is included in Knight Piésold (2017a) (in Appendix K of this document (within Knight Piésold's Appendix A)). The following regulations and guidelines were used to develop the design standards for the Project:

- Montana Code Annotated, Title 82. Minerals, Oil, and Gas, Chapter 4. Reclamation, Part 3. Metal Mine Reclamation (MCA 82-4-375 through 381),
- Administrative Rules of Montana (ARM),
- Federal Emergency Management Agency (FEMA), and
- International Commission on Large Dams (ICOLD).

Montana's 64th State Legislature passed new legislation in April 2015 as the governing legislative document for metal mining in the State of Montana. These new requirements amended seven sections of the Montana Code Annotated, under Title 82. Minerals, Oil, and Gas, Chapter 4, Reclamation; Part 3, Metal Mine Reclamation. All MCA requirements will be addressed for the ongoing design, construction and operation of the Project. The intent of the bill is to ensure that tailings storage facilities are designed, operated, monitored, and closed in a manner that:

- Meets state of practice engineering design standards;
- Uses applicable, appropriate, and current technologies and techniques as is practicable given site-specific conditions and concerns; and
- Provides protection of human health and the environment.

MCA 82-4-376 states that new dams operating in Montana must be designed to withstand either the Maximum Credible Earthquake Event (MCE), or the 1 in 10,000 year earthquake event, whichever is greater. New dams operating in Montana must also be built to handle the Probable Maximum Flood (PMF) event as defined in Section 3.5.3 below.

The dam hazard determination described in the ARM is based on the consequences of dam failure (not the condition, probability, or risk of failure). According to ARM Chapter 36.14, a dam must be classified as a high hazard if the impoundment capacity is 50 acre-feet (approx. 60,000 m^3) or larger and it is determined that a loss of human life is likely to occur within the breach flooded area as a result of failure of the dam. The CTF and PWP both have capacities exceeding 60,000 m^3 (78,400 cu yds.) and local landowners have semi-permanent settlements downstream of the facilities that could be impacted by a dam failure.

The US Department of Homeland Security published Federal guidelines for dam safety (FEMA, 2004). The guidelines also include a hazard potential classification system which categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. The FEMA hazard potential classification system is summarized in Table 3-16.

Table 3-16. FEMA Dam Hazard Potential Classification

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and Generally Limited to Owner
Significant	None Expected	Yes
High	Probable. One or more expected.	Yes (but not Necessary for this Classification)

ICOLD recommends that for major tailings dams, (where failure could result in loss of life and extensive property damage), seismic analysis should be based on the Maximum Credible Earthquake (MCE) (ICOLD, 1989). Damage of the dam is acceptable as long as the integrity and stability to the dam is maintained, and the release of the impounded water and/or tailings is prevented. In addition, for closed circuit dams where no discharge is permitted (i.e., CTF and PWP as opposed to the NCWR), the tailings dam must provide sufficient freeboard to allow storage of the probable maximum flood (PMF) in addition to normal operational tailings pond containment volumes.

3.5.3 Hazard Potential Classifications

The CTF should not be considered a dam by most standards; it will store little to no water in the facility (all water reports to sumps that are pumped back to the PWP) except during periods following exceptional storm events (greater than the 1 in 500 year event). In addition, the CTF is filled with a non-flowable mass of cemented tailings. Although the CTF is not a traditional tailings impoundment, as the material contained in it is non-flowable, the CTF will be designed and constructed in compliance with all applicable requirements for construction of tailings impoundments, including the newly enacted tailings impoundment additions to the mine reclamation laws (MCA 82-4- 301 through 390). For compliance with Metal Mines Reclamation Act (MMRA), i.e., with MCA-82-4-301 through 390, Tintina has designated their preferred “Qualified Engineer of Record” and submitted this in a letter to DEQ on November 10, 2015. In addition, Tintina has selected three Professional Engineers to serve as panel members on the tailing review committee on March 8, 2016. On April 28, 2016 the three panel members met on site with the Engineer of Record and design engineers from Knight Piésold, for a site visit and reviewed the design criteria.

According to the classification scheme, the CTF and PWP are considered to have a high hazard potential classification based on the potential volume of water stored, expected loss of life, and extensive property damage in the event of embankment failure.

The guidelines for high hazard dams specify further that the design must be such that the most severe earthquake that can be reasonably anticipated will not cause catastrophic failure, such as uncontrolled release of a reservoir, although severe damage or economic loss may occur. Under SB 409, for high hazard potential classification dams this is equated with the 1 in 10,000 year event as the Maximum Design Earthquake (MDE). The hazard potential classification and relevant Inflow Design Flood (IDF) (including the PMF event) and Maximum Design Earthquake (MDE) for each facility are summarized in Table 3-17.

Table 3-17. Dam Hazard Classification Design Criteria

Facility	Hazard Classification	Inflow Design Flood	Maximum Design Earthquake
CTF	HIGH	Probable Maximum Flood Event	1 in 10,000 year event
PWP	HIGH	Probable Maximum Flood Event	1 in 10,000 year event
CWP	LOW	1/200 year event	1 in 10,000 year event
NCWR	LOW	1/200 year event	1 in 10,000 year event

3.5.4 Seismicity

MMRA (MCA 82-4-375 through 380) requires that new tailings dams in Montana be able to withstand the greater of either the 1 in 10,000 year earthquake event, or the Maximum Credible Earthquake (MCE). To comply with MCA 82-4-376 the Maximum Design Earthquake and Earthquake Design Ground Motion (EDGM) has been defined as the 1 in 10,000 year earthquake event which corresponds to a Peak Ground Acceleration (PGA) of 0.35 *g* (where *g* is acceleration due to gravity). The PGA was defined using the United States Geological Survey (USGS) Uniform Hazard Response Spectra (available on the USGS website http://geohazards.usgs.gov/hazardtool/application.php) for the 1 in 10,000 year return period.

3.5.5 Stability Analyses

Stability analyses of the CTF, PWP and NCWR embankments were completed to investigate the slope stability under static and seismic loading conditions. The stability modeling for all structures uses pore water pressures calculated during the seepage analysis. The effects of the groundwater table were incorporated into the stability analysis for the CTF, the only facility excavated into groundwater.

A brief discussion of the methodology and design criteria is presented below, with typical cross-sections and results. Embankment slope designs are typically developed using the maximum cross-section for risk analysis. This is because, the higher a slope is built, the less stable it becomes due to the loading force on the embankment from the weight of the construction materials. Therefore, the maximum cross section typically represents the highest risk scenario. Both the internal and external slope embankments of the CTF have also been shown to provide long-term geotechnical stability (Section 3.5.5.4, CTF Stability analysis) as designed. A detailed discussion on the methodology, assumptions and results of the stability analyses is presented in Knight Piésold (2017a) in Appendix K.

3.5.5.1 Modeling Approach

The stability analyses were carried out using the limit equilibrium computer program SLOPE/W (Geostudio, 2012). This program uses a systematic search to obtain the minimum factor of safety from a number of potential slip surfaces. The factor of safety is the ratio of the strength of the designed structure over the loads acting on the structure. Factors of safety were calculated using a slope stability analysis method known as the Morgenstern-Price Method.

3.5.5.2 Design Criteria

Knight Piésold utilized a target minimum factor of safety of 1.5 as the design criteria for the stability analyses, in accordance MCA 82-4-375 through 380 design requirements and standard industry practices for dam design. MCA-82-4-376 defines the minimum acceptable factor of safety under static loading conditions as 1.3 for end of construction, 1.5 for long-term operations and closure, and 1.2 for post seismic scenarios. A factor of safety of 1.2 is acceptable for post-earthquake (seismic) loading conditions provided that the resulting embankment deformations or crest settlements are not large enough to cause a release of stored water or tailings, and that the overall stability and integrity of the embankment is maintained. The target factor of safety used by Knight Piésold for the design of the Project facilities exceeds MCA-82-4-376 guidelines and is a conservative design criteria.

3.5.5.3 Material Strength Parameters

The material unit weights and effective strength parameters for soil and rock types used in the analyses are provided in Table 3-18 and Table 3-19, respectively.

Table 3-18. Soil Strength Parameters

Material Type	Model	Unit Weight	Effective Friction
		(kN/m^3)	(Degrees)
Fresh Shale Rock Fill (Embankment Fill)	Shear/Normal Function (Lower Leps[2])	21	-
Tailings + 0.5-2% Additives[1]	Mohr-Coulomb	22	45

NOTES: 1. Additives to include cement, fly ash and/or slag.
2. Leps Reference: Leps (1970)
3. Table from Appendix K (Knight Piésold, 2017a)

Table 3-19. Rock Strength Parameters

Rock Type	Model	Unit Weight	GSI	UCS	m_i	D
		(kN/m^3)	-	(MPa)	-	-
Shale (Highly Weathered)	Generalized Hoek-Brown Criteria	22	30	10	6	0
Shale (Moderately Weathered)	Generalized Hoek-Brown Criteria	23	40	40	6	0
Shale (Fresh)	Generalized Hoek-Brown Criteria	24	50	50	6	0

NOTES: Table from Appendix K. Parameter definitions from Hoek et al. (2002) include: GSI = Geological Strength Index; UCS = Uniaxial Compressive Strength; m_i = Hoek-Brown constant for intact rock pieces; D = disturbance factor

3.5.5.4 CTF Stability Analyses

The factors of safety were evaluated for the following cases of the CTF during steady-state conditions:

- End of construction (static only)
- During operations (static and seismic), and
- Post-closure (static and seismic).

The CTF stability analysis is based on the maximum cross-section through the main (eastern) CTF embankment. Analyses were carried out for the following CTF embankment configurations:

- Final embankment (Crest elevation 1,799 m, approximately 46 m high) with no tailings deposition and no retained water (upstream and downstream failure mode).
- Final embankment (Crest elevation 1,799 m) with tailings deposition and storm storage up to Elevation 1,781 m (upstream and downstream failure mode).
- Final embankment (Crest elevation 1,799 m) with full tailings and storm storage up to elevation 1,797 m (downstream failure mode only)

The cross-section used in the CTF stability analyses is shown on Figure 3.14. The factors of safety for the CTF are shown on Table 3-20. The CTF embankment exceeds the factor of safety requirement for all cases modelled. The critical failure surface and factors of safety for each configuration analyzed are presented in Appendix K, (Knight Piésold 2017a). The effects of the groundwater table were incorporated into the stability analysis for the CTF, the only facility excavated into groundwater (Figure 3.14, blue line beneath the impoundment). Because of the double HDPE bottom liners and sandwiched geonet drain layer that drains to an internal sump, there should be minimal seepage through manufacturing defects in the upper liner (16 L/day) and therefore no hydrostatic head on the bottom liner. Seepage through the bottom liner is therefore determined to be negligible. In addition, the foundation drain system is designed to divert groundwater beneath the facility (estimated flow 15 gpm) also resulting in no hydrostatic head or pressure against the bottom liner from below. The installation of the foundation drain system will be optimized during construction to intercept groundwater flows. Water from the foundation drain will be collected in the foundation drain pond and pumped back to the CTF sump operationally prior to treatment. Water quality will be monitored in the foundation drain pond in both operations and in closure. In addition Figure 3.36 shows that the natural groundwater table is below the embankment footprint, and therefore will not impact embankment stability. Both the internal and external slope embankments have also been shown to provide long term geotechnical stability (Section 3.5.5.4, CTF Stability analysis).

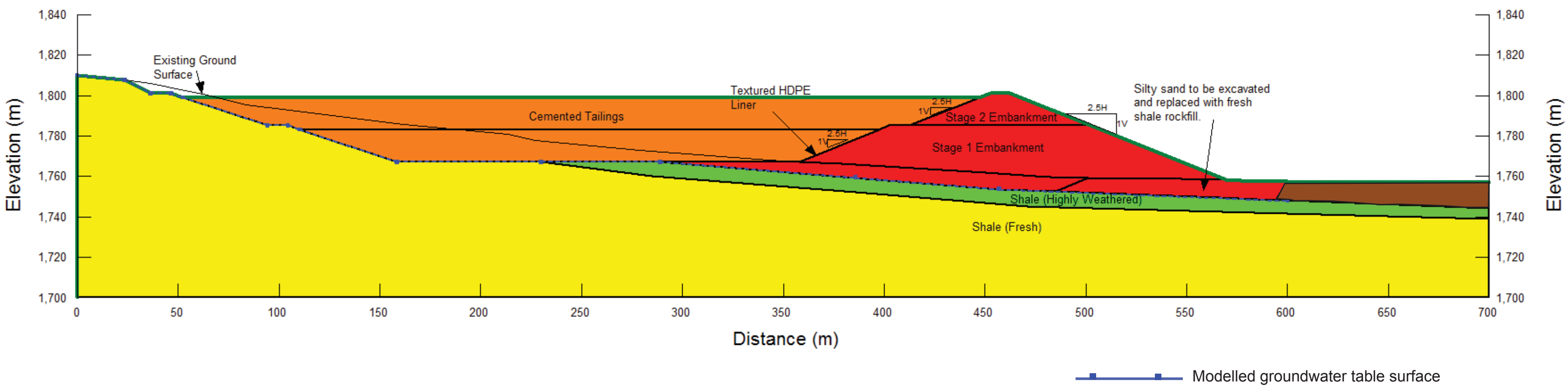
Table 3-20. Results of CTF Stability Analysis

Slip Surface Direction	End of Construction			Post-Closure	
	Short-term Stage 1 End of Construction	**Final (Stage 1)** tailings to El. 1781 m (Operating Conditions)		**Final (Stage 2)** Tailings and Storm Water to El. 1797 m	
	Static	**Static**	**Seismic**	**Static**	**Seismic**
Required Minimum Factor of Safety	**1.3**	**1.5**	**1.2**	**1.5**	**1.2**
Upstream	2.5	2.5	1.6	n/a	n/a
Downstream	2.3	2.3	1.5	2.3	1.5

S

CTF Stability Analysis Cross-Section

N



Results of CTF Stability Analysis

Slip Surface Direction	End of Construction			Post-Closure	
	Short-term Stage 1 End of Construction	**Final (Stage 1)** Tailings to El. 1781 m		**Final (Stage 2)** Tailings to El. 1797 m	
	Static	**Static**	**Seismic**	**Static**	**Seismic**
Required Minimum Factor of Safety	**1.3**	**1.5**	**1.2**	**1.5**	**1.2**
Upstream	**2.5**	**2.5**	**1.6**	**n/a**	**n/a**
Downstream	**2.3**	**2.3**	**1.5**	**2.3**	**1.5**

Prepared by Knight Piesold (2016)

TINTINA RESOURCES

Figure 3.14
CTF Stability Analysis Cross-Section
Mine Operating Permit Application
Meagher County, Montana

3.5.5.5 PWP Stability Analyses

The calculated factors of safety for the PWP embankment exceed the minimum requirements for short term and long-term stability during steady-state conditions.

The following cases were evaluated for the PWP embankment:

- End of construction (static and seismic), and
- During operations (static and seismic)

The stability analysis for the PWP was based on the maximum cross-section through the northern PWP embankment. The analyses were carried out for the following configurations:

- Final embankment (Crest El. 1,800 m) with no retained water (upstream and downstream failure mode), and
- Final embankment (Crest El. 1,800 m) with retained water up to El. 1,798 m (downstream failure mode only)

The cross-sections used in the stability analyses of the PWP are shown on Figure 3.15. The factors of safety for the PWP section are shown on Table 3-21. The PWP also embankment exceeds the factor of safety requirement for all cases modelled. The critical failure surface and factors of safety for each configuration analyzed are presented in Appendix K (Knight Piésold 2017a).

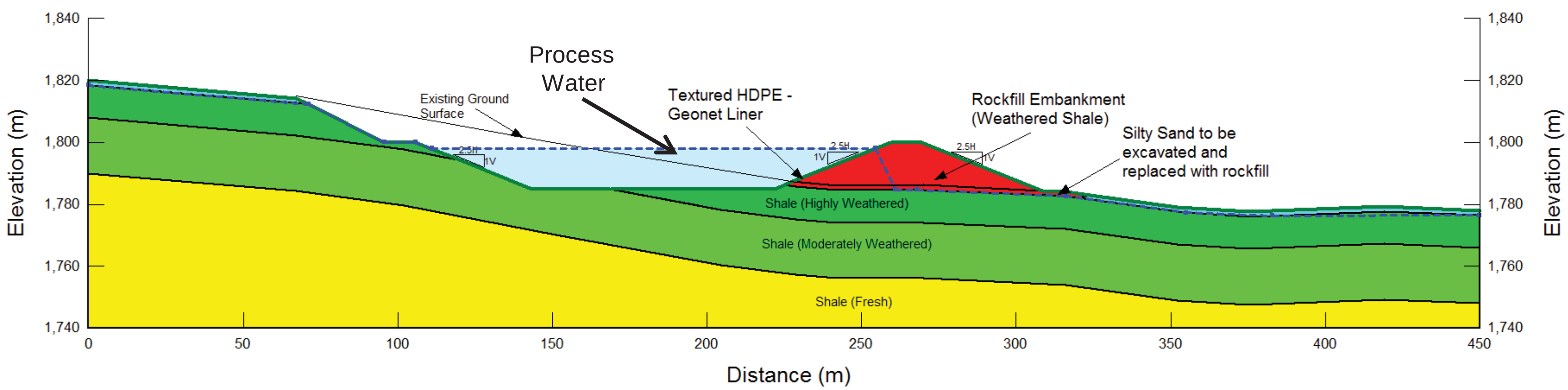
Table 3-21. Results of PWP Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions	
	Static	Seismic	Static	Seismic
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**
Upstream	2.5	1.6	n/a	n/a
Downstream	2.5	1.6	2.5	1.6

W

PWP Stability Analysis Cross-Section

E



Results of PWP Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions	
	Static	Seismic	Static	Seismic
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**
Upstream	**2.5**	**1.6**	**n/a**	**n/a**
Downstream	**2.5**	**1.6**	**2.5**	**1.6**

Prepared by Knight Piesold (2016)

TINTINA RESOURCES

Figure 3.15
PWP Stability Analysis Cross-Section
Mine Operating Permit Application
Meagher County, Montana

3.5.5.6 NCWR Stability Analysis

As with the CTF and PWP, the calculated factors of safety values for the NCWR embankment exceed the minimum requirements for short-term and long-term stability during steady-state conditions.

The following cases were evaluated for the NCWR embankment:

- End of Construction (static and seismic),
- During Operations (static and seismic), and
- Rapid Drawdown during Operations (static only).

The stability analysis for the NCWR was based on the maximum cross-section through the NCWR embankment. The analyses were carried out for the following configurations:

- Final embankment (Crest El. 1,776.5 m) with no retained water to simulate end of construction conditions (upstream and downstream failure mode),
- Final embankment (Crest El. 1,776.5 m) with retained water up to El. 1,776 m to simulate operating conditions (upstream and downstream failure mode), and
- Final embankment (Crest El. 1,776.5 m) with rapid drawdown of retained water to El. 1,764 m (over 24 hours) with buildup of excess pore pressures within NCWR embankment (upstream failure mode only).

The cross-sections used in the stability analyses of the NCWR are shown on Figure 3.16. The factors of safety for the NCWR section are shown on Table 3-22. As with the CTF and PWP the NCWR embankment exceeds the factor of safety requirement for all cases modelled. The critical failure surface and factors of safety for each configuration analyzed are presented in Appendix K (Knight Piésold 2017a).

Table 3-22. Results of NCWR Stability Analysis

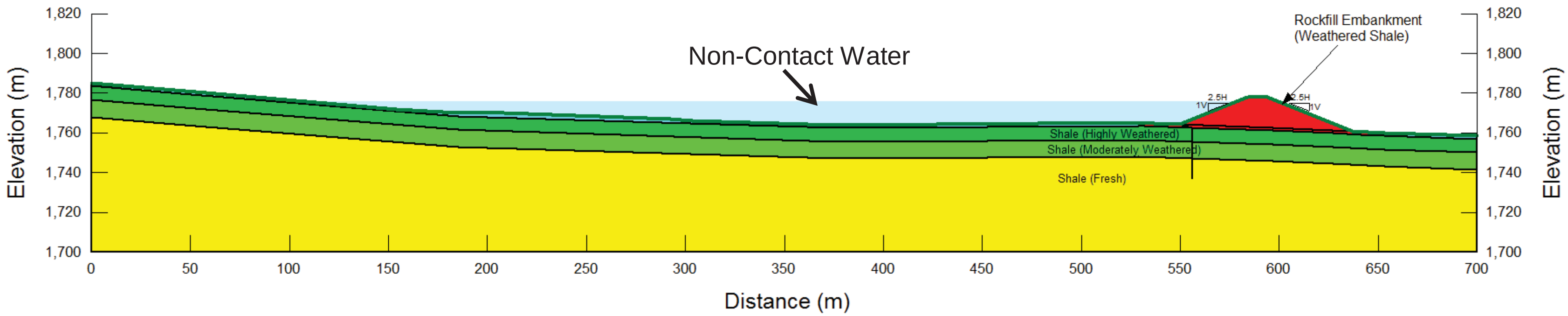
Slip Surface Direction	End of Construction		Operating Conditions		Rapid Drawdown
	Static	Seismic	Static	Seismic	Static
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**	**1.1**
Upstream	2.5	1.6	n/a	n/a	1.5
Downstream	2.5	1.6	2.0	1.3	n/a

The effects of hydraulic pressures against the liner on the upstream face of the embankment are discussed in section 3.6.9.3 (NCWR Embankment Fill Zone).

W

NCWR Stability Analysis Cross-Section

E



Results of NCWR Stability Analysis

Slip Surface Direction	End of Construction		Operating Conditions		Rapid Drawdown
	Static	Seismic	Static	Seismic	Static
Required Minimum Factor of Safety	**1.3**	**1.2**	**1.5**	**1.2**	**1.1**
Upstream	**2.5**	**1.6**	**n/a**	**n/a**	**1.5**
Downstream	**2.5**	**1.6**	**2.0**	**1.3**	**n/a**

Prepared by Knight Piesold (2016)

TINTINA RESOURCES

Figure 3.16
NCWR Stability Analysis Cross-Section
Mine Operating Permit Application
Meagher County, Montana

3.5.6 Longevity of HDPE Geomembranes

HDPE geomembrane liner systems will be used in various facilities (discussed in Section 3.6 below) to provide containment of tailings solids, process water, copper-enriched rock, waste rock and contact water. For most facilities used for the Project a 100 mil (0.1 inch) liner thickness is specified, and some facilities (CTF and PWP) are double lined with a geonet drainage layer between the liners. Therefore, a discussion of the longevity of the proposed HDPE geomembrane liners for the intended applications is appropriate (see Knight Piésold, 2016b and Appendix K-3, Life Expectancy of HDPE Geomembrane Lining Systems).

HDPE geomembranes are very durable products that are typically designed with service lives as long as several hundreds of years under ideal conditions (Koerner *et al*., 2016; Rowe and Sangam, 2002; Koerner *et al*., 2005). Degradation of HDPE geomembrane is typically caused by oxidation, which is primarily driven by either thermo-oxidative (temperature based) or photo-oxidative ageing (UV exposure based). Degradation may increase the likelihood of stress cracking or failure and therefore limiting exposure of the geomembrane to sunlight and heat is the most effective way to maximize its lifespan.

The service life (lifespan) of a geomembrane liner is defined as its half-life (defined below) and is affected by physical degradation and chemical resistance that includes three stages (Koerner *et al.,* 2005):

- Stage A: Depletion time of antioxidants
- Stage B: Induction time to onset of degradation
- Stage C: Time to reach the service life, specified as the 50% degradation point (half-life) of the elasticity of the geomembrane.

3.5.6.1 *Physical Degradation*

The half-lives of HDPE geomembranes are estimated through laboratory testing of samples and monitoring of existing lined impoundments (Tarnowski and Baldauf, 2006). Laboratory testing involves incubating samples of HDPE geomembrane at high temperatures in dry and wet conditions for extended periods of time. Measurements of anti-oxidant depletion and physical degradation of the samples are taken and the results are used to extrapolate geomembrane performance at lower temperatures.

The performance of some lining systems installed in the 1970's has been monitored by various researchers over the years (Tarnowski and Baldauf, 2006; Rowe and Sangam, 2002). The anti-oxidant levels and stress crack resistance has been measured on samples from different impoundments around the world. It was found that anti-oxidant depletion occurred on the exposed surfaces of the geomembranes, indicating that geomembrane thickness plays a significant role in the durability of lining systems (Tarnowski and Baldauf, 2006). It was also observed from these past studies that there was no detectable decrease in the tensile resistance (ability to stretch without tearing) of the samples, despite the anti-oxidant depletion.

Geomembranes maintain integrity and function beyond the 50% degradation point although at a reduced performance level. During the service life the impermeability is not impacted, which is a clear advantage of HDPE. Lifetime predictions of unexposed liners are determined primarily by the average field temperature. HDPE lining systems used at 68°F (20°C) from other project sites around the world have been estimated to last up to 449 years (Koerner et al., 2005), although higher temperatures may decrease the service life.

Other advantages of HDPE-products based on their molecular structure include:

- Chemical resistance
- Ageing resistance
- Stress crack resistance, and
- Service life of HDPE – geomembranes.

Frost / ice protection was not included as part of the Project design stage. However, ice protection such as a rub sheet or other measures will be included in the final construction level drawings.

3.5.6.2 Chemical Resistance

The chemical resistance of HDPE products has been investigated by several groups over the past decades, and test results have shown that most chemical compounds across a wide range of concentrations (including sulfuric acid) do not typically cause mechanical or chemical degradation especially at average climatic conditions of 68ºF (20ºC) or less. Double-lined containment with a seepage collection and removal system, which is included for the CTF at the BBC project, will prevent continuous exposure of the secondary (lower) geomembrane to water and acid. As a result of this, and for the reasons described above, chemical dissolution of the HDPE geomembrane planned for use at the BBC project site will not affect the longevity of this geomembrane.

3.5.6.3 Installation Quality Assurance and Quality Control

As previously discussed in Section 3.4.2.1, Tintina commits to a QA / QC program of construction oversight and materials testing, including embankment construction, material compaction and liner installation by third party independent contractors where appropriate, and where specified by the MMRA.

There are numerous ASTM standards for HDPE liner (QA/QC), and conformance testing that can be followed during construction and installation of liners. These include:

- Conformance testing using an independent laboratory,
- Taking random samples at a pre-determined frequency and spacing,
- Confirming the manufacturer's QA/QC tests, and
- Demonstrating that independent testing was performed by the owner/engineer.

Other QA/QC measures that may be employed during the installation of the HDPE liners to assure liner integrity and longevity include:

- Destructive testing of seams (typically performed once per 500 lineal feet and performed on portions of seams that are removed for testing) that includes shipping to independent laboratories for testing and air channel testing for hot wedge welds,
- Non-destructive testing of seams (i.e. performed on 100% of all field seams and vacuum box testing for extrusion welds),
- Surveying of sample locations, and
- Documentation of all testing protocols and results.

Tintina commits to this level of QA/QC testing.

3.5.6.4 Project Liner Systems and Estimated Longevity

As previously discussed, the lining systems designed for the CTF, PWP, WRS and copper-enriched rock pads at the Project are specified at 100 mils (0.1 inches). The CTF and PWP will be double lined and "sandwiched" around a high-flow geonet drainage layer. In closure, at the end of the 15-year active mine life, double liners on the CTF will be completely covered by tailings, a welded HDPE cover, and minimum of four feet of fill materials with a vegetative cap. This will create optimal conditions for maximizing the service life of the geomembrane. Average warm month (May through September) field temperatures at the project site range from 44.6º to 61.7ºF (7° to 16.5°C) (Table 2-2). The temperature variations that the Project lining systems will be exposed to will be considerably less due to the placement of cover materials over the lining system during construction of the facility. The cover materials to be placed on the CTF HDPE lining system, include: sub-grade bedding material, deposited tailings, and waste rock (see Figure 3.36, Basin Drain - Section A).

The upper geomembrane layer will be mostly covered during construction of the CTF with the materials described above, and will be progressively submerged by tailings during operations, limiting its exposure to UV radiation and air for the 15-year active mine life. The lower geomembrane will be quickly covered by the upper liner and the materials described above, and will only be exposed to UV radiation for a few weeks during construction. Overall average monthly temperatures at the project site of 37ºF (2.8ºC) as stated in Table 2-2, is optimal for inhibiting chemical degradation of the CTF geomembrane.

Based on the design details of the Black Butte Copper CTF HDPE lining system as described above, the ambient temperature range documented at the project site (Table 2-2), and the recommended CTF construction method defined above (i.e. materials placed on top of the CTF lining system) that implements typical QA/QC and conformance testing protocols as defined above, Knight Piésold (2016b) estimates the service life of the CTF lining system to be in the order of 400 years or more.

3.5.7 Seepage Analysis

3.5.7.1 Modeling Approach

This section provides a brief discussion on potential seepage rates during operations of the CTF, PWP, and NCWR. Detailed discussions on the modeling approach, assumptions, and results are presented in Appendix K (Knight Piésold 2017a).

As previously discussed in Section 3.5.2 above, the CWP, CTF, and PWP facilities will be double lined impoundments that have two layers of HDPE geomembrane with a layer of high-flow geonet sandwiched in between the 100 mil HDPE geomembranes. The geomembrane is intended to be impermeable with seepage only possible through defects that may occur during fabrication and/or installation. Seepage through the geomembrane liner systems of the CTF and PWP was modelled using both empirical seepage rate equations and numerical modeling. Empirical methods were based on Giroud and Boneparte (1988a) and numerical modeling was completed using the 2D finite element computer program SEEP/W (Geostudio, 2012).

The lining systems in the CWP, CTF, and the PWP will significantly limit the potential seepage from the facility to flow through potential defects in the geomembrane. Leakage through the lining systems was modelled using empirical leakage rate equations, which assume a number of defects per hectare (acre) for various geomembrane installation methods. This assessment was carried out to determine potential leakage flow rates through the lined facilities during operations of the CTF and the PWP.

3.5.7.2 CTF and PWP Seepage Analysis

Regulatory agencies frequently require a facility seepage analysis, however, most of the calculations involve fixed manufacturer tested defect spacing. The double-lined system of the CTF was modelled for seepage in two separate analyses. The first analysis modelled seepage from the cemented tailings through the upper liner into the geonet. This seepage rate was estimated by modeling a vertical column that represents a unit area of the geomembrane with a single defect, tailings and ponded water. This scenario conservatively represents the CTF in a post storm event condition, where water will be temporarily stored within the CTF until it is pumped to the PWP. The seepage rate through the liner was calculated by multiplying the results of the model by the surface area of the CTF assuming a single 2 mm defect is present for every 1 acre (0.4 ha) of geomembrane (Giroud & Bonaparte, 1989a & 1989b, and Giroud, 1997). The estimated potential seepage rate from the CTF to the geonet under the fully saturated condition modelled is approximately $2x10^{-7}$ m^3/s or 4.2 gallons/day (16 Lpd). However, the CTF will be operated with a small volume of stored water (little or no surface pond and often with small volumes of water stored only in the footprint of the sloping sump 130 x 160 feet; 40 x 50 m) so the actual rates of seepage are anticipated to be far less.

The second seepage analysis of the lower CTF geomembrane modelled the head pressures present between the upper and lower geomembrane (the thickness of the geonet) with defect density of two 2 mm defects per 1 acre (0.4 hectare) of the geomembrane (US EPA, 1992). Knight Piésold estimated the potential maximum seepage through the bottom geomembrane layer to the foundation drain system to be on the order of $3x10^{-6}$ m^3/s, which exceeds the estimated seepage from the upper liner by an order of magnitude. Therefore, total potential seepage from the facility will be limited by the upper liner at a rate of 4.2 gallons per day (16 Lpd), and even then only under conditions where the CTF is inundated with water for a prolonged period of time. Seepage through the CTF Liner System will be collected in the CTF foundation drain system (discussed in more detail in Section 0).

The double-lined system of the PWP was also modelled for seepage in two separate analyses. The first analysis modeled seepage through the upper geomembrane to the geonet layer, influenced by head pressure from the full column of pond water and assuming a defect density of one 2 mm defect per 1 acre (0.4 hectare) (Giroud & Bonaparte, 1989a & 1989b, and Giroud, 1997). The analysis of the lower geomembrane modelled the head pressures present between the upper and lower geomembrane (the thickness of the geonet) with defect density of two 2 mm defects per 1 acre (0.4 hectare) of the geomembrane (US EPA, 1992). Knight Piésold estimated the potential seepage rate from the PWP to the geonet layer at approximately $6x10^{-4}$ m^3/s, and the resultant seepage through the bottom geomembrane layer to the foundation drain system to be on the order of $3x10^{-7}$ m^3/s to $1x10^{-6}$ m^3/s, which equates to approximately 26 to 86 Lpd (6.9 to 22.7 gpd). This foundation drain seepage reports to a seepage collection pond which is pumped back to the PWP.

3.5.7.3 NCWR Seepage Analysis

A seepage analysis was done to determine the approximate rate of water leakage from the NCWR through the topsoil / subsoil and weathered bedrock that comprise the impoundment foundation, and to assess the need for alternative seepage control measures.

Two seepage analyses were completed on the NCWR under the following different conditions:

- The embankment overlies weathered bedrock with no seepage control measures in place aside from the HDPE liner on the upstream face of the embankment, which is anchored into dense ground.

- A grout curtain is included in the weathered bedrock at the upstream toe of the embankment.

It was determined that the rate of water loss to seepage and evaporation from the NCWR when at full capacity is approximately 47,000 cubic yards (36,000 m^3) annually, or 130 cubic yards or 26,257 gallons (100 m^3) per day, of which approximately 117 cubic yards or 23,630 gallons (90 m^3) per day is attributed to seepage.

A linear, vertical line extending from the surface to unweathered bedrock was modelled in the seepage analysis to examine the possible effects of a grout curtain constructed beneath the NCWR's downstream embankment. This barrier was assigned a conductivity of 1x10^{-8} m/sec. It was determined that the installation of a grout curtain does not significantly impact seepage rates out of the NCWR as head pressures from the overlying pond, forces water flow beneath the distal extent of the grout curtain. It was therefore, determined that the grout curtain would not be included.

The actual discharge rates and periods of active (vs. seepage) discharge from the pond will be controlled by water right requirements for surface water mitigation that is overseen and regulated through permitting by the Montana Department of Natural Resources and Conservation (DNRC).

3.5.8 Tailings Characteristics

Physical testing was conducted on samples of tailings obtained from metallurgical testing. Index and consolidation testing was conducted by Knight Piésold (2017a) to characterize the physical properties, and estimate the settled dry density of the cemented tailings deposited into the CTF. Based on Knight Piésold (2017a) index test work results (see Appendix K), the following tailings properties have been adopted for the CTF design:

- Solids content by weight: 79%,
- Specific gravity of the tailings solids: 3.77,
- Average settled dry density: 2.0 tonnes/m^3, and
- Approximate grain size of the tailings: 94% of the tailings pass the 75 micron (No. 200 sieve).

The results of the tailings characterization test work are presented in Appendix K of this document.

Additional index, chemical, and mineralogical testing of the tailings were conducted by Amec Foster Wheeler (Amec) at its Hamilton, Ontario Laboratory (Amec Foster Wheeler, 2015a) with results presented in Appendix K-5 of this document. The tailings test work targeted:

- A cemented paste (CP) mix design for surface deposition with certain specific targeted physical paste properties, and

- A cemented paste backfill (CPB) design with certain specific physical paste properties.

Both are described in Section 3.5.9. The average hydraulic conductivity of the tailings from the Amec Foster Wheeler test work was 2.9 x 10^{-7} cm/s (see Appendix K-5).

The major oxide chemistry of the Project tailings is shown in Table 3-23 below. Multi-element ICP geochemistry of "raw" tailings are also shown in Table 4-1 in Appendix D.

The primary minerals occurring in the tailings are pyrite and quartz.

Binding agents, a mix of 0.5-2% cement, fly ash, or slag by weight for surface deposition will be added to the tailings during thickening that will create a non-flowable mass after deposition. The binder and paste testing methodology and results are presented in Section 3.5.9.

RO brine could also be used in tailings thickener. The effect on concrete properties from what are effectively very low concentrations of chloride, sulfate, and other deleterious ions in the brine will be minor, and will not affect the final strength, very low transmissive character or structure of the cemented tailings. However, the preferred method for brine disposition will be returning it to the PWP for reuse in the mill with ultimate salt disposal with the cemented paste either underground or in the CTF. The proposed binder content for the cemented tailings paste backfill to be placed underground is 4% (by weight) dominated by equal proportions of cement and slag (with lesser or no fly ash additions).

Table 3-23. Chemical Composition of the BBC Tailings

Tailings sample	**LCT Tailings**
Sample Number	**S153-15**
Element Oxide (%)	(%)
SiO_2	37.2
Al_2O_3	1.83
Fe_2O_3	27.6
MgO	0.30
CaO	0.39
Na_2O	0.10
K_2O	0.80
TiO_2	0.07
P_2O_5	0.06
MnO	0.03
Cr_2O_3	0.06
V_2O_5	<0.01
C(t)	0.36
LOI*	18.4
S	24.8
SO_3	-
Sum	**86.8**

NOTES: (1) Data from Amec Foster Wheeler in Hamilton, Ontario, Canada (Amec Foster Wheeler, 2015a)
(2) Tailings sample prepared and shipped to Amec by International Metallurgical and Environmental Inc.
(*) LOI Value affected by large percentage of pyrite in sample; LOI = Loss on ignition

Additional paste design mixes may be tested in the future to optimize the effectiveness for each binder type to meet the rigid requirement for ground control for mining. Over the life of the mine, binder mixes could be modified as the availability of supplies and suppliers change over time.

The proposed binder content for the cemented tailings paste to be placed on the surface in the cemented tailings facility is 0.5 to 2% (by weight) dominated by equal amounts of cement and slag (with lesser or no fly ash additions). Additional paste design mixes may be tested in the future to optimize the effectiveness for each binder type to meet the requirement for a non-flowable mass and weathering responses of the material in the CTF.

The results of the tailings characterization test work are presented in Appendix K of this document (Knight Piésold 2017a, Appendix C of Appendix K).

3.5.9 Binder Sources, Cemented Tailings Paste Suitability, and Laboratory Test Results

This section describes the suitability of the Project cemented tailings paste, and identifies locally available cementitious binders. Characterization of the binders and those incorporated into the Project cement paste (CP) mix designs tested to date for surface deposition (into the CTF) and for cemented paste backfill (CPB) (into the underground workings) is also presented.

The following subsections will:

- Define the physical targets of the paste mix designs for surface deposition and for cemented paste backfill;
- Define the different binder types;
- Identify the local sources of the different available, sustainable, and cost effective binders;
- Report the laboratory test results for the binders, tailings water, and two paste mix designs (one containing 2% binder and another containing 4% binder) that are fully presented in Appendix K-5 of the MOP Application; and
- Summarize the physical and strength paste characteristics containing the 2% and 4% binder mixes.

The tailings material will make up the largest portion of the overall paste mixture and the characteristics and index tests have been previously summarized in Section 3.5.8 (Tailings Characterization) with laboratory test results reported in Appendices K and K5 of this document.

3.5.9.1 Cement Paste Mix Design Physical Targets

Two CP mix design were established early to guide the Project experimental paste program:

- The first cemented paste (CP) mix design is for surface deposition with the following targeted physical paste properties:
    - o Slump for the paste mixes is 7 to 9 inches (~178 - 229 mm) for paste pumpability, and
    - o No requirement for unconfined compressive strength (UCS) was established, since the material is fully contained and laterally supported in the depositional environment. The principal design criteria was for this material to be non-flowable once deposited.
- The second cemented paste design is for underground mine backfill (CPB) with the following targeted physical paste properties:
    - o Slump for the paste mixes is 6 to 8 inches (approximately 152 to 203 mm) for paste pumpability, and
    - o UCS at 14 days for the *UCZ* and *LCZ* is 150 kPa (0.15 MPa).

3.5.9.2 General Binder Types Available for Cemented Paste

Binder is defined as a substance used in construction that sets and hardens and can bind other materials together. The binder may be any cementing material, either hydrated cement or a product of cement or lime and reactive siliceous materials. The kinds of cement and the curing conditions determine the general type of binder formed. Balancing economic factors and performance are the primary concerns focusing research and aiding selection of supplementary cementitious materials (SCM), such as slag, fly ash (FA) and natural pozzolans (see definition below) which can be added to the fill as a partial replacement of Portland Cement (PC). The mixes with SCM have good engineering performance and reduce costs. Among other benefits of using slag, or fly ash (FA), as partial cement replacement compared to PC is their improved resistance to sulfate attack.

Cement is defined as a powdery substance made with calcined lime and clay. It is mixed with water to form mortar or mixed with sand, gravel, and water to make concrete.

Portland cement (PC) is used as a binder in paste backfill where structural strength is required of the backfill and where resistance to liquefaction is necessary.

Slag is a non-metallic binder product, consisting of silicates and alumino-silicates of calcium, magnesium and other bases, developed in a molten condition simultaneously with iron in a blast furnace; when rapidly cooled it forms a glassy granular material that is ground and used as a supplementary cementaceous material additive to cement; as an additive it provides good engineering performance at reduced costs and has significant improved resistance to sulfate attack over cement.

Slag cement is defined as a hydraulic cement formed when finely ground granulated blast furnace slag is mixed with cement.

Fly ash (FA) is "the finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gases" as defined by *ASTM C618 "Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete"*. ASTM C618 covers coal FA and raw and calcined natural pozzolan for use in concrete, where cementitious and pozzolanic action is desired.

Pozzolans are a broad class of siliceous or siliceous and aluminous materials which, in themselves, possess little or no cementitious value but which will, in finely divided form and in the presence of water, react chemically with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties.

3.5.9.3 Testing Methods for Binders and Tailings Water

The different binders may be characterized using the following testing methods: physical, chemical, mineralogical, and strength tests. Many of the physical, strength, and chemical tests follow ASTM and/or American Association of State Highway and Transportation Officials (AASHTO) Standardized Testing Methods and are fully described in Appendix K-5 (K5-B) of this document.

The chemical characterization testing methods for the tailings water includes: pH, dissolved sulphate, dissolved chloride, and metals and is also included in Appendix K-5 (K5-B) of this document.

3.5.9.4 Binder Selection and Sourcing for Use in Paste for Project

Selection and sourcing of potential binders for the Black Butte Copper project included the following:

- Identifying commercially suitable binder types and sources that are sustainable and cost effective for the Project, and
- Identifying and evaluating suitable existing binder manufacturers and sources (plants). This activity focused on reviewing the physical and chemical characteristics for several binders including Portland Cement, slag, and fly ash available in Montana near the Project.

The following binders listed in Table 3-24 are supplied by Lafarge and Holcim and are close enough to the Black Butte Copper project to possibly act as a binder source for the life of the proposed mine. The listed Lafarge and Holcim binders are available at the cement terminals in Missoula and Three Forks, Montana, respectively. Samples of each of the binders listed in Table 3-24 were collected and analyzed by Amec Foster Wheeler in 2015. Physical, chemical, and strength testing were performed for each binder type listed in Table 3-24 and the Lafarge Slag and Lafarge Portland Cement (Type I/II) results are included in Appendix K-5 of this document. All of the listed binders meet the Standardized Testing Methods and/or project paste design specifications (targets) for use in the Project cemented tailings paste for both surface deposition into the CTF and/or as cemented paste backfill underground.

Table 3-24. List of Acceptable Locally-Sourced Binders Available for Use in the BBC Paste

Binder Type	Supplier	Type	Binder Source	Cement Plant Source
Portland Cement	Lafarge	Type I/II	Richmond B.C., Canada	Missoula, Montana
	Holcim	Type I/II	Three Forks, Montana	Trident Plant in Three Forks, Montana
	Holcim	Envirocore Hydraulic Cement Type GU	Three Forks, Montana	Trident Plant in Three Forks, Montana
Slag	Lafarge	Grade 100 NewCem	Seattle (via Asia)	Missoula, Montana
Fly Ash	Lafarge	Type F	Centralia, WA Power Plant	Missoula, Montana

Note: The Lafarge Portland Cement (Type I/II) and the Lafarge Type F Grade 100 NewCem slag were used as the binders for the BBC paste experimental program

3.5.9.5 Lab Test Results for Binder Materials and Tailings Water Characterization

The physical, chemical, and strength test results for the binders are presented in Appendix K-5 (K5-B) of this document. The Portland Cement strength test results (Table 3-25) and chemical test results (Table 3-26) were completed by Amec Foster Wheeler (2015a). Tailings water chemical results are also listed in Appendix K-5 (K5-B) of this document.

Table 3-25. Results of Strength Development Testing for Portland Cements

		Compressive strength (MPa)			
Cement Type		GU*	Lafarge Type I/II	Holcim Type I/II	Holcim Enviroc
Sample No.		NA	S122-15	S134-15	S135-15
Age (days)	3	13.00	27.82	31.15	19.56
	7	20.00	35.42	43.06	26.42
	28	28.00	45.60	47.41	29.89
7-day/28-day (%)		71.43	77.67	90.83	88.39

Notes: (1) *ASTM C1157 standard requirements for hydraulic cements; (2) Data from Amec Foster Wheeler Laboratory in Hamilton, Ontario, Canada

Table 3-26. Chemical Composition of Binders

Binder sample	**Lafarge Portland Cement Type I/II**	**Lafarge Fly Ash Type F**	**Lafarge Slag**	**Holcim Portland Cement Type I/II**	**Holcim Envirocore™**
Sample Number	**S122-15**	**S123-15**	**S124-15**	**S134-15**	**S135-15**
Element Oxide (%)	(%)	(%)	(%)	(%)	(%)
SiO_2	32.0	46.7	20.4	20.2	18.6
Al_2O_3	13.4	18.1	4.83	4.11	4.14
Fe_2O_3	0.99	5.97	3.45	3.29	2.80
MgO	5.08	5.89	0.70	2.37	1.78
CaO	42.3	15.2	63.4	64.6	63.8
Na_2O	0.23	3.11	0.37	0.17	0.12
K_2O	0.41	1.46	0.31	0.49	0.34
TiO_2	0.50	0.95	0.28	0.21	0.22
P_2O_5	0.03	0.41	0.06	0.05	0.05
MnO	0.23	0.10	0.07	0.04	0.04
Cr_2O_3	<0.01	0.02	0.01	0.02	0.02
V_2O_5	<0.01	0.03	0.01	0.01	0.01
C(t)	0.53	0.07	0.58	0.57	1.49
LOI	1.54	0.55	3.13	2.82	6.22
S	1.50	0.35	1.21	1.10	0.91
SO_3	3.75	0.87	3.02	2.76	2.25
Sum	**96.7**	**98.5**	**97.0**	**98.4**	**98.1**

Note: Data from Amec Foster Wheeler Laboratory in Hamilton, Ontario, Canada

3.5.9.6 Paste Mix Procedures, Testing Protocols and Test

Tailings and binder sample handling and shipping details, paste mixing procedures, paste testing protocols, and paste testing methods are all described in Appendix K-5 (K5-C) of this document.

Cemented Paste (CP) mixes were designed to be workable and to meet the project cone slump requirements (targets). The batches used for fresh and hardened paste mix properties had a total batch mass of approximately 51 pounds (23 kg). The amount of water for each batch was determined based on slump measurements conducted in trial batches.

The mixing procedure for the two paste dosages (2% binder content and 4% binder content) is described in Appendix K-5 (K5-C) of this document. The sample preparation and curing was done in accordance with ASTM C192 / C192M – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory. The CSP mixes were batched in a 66 pound (30 kg) capacity rheometer mixer.

Twelve 2-inch x 4-inch (51 mm x 102 mm) and eight 3-inch x 6-inch (76 mm and 152 mm) cylinder specimens were prepared for each mix for density and UCS measurements, as well as specimens for geochemistry and triaxial tests. All of the specimens were cured in the curing room at 20°C (68° F) and 100% relative humidity and demolded prior to the density and UCS tests.

The cemented paste test work was conducted in three sequential steps:

1) Index tests were conducted.
2) Trial batches were conducted to develop mix designs to meet the target properties, including slump, while maximizing the tailings content for a given binder and binder dosage rate. Upon completion of the trial batches the fill and water content for CSP mixes with different binder dosage rates was defined for the full size batches tested in the test program.
3) CSP test program was conducted assuming the following variables (factors):
    - Slump: mixes with one nominal slump value of 8 inches (203 mm) were designed and evaluated in this program.
    - Binder type: one blend of Portland cement Type I/II and slag from Lafarge based on the certificates presented in Appendix K-5 (K5-B) of this document.
    - Binder dosage rate: mixes with two binder dosage rates were evaluated in the test program: 2% and 4%.

Appendix K-5 (K5-C) of this document lists:

- The paste standardized test methods for the fresh mix properties that have been completed for the two different binder dosages: one with 2% total binder (1% Lafarge Portland Cement Type I/II and 1% Lafarge slag), and the other with 4% total binder (2% Lafarge Portland Cement Type I/II and 2% Lafarge slag); and
- The standardized test methods for the hardened properties for the two different binder dosages noted above.

3.5.9.7 Cemented Tailings Paste Test Results Using 2% and 4% Total Binders

The laboratory test results (Amec Foster Wheeler, 2015a) for the two cemented tailings paste mix designs using 2% and 4% total binder dosage rates are presented in Table 3-27, Table 3-28, Table 3-29, Table 3-30, and Table 3-31 below and in Appendix K-5 (K5-C) of this document. Each paste sample tested used 50% Lafarge Grade 100 NewCem slag and 50% Lafarge Portland Cement (Type I/II) sourced from the Missoula, Montana cement plant.

Table 3-27. Surface Paste Mix Designs (Cylinder Slump)

No.	Mix Label	Binder type (%)		Binder dosage rate	Cw	Cylinder slump	
		PC	Slag	(%)	(%)	(mm)	(inches)
1	LCT-S50-2	50	50	2	79.50	16	0.63
2	LCT-S50-4	50	50	4	79.00	15	0.59

Note: The term “Cw” represents the total solids content of the mix, accounting for all water (both mix water and absorbed water on the aggregate). For example, a mix with 165 pounds (75 kg) of dry aggregate, 11 pounds (5 kg) of dry binder, and 44 pounds (20 kg) of water would have a Cw of 80.0%.

Table 3-28. Surface Paste Mix Designs (Cone Slump)

No.	Mix Label	Cone slump		Testing age	Cylinder specimen
		(mm)	(inches)	(days)	
1	LCT-S50-2	210	8.27	7, 14, 28, 56	2"x4", 3"x6"
2	LCT-S50-4	205	8.07	7, 14, 28, 56	2"x4", 3"x6"

The hydraulic conductivity of the two different paste mixes is described in Table 3-29.

Table 3-29. Hydraulic Conductivity of Paste With 2% and 4% Total Binders

Sample Tested		Surface paste 2% binder, 50%Slag-50% PC	Surface Paste 4% binder, 50%Slag-50% PC
Sample Number		LCT-550- 2	LCT-550-4
Test Method	Results	(cm/s)	(cm/s)
Hydraulic conductivity (k)	Average inflow (run #1	1.69×10^{-06}	9.50×10^{-09}
	Average outflow (run #1)	1.64×10^{-06}	1.09×10^{-08}
	Average of inflow and outflow (run #1)	1.66×10^{-06}	1.02×10^{-08}
	Average inflow (run #2)	-	-
	Average outflow (run #2)	-	-
	Average of inflow and outflow (run #2)	-	-
	Overall Average	1.6×10^{-6}	1.0×10^{-8}

Note: PC = Portland Cement (Type I/II); Data from Amec (2015a)

Table 3-30. Trial Batches Paste 2% Binder.

No.	Cw	Cylinder slump		Cone slump	
	(%)	mm	inches	mm	inches
1	80.00	14	0.55	155	6.1
2	79.50	16	0.63	210	8.3

Note: The term "Cw" represents the total solids content of the mix, accounting for all water (both mix water and absorbed water on the aggregate). For example, a mix with 165 pounds (75 kg) of dry aggregate, 11 pounds (5 kg) of dry binder, and 44 pounds (20 kg) of water would have a Cw of 80.0%.

Table 3-31. Trial Batches Paste 4% Binder.

No.	Cw	Cylinder slump		Cone slump	
	(%)	mm	inches	mm	inches
1	82.00	0	0.00	0	0
2	81.50	6	0.24	65	2.6
3	81.00	10	0.39	80	3.1
4	80.00	10	0.39	115	4.5
5	79.00	15	0.59	205	8.1

The following are significant conclusions resulting from the cement tailings paste test work:

- The optimum total solids content (C_w) for the 2% binder mix is 79.5% at a cone slump of 8.3 inches (21.1 cm),
- The optimum C_w for the 4% binder mix is 79% at a cone slump of 8.1 inches (20.6 cm),
- The 2% binder mix does not achieve final set until approximately 28 days age,
- The 4% binder mix achieves final set after approximately 96 hours (4 days),
- All the 28 day UCS test results for the 4% binder mix show a continued increase in strength when compared to 7-day results, and
- The 4% binder mix achieves compressive strengths of 0.85 MPa at 7 days, and 1.12 MPa at 28 days.

3.6 Infrastructure Support and Waste and Water Management Facilities

Below is a list of major surface mine support facilities. Each is described in detail in the subsections that follow.

- Roads
- Portal pad
- Waste Rock Storage pad and Copper-enriched Rock Stockpile
- Process Water Pond (PWP)
- Contact Water Pond (CWP)
- Cemented Tailings Facility (CTF)
- Non-Contact Water Reservoir (NCWR)
- Material stockpiles
- Pipelines
- Equipment and contract manpower required for site facility construction

Many of the detailed conceptual design drawings of facilities are presented in Knight Piésold (2017a and 2017c) (Appendix K and Appendix K-1, respectively). Separate construction drawings for the facilities will be finalized later. Detailed conceptual volumes of the construction materials required to construct all of the facilities along with the generalized sources for these materials are listed in Table 3-14b of the MOP Application.

3.6.1 Roads

3.6.1.1 <u>Existing Highways and County Roads</u>

A traffic impact study will be completed in conjunction with Meagher County Roads Department, the State of Montana Department of Transportation (MDT), and the Federal Highway Administration. This will assess any traffic controls and necessary safety improvements required for the junction of the Project's main access road and the Sheep Creek road, as well as the intersection of the Sheep Creek road with US 89. The intersection of the county road and US 89 is located just south of a blind near right-angle turn along US 89 (Figure 1.3 and Figure 2.29).

Tintina expects to support Meagher County's Roads Department maintenance along the Sheep Creek and Butte Creek roads as necessary, with the level of commitment likely to be determined by interaction between the Company and the County.

3.6.1.2 Main Access Road, and Stream Crossings

The access road route alignment was designed to minimize impacts to local ranchers, sportsmen / sportswomen, property owners, creek crossing widths, impacts to wetlands, and overall travel distances. Maximum grades will be less than 7%, and cut and fill balances will be optimized. The permanent access road (Figure 1.3) will be a private gravel road designed and constructed to Meagher County and Montana MDT specifications and standards. Meagher County construction guidelines use typical road cross-sections and plans from Montana's Local Technical Assistance Program (Figure 3.17). The access road will be designed for a maximum speed of 35 mph, crowned, and have maximum grades of 7%. The roadway will be two lanes, each 12-feet (3.7 m) wide, with minimum 1-foot (0.3 m) wide shoulders developed with side slopes of 2.5H:1V (horizontal to vertical). All mine haul roads will require berms of one-half axle height or greater for the largest truck using the road as per MSHA safety requirements. Similar berms will be constructed along the access road, if determined to be necessary by MSHA. Water diversions off of the main access road, through berms (if they are required) and into storm-water diversion ditches are typically laid-out on a site specific basis taking advantage of natural topography and avoiding diverting storm-water directly into natural ephemeral or perennial drainage channels. In practice, the berms can have openings at any number of pre-planned locations to prevent excessive water flows and eliminate the erosion concerns resulting from storm-water diversion. The access road will support truck loads delivering supplies to the site, and transporting concentrate from the site.

The access road will be gravel surfaced over a compacted sub-grade and crushed gravel upper surface. It will have drainage control, culverts, and sediment control basins. The road will be routinely watered to reduce airborne dust. Other controls for dust may include, speed and traffic controls and treatment with magnesium/calcium chloride. Periodic grading will be conducted as necessary.

Topsoil and subsoil from access road construction will be temporarily stored and reused in concurrent reclamation along the roadways, excess soils will be salvaged separately and transported to stockpiles. Road subgrades will be constructed of clean compacted sub-grade gravel road-base materials and topped with crushed and durable gravel purchased from local off-site quarrying operations. Drainage from the road is deemed to be non-contact water and will be collected in roadside ditches designed to accommodate the 10-year return storm event. Drainage control, culverts, and sediment control basins will be established as necessary along the roadways. The ditches will be hydroseeded with native species or riprapped for erosion protection depending upon the anticipated velocities and volumes in the ditch section. Water will be diverted to natural drainage areas. Crossing culverts will be installed as needed along the route.

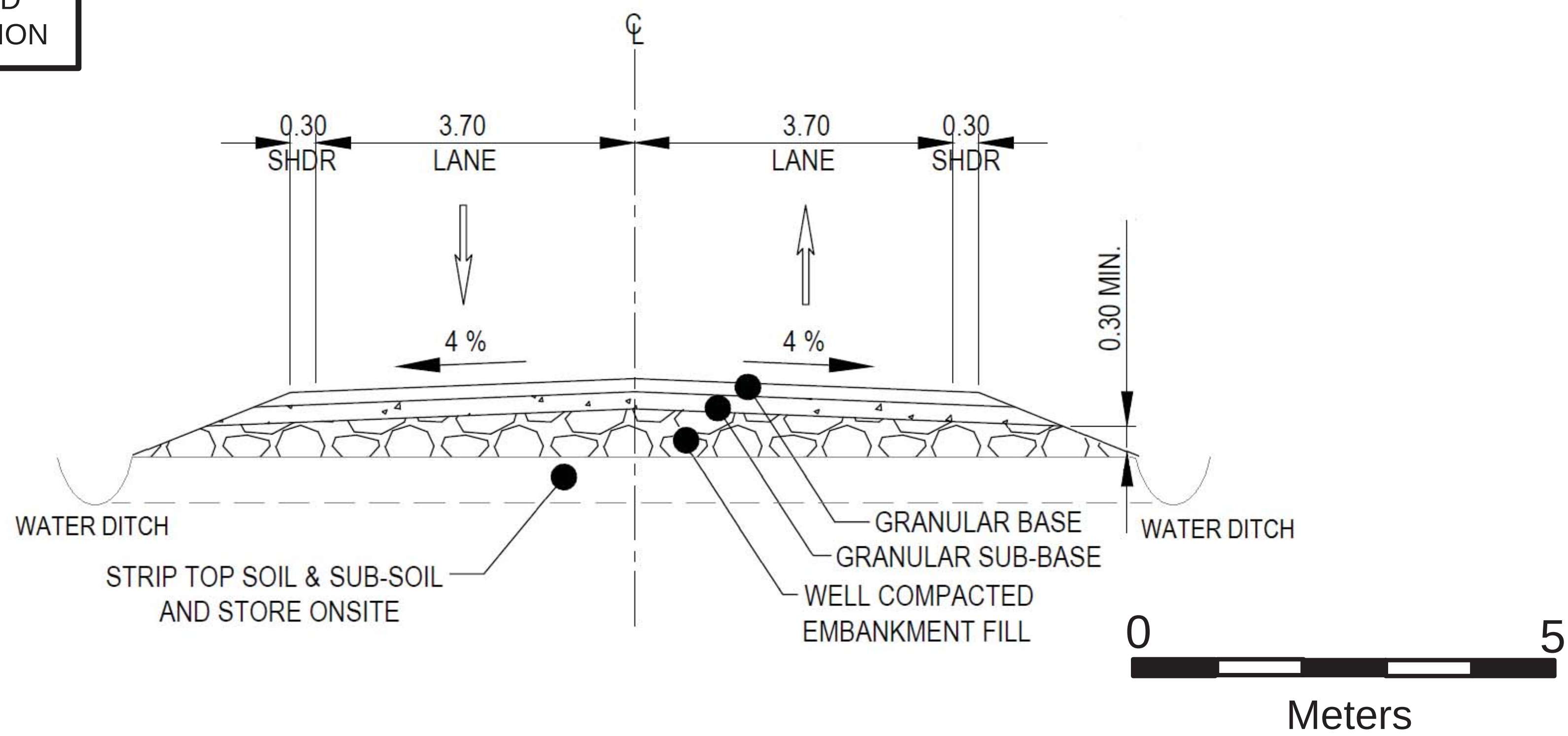
There are two planned creek crossings on the private mine access road (Figure 1.3). The access road crossing on Brush Creek has been relocated for this revision (Revision 3) of the MOP document. As a result of the USACE tribal consultation process and various site visits, Tintina voluntarily moved the access road crossing location on Brush Creek, the nearby buried alluvial conveyance pipeline, and the nearby proposed powerline to avoid a cultural site (Site 24ME1108; Figure 2.27). This revised crossing location slightly decreased the amount of fill within wetlands (<0.01 acres; <0.004 ha) at the Brush Creek crossing. Tintina Resources has subsequently realigned the proposed access road which now passes 100 feet south of Site 24ME1108 (see Figure 1.3 for new location). The sites for stream crossings were selected specifically to minimize impact to wetlands. Impacts are only anticipated to Waters of the US (WOTUS) for these two crossings that involve 0.11 acres (0.04 ha) of wetlands and 154 linear feet (47 m) of streams (see Section 3.8.3). At each creek crossing, a 9.8 foot (3 m) diameter bottomless pipe arch, and two 6 foot (1.8 m) diameter round culverts will be installed, one on each side of the half pipe arch (Figure 3.18). Any storm flow not accommodated is expected to potentially overtop or damage the road requiring occasional repairs. The two creek crossings will permanently impact two wetlands and two streams. These include two areas which are shown on the wetlands delineation map in Appendix C-1 (Westech, 2014). The eastern crossing will impact 0.05 acres (0.02 ha) of wetlands (W-LS-05) and 86 feet of Little Sheep Creek (S-LS-O4). The western crossing will impact 0.06 acres (0.02 ha) of wetlands (W-LST1-02) and 68 feet (21 m) of the Bush Creek tributary to Little Sheep Creek (S-LST-001).

Drainage control will be established along the roadway and the cut and fill slopes to control erosion, and culverts will be installed as necessary. Cut and fill slopes will be revegetated as soon as practicable. Vendor use and deliveries along Project roads will be restricted to daylight hours and week days whenever possible.

There will be a gate and guard house at the western end of the main access road to restrict public access to the mine site (Figure 3.9) along with a set of truck scales in the gate/guard house area.

PRELIMINARY
DRAWING

NOT TO BE USED
FOR CONSTRUCTION

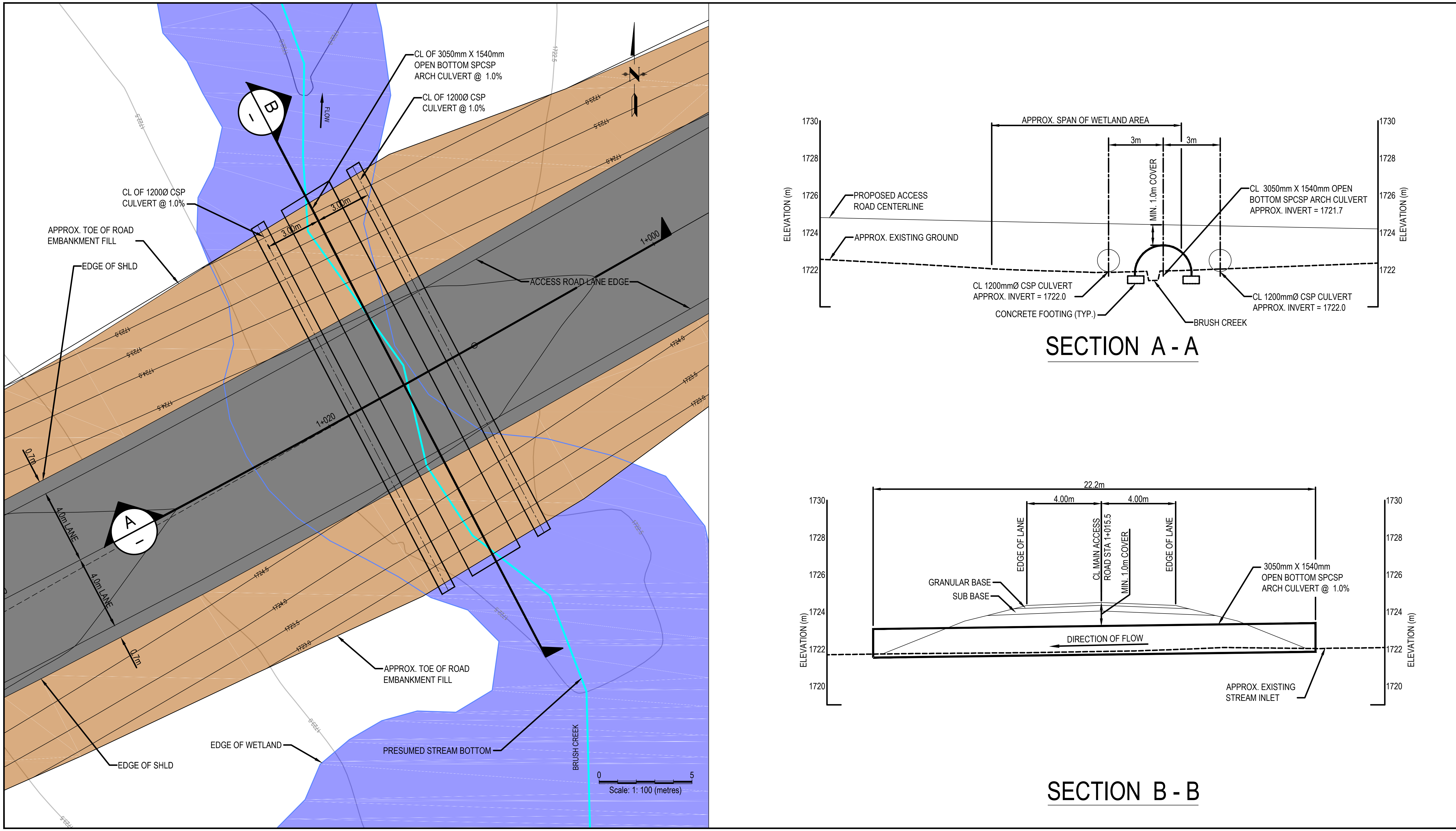


TYPICAL ACCESS ROAD & INTERNAL SERVICE ROAD CROSS SECTION

Prepared by Tetra Tech Inc.

TINTINA RESOURCES

Figure 3.17
Typical Access Road and Internal Service Road Cross-Section
Mine Operating Permit Application
Meagher County, Montana



Prepared by Tetra Tech Inc. (Revised July 2017)

TINTINA RESOURCES

FIGURE 3.18

Stream Crossing Culvert Plan

Black Butte Copper Project

Meagher County, Montana

3.6.1.3 Construction Access Road

A temporary access road will be required during construction of the main access road. Tintina plans on using the existing road entering the site from the west off of the Butte Creek County road (Figure 2.30). A gate will be installed at the west end of this construction access road to prevent the travelling public from entering the site.

3.6.1.4 CTF Road

The proposed CTF road runs, from the portal pad, to the north of the mill pad, and then southeast to the CTF (Figure 1.3 and Figure 3.9). There will be a short branch off the CTF road to access the temporary WRS and copper-enriched rock stockpile pads. The proposed CTF road will be constructed for use by 44 ton (40-tonne) trucks hauling waste rock from underground to the Temporary WRS and copper-enriched rock from underground to its respective stockpile.

The haul road from the portal pad, along the north side of the mill pad and from there to the CTF has the potential to have small amounts of PAG materials along its upper surface, and potentially PAG run-off following storm events. Waste rock material that is moved from underground to the WRS pad and later off the temporary WRS pad to the CTF, is coarse rock. Care will be taken to quickly collect (a daily operations task) and clean up rocks that fall from the haul trucks to minimize the increased costs of tire damage and repairs. Operations personnel from the equipment operators to the supervisors are responsible to keep the road ways clean. The road berms will keep any of the waste rock spillage from the haul trucks on the roads. BMPs that could be implemented during operations are listed in Section 3.7.6. Map 6 shows the site drainage map for the facilities that include diversion ditches and collection ditches, drainage controls, culvert road crossings, and outfalls.

Roadway design criteria for the CTF surface facility road are similar to access roads. Maximum grades are approximately 8% and maximum speed limits on all roads are expected to be approximately 30 mph (50 kph). Speed limits will be finalized by operating management in conjunction with MSHA. The CTF haul road will require berms of one-half axle height or greater for the largest truck using the road as per MSHA safety requirements. Figure 3.19 is a typical CTF road construction cross-section. MSHA berms will be constructed using borrow material generated during road construction. If additional material is needed, it will either be sourced from facility excavation footprints or it will brought in from an outside source as necessary (i.e. as specially prepared construction materials – road base and top dressing).

Topsoil and subsoil from CTF road construction will be temporarily stored and reused in concurrent reclamation along the roadways. Excess soils will be brought to the topsoil and subsoil storage areas west of the CTF. Drainage from the CTF road will be deemed contact water as the road is used to haul waste rock from the mine to the CTF, and most of this water collected in HDPE or half culvert lined roadside ditches that transfer contact water to the CWP for subsequent treatment. Some of the water from the CTF haul road along the east side of the CTF, will need to be diverted to the CTF foundation drain pond, prior to being pumped to the PWP or directly to the water treatment plant. In areas of fill, a “false-ditch” will be designed and constructed in order to capture the contact water. Crossing culverts will be installed as needed along the route.

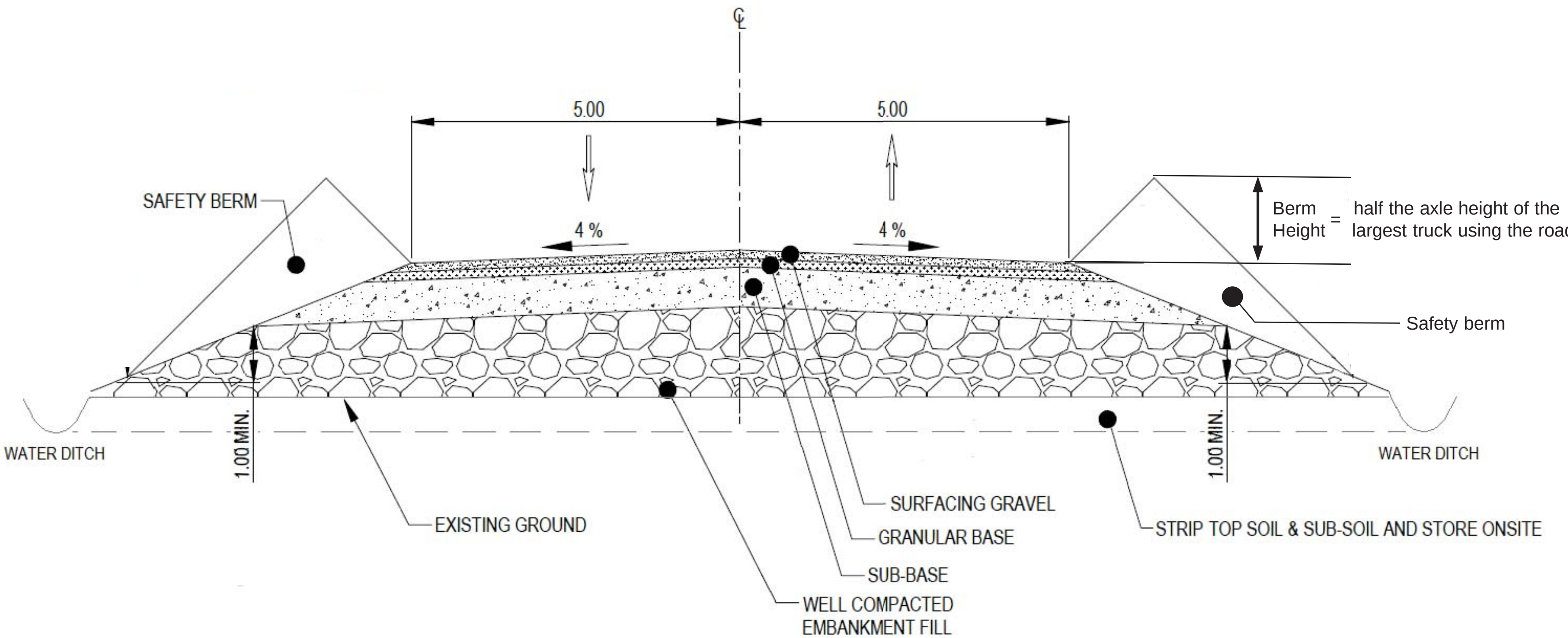
3.6.1.5 Service Roads

Service roads will access the PWP, NCWR, CWP, and topsoil and subsoil storage areas. These internal roads will be designed using applicable low volume road design criteria that include a 16-foot wide roadbed, maximum 8% grade, and 2.5H:1V side slopes and design speeds of approximately 25 mph (40 kph). There will be other minor one lane tracks for maintenance purposes such as beside the mill conveyor, to the west of the portal pad. Road-side ditches for the internal service roads will discharge to their existing drainage catchment outlets. The ditches will be hydroseeded with native species or riprapped for erosion protection depending upon the expected velocities in the ditch section. Crossing culverts will be installed as needed along the route. Impacts are only anticipated to Waters of the US for two service road stream crossings and include 0.02 acres (0.01 ha) of wetlands and 25 linear feet (7.6 m) of streams (Section 3.8.3).

Internal roads are intended to only be used by single haul units and light vehicles.

3.6.1.6 Traffic Controls

A traffic impact study will be completed to assess any traffic control and intersection improvements where the main Project access road ties into the county roads and where the county roads tie into US 89. The posted maximum speed limit for Project roads will be developed by the operating and construction management and MSHA requirements.



PRELIMINARY DRAWING

NOT TO BE USED FOR CONSTRUCTION

TYPICAL CTF ROAD CROSS SECTION
SCALE 1:100

NOTES: (1) Berm size regulated by MSHA
(2) Ditches will be lined with either HDPE or utilize a half culvert that will transfer contact water to the CWP for subsequent storage and treatment.

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TINTINA RESOURCES

Figure 3.19
Typical CTF Road Cross Section
Mine Operating Permit Application
Meagher County, Montana

3.6.2 Power and Powerlines

The primary source of electricity to the site during operations will be by outside feed provided by either Fergus Electric Cooperative or NorthWestern Energy using above ground, overhead power lines. Tintina estimates that its total power requirements for the Project will be approximately 9 to 12 megawatts (MW). Upgraded power lines will be permitted (including the Major Facilities Siting Act (MFSA) responsibilities) and installed by the power provider, and the provider will own the line delivering power to the mine permit boundary. The power supply line will be fed from the existing right-of way adjacent to the Sheep Creek County road, into the permit boundary area just east of the core sheds. The powerline would then continue along a new right-of-way parallel to the Project's main access road, and from there to the electrical substation along the north side of the mill pad. The powerline would continue along a new right-of-way to the electrical substation along the north side of the mill pad. The total length of the powerline within the permit boundary to the substation is a distance of 1.7 miles (2.75 km). With the exception of a surface powerline to the Public Water Supply (PWS) well (1.12 miles, 1.8 km), all other power supply lines would be buried. Figure 1.3 and Figure 3.9 show the powerline location. The substation will reduce the voltage such that it is suitable for the underground and surface uses at the site. Power poles will be single pole and designed to be avian safe with insulated conductors at cross arms. The power poles will be approximately 492 feet (150 m) apart. The estimated total site wide power line length is 2.82 miles (4.55 km) (including the 1.1 mile (1.8 km) line to the PWS well; PW-6). The estimated number of power poles is approximately 30. Power pole installation will avoid impacts to wetlands. Impacts to WOTUS for the water supply line to the PWS well (PW-6, Figure 1.3) are estimated at 0.01 acres of wetlands and 7 linear feet (2.1 m) of streams (Section 3.8.3) where it crosses Coon Creek.

Two diesel EPA Tier 3 or 4 certified and compliant generator sets (a 545 kW and a 320kW) will provide power on the portal pad prior to the substation coming online. These generator sets would be replaced by two 1MW diesel EPA Tier 3 or 4 certified and compliant generator sets located next to the substation for operational backup emergency power generation purposes only. These 1MW back-up generators may be stored in 20-foot shipping containers. The most critical power loads are required for fire/equipment and pumps, thickener rakes, reagent agitators/pumps, emergency lighting, ventilation exhaust fans, and electrical heaters. Other (320 to 1,800kW) trailer-mounted mobile generators will be used around the Project site to support specific construction projects.

3.6.3 Portal Pad

3.6.3.1 General

The portal pad will have a total disturbance area of 6.9 acres (2.8 ha), and is designed to have a finished upper working surface area of approximately 4.9 acres (2.0 ha) (Figure 1.3 and Figure 3.20). The depth to the groundwater table in this area is approximately 128 feet (39 m) below the portal pad elevation based on Figure 2.8 and Figure 3.21 and monitoring well MW-8, which lies about 833 feet (254 m) to the south of the portal pad. The portal pad will be constructed after topsoil and subsoil are removed and transported to storage stockpile areas, and run-off diversion ditches are excavated uphill of the site. The diversion ditches will discharge to natural channels through infiltration basins, or through dissipater structures that allow water to infiltrate into shallow colluvial or bedrock materials.

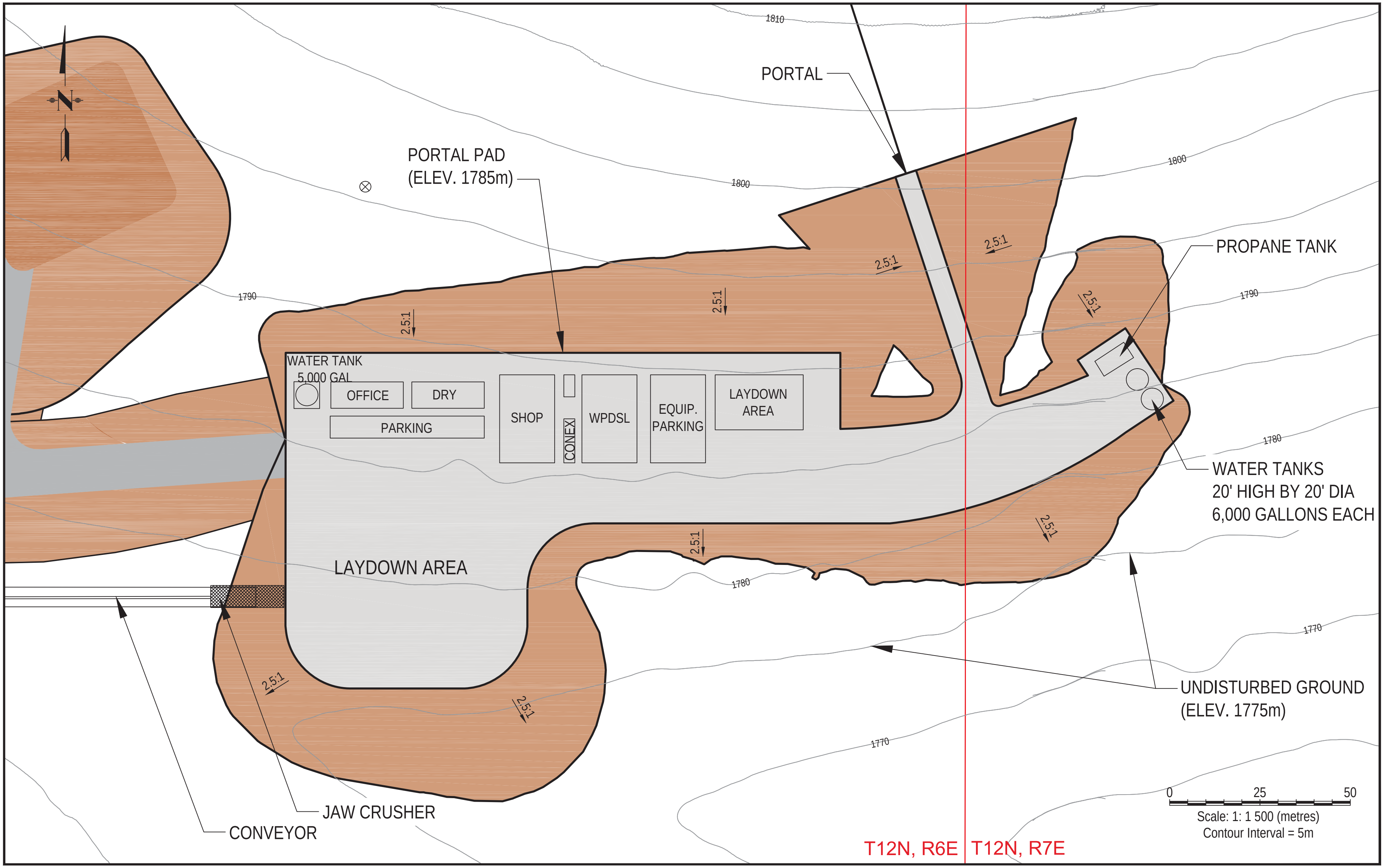
The portal collar will be constructed with an inside dimension of 17 foot wide by 17 foot (5 m x 5 m) high with an arched top. The area around the portal will be excavated to allow easy access, and ventilation, air and water pipelines and other necessary utilities required for the operation of the mine. Construction scheduling calls for excavation of the underground mine to begin as soon as access to the site is available and the portal pad is constructed. The proposed portal location lies 128 feet (39 m) above the regional ground water table. The first approximately 1,700 linear feet (518 m) of mining along the initial decline will be above the water table. Because the collars of the ventilation raises are also located well above the water table, none of the mine openings will be capable of discharging groundwater either operationally or in closure. Underground mining will proceed as other surface support facilities are constructed. Surface disturbances associated with the construction of a flat portal pad (Figure 3.20) are discussed below under Section 3.6.3.2.

The flanks of the portal pad will consist of compacted, 2.5:1 H:V fill slopes. The pad will require both cuts into undisturbed ground and compacted fills to create a nominal level working surface area. Construction of the portal pad will require approximately 91,557 cubic yards (70,000 m^3) of fill (Table 3-14a and Table 3-14b). This initial fill will be obtained by excavation of 52,318 cubic yards (40,000 m^3) from the hillside upon which the pad will be constructed (Table 3-14a and Table 3-14b). Additional material will be obtained from excavations associated with other surface facilities. Road base and durable gravel surfacing material will be purchased from local off-site quarrying operations.

The top of the portal pad will be constructed with a gently sloping upper surface to the south that allows for gravity-flow drainage. A safety berm will be constructed along the south edge of the pad with a low point located in a topographic reentrant on the upper surface of the pad (Figure 1.3 and Map 6). Lateral flow along the south edge of the portal pad's upper surface will be directed in lined ditches along the safety berms to the reentrant where it will enter a lined slope drain. A HDPE lined slope drain with appropriately sized rock to reduce flow velocities will be used to drain runoff from the portal pad upper surface to below the toe of the fill material (more than one slope drain may be required to effectively drain the portal pad surface). Based on site conditions an open channel slope drain is more appropriate due to snow deposition and freezing conditions. The slope drains will be placed from the surface of the portal pad down to diversion ditches at the toe of the portal pad fill materials (Figure 1.3 and Map 6). A diversion ditch constructed from the toe of the fill materials will route runoff to the water (not brine) section of the CWP to allow suspended solids removal and temporary storage prior to pumping of water from the CWP to the RO WTP or the PWP. Map Sheet 6 (Site Drainage Control) depicts drainage control features for the portal pad area.

3.6.3.2 Portal Pad Use during Start-up Surface Construction and Underground Decline Construction

The start-up surface / underground decline construction phase of the mine project will begin at the onset of the mine project and take approximately 2.5 years to complete (until the PWP and CTF are completed, and the mill becomes operational). Underground mining will commence as major mine support facilities are constructed. The portal pad will be used for temporary support facilities during the initial two to three years. Temporary ancillary support facilities needed for mining contractor support will consist of: an office/ dry / change house; a mobile equipment maintenance garage / wash-pad / fuel storage and fueling station building; shop / warehouse with a power supply area (with generators and air compressor); storage facilities (intermodal Conex units); a potable water tank; a sanitary holding tank; a temporary propane tank; laydown / equipment parking; and subcontractor parking areas. The layout proposed for these facilities on the portal pad is depicted on (Figure 3.20). Each of these facilities is described in detail below. Note that the dimensions and precise locations of these facilities may be somewhat modified during actual construction.



Prepared by Tetra Tech Inc. (2017)

FIGURE 3.20

Plan Map of Portal Pad Showing Contractor Support Facilities

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana

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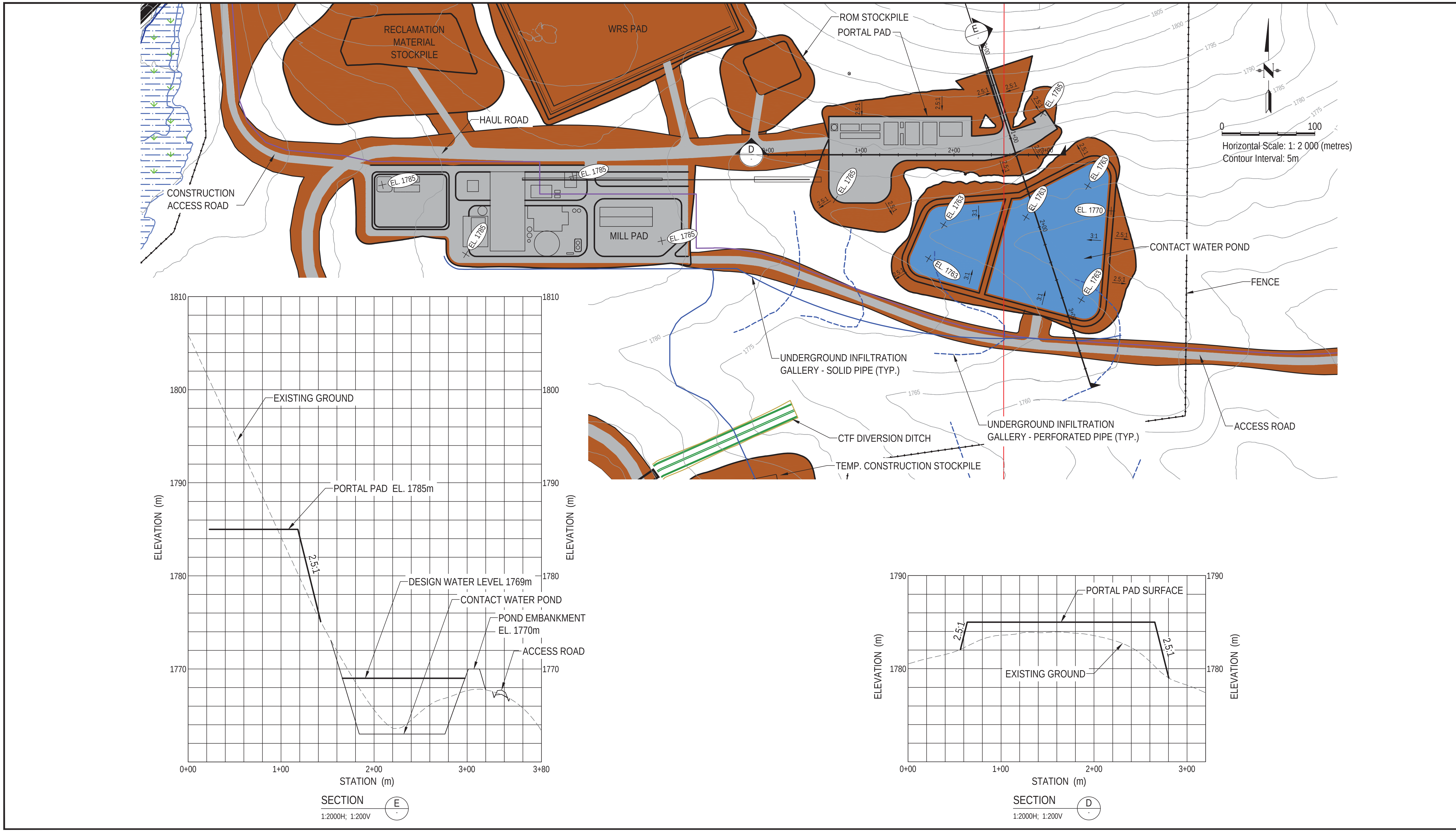

Prepared by Tetra Tech Inc. (March 2017)

2.5:1 = 2.5(H):1(V) SLOPE

FIGURE 3.21

Portal Pad Plan and Cross Sections

Black Butte Copper Project

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Office: A 24 x 66 foot modular office trailer (such as that typically used on construction sites) will be provided for use by engineering, safety, and other mine support personnel.

Dry/Change House: A 24 x 66 foot modular office trailer (as typically used on construction sites) will also be provided for employees to use to change and shower. This building will serve as a gathering point for workers waiting to go underground.

Fuel/Oil Storage, Power Supply Wash/Lube Pad, and Shop Building: The eastern 50 x 80 foot fabric covered, insulated, steel truss arch building will be constructed on a concrete slab with built in containment for fuel storage, lubricants and shop fluids (labeled WPDSL on Figure 3.20). This facility will serve as a fuel and oil storage facility, contain a fueling station and lubrication / maintenance bays, and will also house a wash pad for equipment. The entire concrete pad for the building will slope to a perimeter foundation curb on the inside of the building, along one side, and drain toward one end of the pad. The wash pad will slope into a sediment sump built into the concrete pad that can be cleaned with mobile equipment. The sediment sump overflows into a hydrocarbon skimming and sediment settling sump. The underflow from this sump will report to a "grey" water sump that will be pumped into a wash pad water recycle system for further cleaning prior to reuse. Wash pad sediments will be disposed of in the CTF along with waste rock and oil-skimming residues will be collected and hauled off-site by a licensed hazardous waste disposal company. The fuel / lube storage area will report to a hydrocarbon containment sump which will be sized for 110% containment of the total tank capacities located in the facility.

Fuels Storage and Fueling Stations: The Project will use both diesel and bio-diesel products as well as a smaller volume of gasoline. Two large diesel above ground storage tanks (AST) are planned for the Project along with several day tanks that will be placed on appropriately design concrete pads. The planned fuel-storage tanks for the Project startup phase include:

- 8,000 gallon double-walled tank (diesel)
- 6,000 gallon double-walled tank (bio-diesel)
- 500 gallon double-walled tank (gasoline)
- 500 gallon day tank (diesel generator)
- 250 gallon day tank (diesel generator).

A fuel and lubricant truck will be used to dispense fuel to mobile equipment and fueling stations will be constructed at the fuel storage tanks and in the generator fueling area. The fuel stations will be located on concrete pads with spill containment to capture potential spills.

Various oils and anti-freeze necessary for mine operations will also be stored on the same concrete pad as the fuel tanks. A semi-van trailer or Conex unit will store lubricants, oils, antifreeze, and other similar materials, and will be placed near the fuel tanks to complete the fuel/lube station. It is estimated that there will be approximately 2,000 gallons (7,571 liters) of various oils, including storage for used oil. No fuel is expected to be stored in the underground workings.

Used oil will be collected and hauled off-site by a licensed hazardous waste disposal company. During the start-up surface construction and initial underground decline development phase, emergency spill response kits will be located in: (1) the Conex unit in the storage/containment area near the WPDSL building on the portal pad (Figure 3.20), and (2) at the core shacks located on the northeastern side of the mine permit boundary area (Figure 1.3).

Propane Storage: Propane tanks will be used to temporarily store propane on the construction portal pad to seasonally heat mine air prior to the completion of the first ventilation raise. Operationally, propane will be stored at the ventilation raises once they have been constructed, to seasonally supply heaters for underground air intakes.

Laydown/Equipment Parking: An open 50- x 80-foot storage laydown area will be reserved for various parts and materials required in the mining process. The area will be large enough to be also used as an equipment parking area. Smaller parts and equipment will likely be stored in temporary material storage units (Conex units) in the laydown area.

Employee Parking: A graded and graveled parking area located near the office and wash / dry building will be reserved for employee parking. As stated above in Section 3.6.1, road base and gravel surfacing will be purchased from local commercial quarrying operations.

Shop/Warehouse and Power Supply Building: The western-most 50- x 80-foot fabric covered, insulated, steel truss arch building will be constructed on a concrete slab to house a mine shop, warehouse, and on-site power supply generators. This facility will primarily serve as a fabrication / maintenance shop and equipment repair area. The building will also provide warehouse space to store supplies, parts, small quantities of lubricants, and other items.

Line power is available near the site. However, this line does not have sufficient power to support the anticipated first 2.5 years of mining and support activities. Therefore, two on-site generators are planned for the Project start-up and will continue to provide power until adequate line power and an electrical substation are constructed at the site. These generators will then be used as back-up power sources in the case of line power failure. The generators will be housed in or adjacent to the Shop / Warehouse building. One generator (a 545 kW unit) will be the primary source of power until line power is provided to the site, and then will be used as a back-up generator in the case of line power failure. This generator will be housed in a van-trailer with a “day-use” diesel fuel tanks of approximately 500 gallons each and containment will be provided for two -500 gallon (1,892 liter) day-use fuel tanks. A 320 kW backup generator will provide emergency backup power for the underground pumps, vent fans, and shop in the event the main generator power supply is disrupted. The 320 kW generator will be skid mounted and has a “day” fuel tank with approximately 250 gallons of fuel on board. Containment will be provided for 500 and 250 gallon day-use fuel tanks on the generators. The generators will be alternated during use. Back-up power for the operational phase is discussed above in Section 3.6.2. In addition to these two generators there will be a number of smaller, mobile generators in use around the Project site to support other construction projects. Once adequate line power and substation are operational the larger two generators will then be used as emergency back-up power sources in the case of line power failure for the remainder of the construction / early mining phases of work.

Fuel will be transferred from the fuel storage area to the generator’s day-use tanks as needed. Most of the underground equipment will be electric or diesel powered. On-site generated electricity will be used to provide underground and surface electrical transmission to power underground pumps, ventilation fans, and equipment as well as the shop and WPDSL buildings. Power will be distributed to pumps in the CWP area, and distribution lines will be buried between the generators housed in or adjacent to this building and the portal and other facilities.

Temporary Surface Explosive Storage: Explosives will be temporarily stored on the surface in two separate explosives magazines. One magazine will be for initiation devices and one will be for explosives. The surface powder magazine locations have been carefully determined based on safety and security (Figure 1.3). The surface magazines will follow both MSHA and Alcohol, Tobacco and Firearms regulations (ATF, Title 27 CFR, https://www.atf.gov/rules-and-regulations/regulations-alcohol-tobacco-firearms-and-explosives). ANFO will be the primary explosive used for underground mining. Depending on the rock hardness and amount of water encountered, stick powder, slurries, or emulsion based explosives products may be used with or instead of ANFO. The temporary surface magazine storage will remain in use until the underground workings advance to a safe distance from the portal when they can be relocated underground. Underground magazines will be relocated as necessary to areas in support of active underground mining.

Septic and Drain Field: Portable toilets will be provided and maintained by a local subcontractor during initial mobilization / construction phases. An on-site wastewater (septic / drain field) system (see Section 3.8.9) will ultimately be constructed to manage office trailer and mine dry / change house wastewater. This system will be designed to accommodate all on-site staff. The location (Figure 1.3 and Section 3.8.9) may change slightly based on field leach tests and the final design approved by the county. The system will need to be approved by the Meagher County sanitarian.

Core Shed: Two steel-sided and roofed pole barns with concrete slab floors have been installed and are in use as a core storage sheds (Figure 1.2 and Figure 1.3). Their construction was permitted under Tintina's existing exploration license.

3.6.3.3 Portal Pad Use during Mine Operation

All of the temporary contract miner support facilities constructed on the portal pad will be removed after permanent replacement support facilities are completed on the mill pad. During the remainder of the mine operation, the portal pad will be an open surface upon which mine trucks and other vehicle circulate, with designated drive, parking, and equipment laydown areas. At that time, the entire surface area of the portal pad will be compacted road-base / gravel, or small, local concrete slabs. All portal pad surface area drainage will be collected as contact water and directed to the contact water collection pond. Water collected in the CWP will be treated in the WTP before being discharged to groundwater in the subsurface infiltration gallery system. All snow removed from the portal pad in winter months will be removed by a loader, and trucked directly to the PWP for disposal.

3.6.3.4 Portal Location and Alternative Locations Evaluated

Two other portal/decline locations were evaluated prior to selecting the proposed site. One was located in the NE/4, NE/4 of Section 24 and the other was in the center of the N/2 of Section 25. Although these proposed declines would have been shorter (i.e., closer to the Johnny Lee deposit), they would have intercepted higher amounts of sulfide-bearing rock and caused surface support facilities to be spread out over a greater geographic area, resulting in more disturbance acres. In summary, the proposed portal location and decline alignment were selected because they allow for consolidation of facilities into a smaller geographic area, result in mining of a lower volume of sulfide-bearing waste to access the copper-rich deposits, and eliminate the risk of discharge from the portal operationally and in closure.

3.6.4 Ventilation Raises and Secondary Escape Way

Ventilation is required in underground mining to clear fumes from blasting and diesel equipment, to provide fresh air, and seasonally warm air to the underground workings. In the Johnny Lee deposit, this will be accomplished with four (4) ventilation raises (Figure 1.3, Figure 3.3, and Table 3-32). These are vertical shafts that will be mined as "raises" (shafts constructed from the bottom-up). However, the ventilation raises may also be drilled either from the top-down or from the bottom-up, or alternatively constructed using the alimak raise method (raise climbing mining platform). Pilot drill holes will be completed in the ventilation raise footprints that will be used to provide geotechnical information for the final engineering design of the ventilation raises. These drill holes will also identify the presence / absence (and thickness) of any high-sulfide mineral bearing zones.

Construction of the ventilation raises completed by a raise boring machine (Figure 3.22) will include: (1) a concrete collar on surface that will be constructed down through unconsolidated or poor rock quality materials, (2) raise bore foundation (platform) construction that could include a 2 to 3 foot (60-90 cm) thick concrete pad; (3) pilot hole drilling (either from the surface or from underground); and (4) reaming of the pilot hole to 16 feet (4.9 m) diameter and cuttings removal.

The Johnny Lee ventilation raises will be approximately 16 feet (4.9 m) in diameter and will range in height from 314 feet (96 m) to 1,160 feet (354 m) feet in order to reach the surface from the working levels (Table 3-32). Two of the proposed ventilation raises will be fresh air intakes and the other two will be exhaust air raises (as will the mine portal) (Figure 3.3). Air will be moved through the mine by pairs of high volume fans located underground at the base of the two exhaust raises. The fans push air up the exhaust raise and pull air into the intake raises thereby driving circulation through the mine. This fan location minimizes noise at the surface. When mining is initiated, the portal acts as the main ventilation source and temporary fans are advanced with mining along the main development workings. During winter months intake air must be heated with propane fired heaters before entering the mine. The heaters and propane tanks will be located on the surface at the collars of the intake ventilation raises.

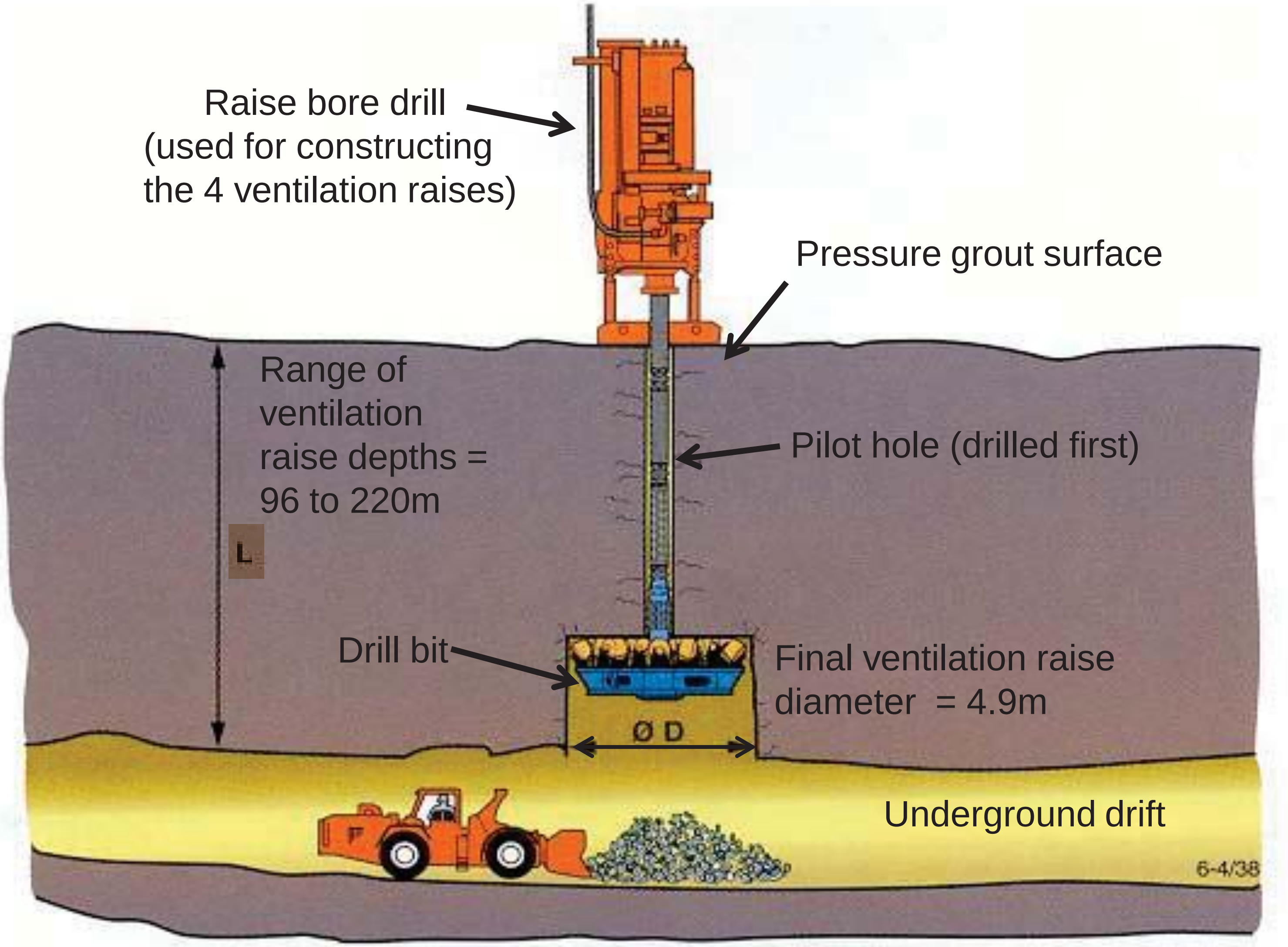
Table 3-32. Ventilation Raise Dimensions

Ventilation Raise Name	Raise Bore Diameter (m)	Raise Length (m)
IVU	4.9	124
IVL	4.9	354
EVU	4.9	96
EVL	4.9	116

Notes:
IVU = Fresh air intake ventilation for the Upper Copper Zone;
IVL = Fresh air intake ventilation for the Lower Copper Zone;
EVU = exhaust ventilation for the Upper Copper Zone; and
EVL = exhaust ventilation for the Lower Copper Zone

All raises may require some form and amount of ground stabilization (wire screen, rock-bolting, and perhaps shotcrete) and some amount of water inflow control (pressure grouting) where necessary. The amount of ground support required depends on how they are driven and the actual ground conditions encountered. Any raise that will be used by miners will be supported, and all areas of excessive water inflow will be grouted. Consequently, excessive water is not anticipated in the ventilation shafts. However, all water in the underground workings flows into collection sumps, so in the event water did inadvertently enter a ventilation shaft, it would be captured in the underground dewatering system.

A secondary escape way for underground mine personnel is required by MSHA and MSHA will approve final designs and locations. There will be one secondary escape way provided for mining of the Johnny Lee deposit (Figure 1.3, Figure 3.2, and Figure 3.3). The secondary escape way will be located at the site of the fresh air intake ventilation raise for the *LCZ* (IVL) shown on Figure 1.3, Figure 3.2, and Figure 3.3. This secondary escape way will be equipped with a mechanized escape hoist installed at the raise collar. Because the exhaust fans will be located underground, the top of the mechanized egress raise will have a concrete collar foundation and a tripod style headframe that will support the secondary egress conveyance. This secondary egress raise will incorporate a 60-horse-power (HP) hoist mounted in a shipping container and will provide hoisting speeds of up to 30 feet/sec (0.9 m/s). The bullet-shaped conveyance will be capable of evacuating two men per trip. Surface disturbances associated with ventilation raises and other surface disturbances are discussed above in Section 3.4.1.



Note: Some ventilation raises may alternatively be constructed using the Alimak raise method

Prepared by Tintina Resources (after Ferreira (2005)

TINTINA RESOURCES

Figure 3.22
Schematic Section Showing Raise Bore Drilling Method
Mine Operating Permit Application
Meagher County, Montana

3.6.5 Temporary Waste Rock and Operational Copper-enriched Rock Storage Facilities

3.6.5.1 Design Characteristics

A total of 778,810 tons (706,525 tonnes) of underground waste rock will be generated over the life of the mine, all of which will eventually be placed in the CTF. The temporary WRS pad has a design capacity of 551,155 tons (500,000 tonnes) which will easily accommodate the first two years of the underground waste rock generation (453,642 tons or 411,537 tonnes) included in the mine production schedule. The waste rock has potential for acid generation and metal leaching (see Section 2.4.2), and operationally will be co-disposed with the tailings in the CTF during mining operations. Waste rock will be placed on the temporary WRS facility as run-of-mine material prior to construction of the CTF, and will require a disturbance footprint of 10.2 acres (4.1 ha) for construction. The depth to the groundwater table near these two facilities is approximately 134 feet (41 m) below the base elevation of the waste rock pad excavation based on Figure 2.8 and Figure 3.23 and monitoring well SC15-198, which lies about 246 feet (75 m) to the southwest of the temporary WRS pad.

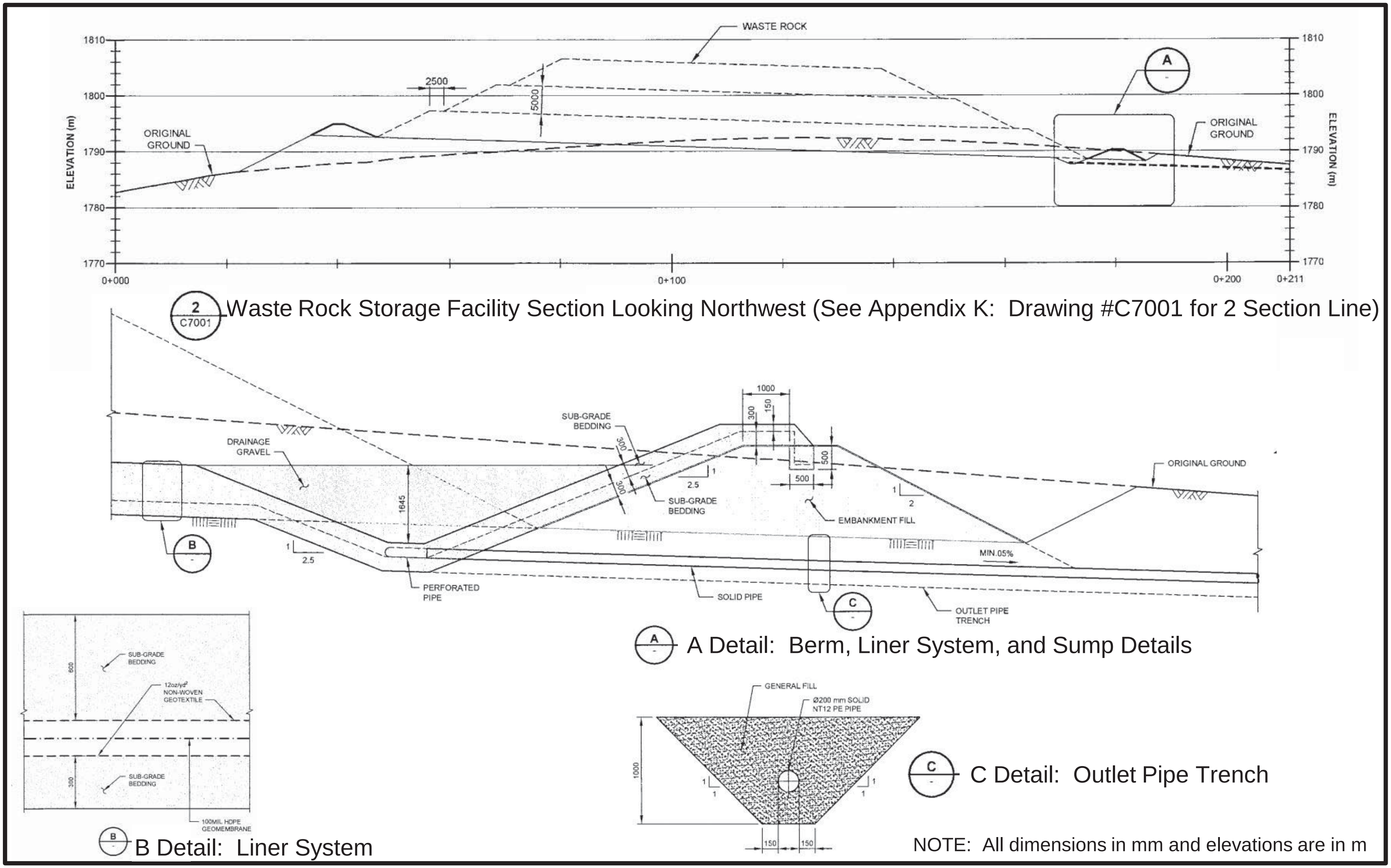
3.6.5.2 Liner and Seepage Reclaim Water Systems

The waste rock generated during the first two years of mining (453,642 tons or 411,537 tonnes) will be temporarily stockpiled on an HDPE-lined WRS pad as run-of-mine material, located west of the mine adit portal pad and north of the mill pad (Figure 1.3 and Figure 3.23). The temporary WRS pad is designed to contain 551,155 tons (500,000 tonnes) of waste rock. Waste rock will be stacked over a 10.2 acre area to a maximum height of 50 feet (15 meters) in 16-foot (5 meter) lifts with 8-foot (2.5 meter) benches (Figure 3.23). Additional waste rock material will be placed on top of the upper liner in areas where mine trucks will establish routinely traveled access ramps onto the pad.

The WRS pad will have a 100 mil (2.5 mm, 0.1 inch) HDPE geomembrane with a minimum 12-inch (300 mm) thick layer of excavated and prepared sub-grade bedding material comprised of waste rock above the liner and granodiorite below it for protection from the mine fleet traffic during waste rock placement (see Table 3-14b).

The remaining 325,168 tons (294,988 tonnes) of waste rock generated during production mining will be placed directly into the CTF as lenses of waste along the flanks of the CTF haul ramp and comingled with and covered by cemented paste tailings.

The WRS pad and liner will be sloped to the south (see Knight Piésold drawing numbers C7001 and C7002 in Appendix K) towards an outlet pipe along the south edge of the pad (Detail "C" in Figure 3.23; Drawing C7003 in Appendix K). This outlet pipe will transfer collected precipitation and seepage through the waste rock pile from the top of the liner to the double lined CWP adjacent and to the south of the mine portal pad (Drawing C7002 in Appendix K and Map Sheet 6). Water from the WRS pad will be gravity drained to the CWP by a 200 mm Solid NT12 PE pipe (shown on Detail "C" in Figure 3.23). Water will be temporarily stored within the CWP during the period of use of the temporary WRS pad, prior to its automatic pump transfer to the WTP.



From: Knight Piesold (2016): Drawing #C7003 (Appendix K)

TINTINA RESOURCES

Figure 3.23
Cross-Section of Waste Rock Storage Facility Showing Details
Mine Operating Permit Application
Meagher County, Montana

3.6.5.3 Reclamation of the WRS

The waste rock stored on the WRS facility will be mined from several different lithologies, which contain variable amounts of sulfide minerals, all of which will be stored in the same facility. Therefore, all waste rock will be considered PAG. All waste rock from the pre-production period will be transferred into the CTF once installation of the geomembrane across the basin floor of the CTF has been completed (approximately 2 years). A protective layer of granodiorite sub-grade bedding material will be placed over the top of the CTF liner system, and ROM waste rock will then be spread over a portion of the CTF basin floor to create a basin drain system prior to beginning tailings deposition, as described in Section 3.6.5.3. Additional waste rock and/or near-surface construction materials as discussed in Section 3.6.8.8 will be placed in the basin drain system in the drainage layer, sump areas, and will also be used to construct the CTF haul ramp as needed.

Reclamation of the WRS facility will occur after the waste rock has been transferred to the CTF (after approximately the first two to three years of mining). Reclamation will include removal of the upper cushion layer and the HDPE liner under the facility and placing them in the CTF, backfilling the excavation in the WRS facility area with material from the excess excavation material stockpile (immediately to the west of the WRS facility) (Figure 1.3), reshaping, soil/subsoil placement, and reseeding.

3.6.5.4 WRS Percolation (HELP) Modeling

As part of the MOP Application, Hydrometrics, Inc. performed a hydraulic analysis of the temporary WRS where the percolation of precipitation moisture through the facility was simulated and the volume of percolated water discharging to the collection system on the top of the bottom liner of the facility was estimated (Hydrometrics, 2016c). Hydrometrics used the Army Corps of Engineers Hydrologic Evaluation of Landfill Performance (HELP) model (version 3.07), which simulates one-dimensional soil profile moisture flow based on site-specific climate date, soil properties and stockpile dimension. Results of the Hydrometrics evaluation are presented in Appendix M-1 and are summarized below.

Climate Data: The HELP model uses four climate parameters: precipitation, mean daily temperature, solar radiation and evapotranspiration. For baseline climate data, default datasets are available from Helena, Montana. Helena is the nearest weather station with similar latitude and elevation providing cumulative weather data. However, Tintina also operates a weather station near the mine site and precipitation and temperature data from that station from May 2012 to November 2014 (Knight Piésold, 2015a) were used to modify the Helena data to incorporate into the default values and develop synthetic climate data more representative of the actual Project site.

To synthetically generate daily precipitation, the default Helena dataset was loaded and then the monthly precipitation averages were edited to reflect those from the Tintina weather station. Two modifications were made to the Tintina monthly averages. First, the March 2013 value was excluded from the set. That month included a 4-inch (10.2-cm) precipitation event that exceeded the estimated 100-year, 24-hour storm for the site. Second, precipitation averages from November to March were reduced by 75% to account for snow removal on the waste rock pile. As the waste rock is distributed into layered benches with a bulldozer, most snow will be pushed from the surface and the moisture will not percolate through the waste rock.

Using these data and assumptions, the HELP model synthetically generated daily precipitation and temperature data resulting in an average annual precipitation for the two simulation years with annual totals of 14.3 inches (36.3 cm) and 19.4 inches (49.3 cm) of precipitation onto the waste rock pile and an average annual temperature of 35.9°F (2.2°C). Solar radiation data were based on latitude of 46.77°N, which is the latitude of the Project site rather than Helena. Evapotranspiration was based on the same latitude along with a bare soil evaporative zone depth of 14 inches (35.6 cm).

The HELP model uses climate data from the Tintina and Helena, Montana meteorological stations; whereas the meteorological analysis (Section 2.1.3) uses climate data from Tintina, Bozeman and Millegan stations. This is due to limitations in the data that the HELP model provides. The synthetic data set for precipitation, temperature, and evapotranspiration generated in the HELP model was within the range of data summarized in the meteorological analysis (Section 2.1.3). Therefore, any difference between estimated percolation values derived from the two data sets is anticipated to be small and well within the inherent error of the percolation model.

Soil Type and Stockpile Dimensions: The waste rock generated during the life of mine operations is anticipated to consist predominately of cobble- and gravel-sized materials with very little sand or finer material. To represent the waste rock material that will be placed on the temporary WRS pad in the first two years (the life of the WRS facility), the gravel option in HELP was selected, which assumes a porosity of 39.7% and a hydraulic conductivity of 0.30 cm per second. The HELP model subsequently generated a run-off curve number of 69.8 based on gravel parameters, a cross-slope of 2%, and a slope length of 300 feet (91 m). The lifts were assumed to be devoid of vegetation.

The hydraulic analysis assumed the WRS pad facility would consist of three separate lifts of waste rock 16.5 feet (5 m) each in height, and each with different footprints decreasing in area from 11.1 acres (4.5 ha) for the first or bottom lift to 3.1 acres (1.3 ha) for the top or final lift. The first lift is estimated to utilize approximately 50% of the total WRS storage capacity (based on the WRS facility design by Knight Piésold (Knight Piésold, 2017a) with the remaining storage utilized in the second and third lifts. All three lifts were modeled as vertical percolation intervals.

Assuming constant mine production, the first lift is estimated to reach completion near the end of the first year of operation, the second lift within another seven months, and the third lift by the end of the second year.

Simulation Strategy: To simulate percolation through the WRS facility over two years, four separate simulations were run. The first simulated percolation through the first lift over a one-year period. Three simulations were run for the second year, one involving only one lift, one involving two and one involving all three lifts. In each, the percolation volume was determined by multiplying the model percolation result by the appropriate lift surface area.

Results: The simulated WRS facility percolation results to the drainage collection system are summarized in Table 3-33. Over the full two-year simulation period, the HELP model estimated a total percolation through all three lifts of the WRS of 118,330 cubic feet (3,351 cubic meters), which amounts to an average vertical flow rate of less than 1 gpm (3.8 Lpm). The maximum monthly average flow rate estimated by the model was 2.7 gpm (10.2 Lpm) and occurred in July of the second year.

Table 3-33. HELP Model Simulated WRS Facility Percolation Results

Year	Month	Percolation		WRS Footprint		Volume		Average Flow Rate	
		(inches)	(cm)	(acres)	(ha)	(ft^3)	(m^3)	(gpm)	(m^3/day)
1	1	0	0	0.63	0.25	-	-	-	-
1	6	0.151	0.383	3.75	1.52	2,050	58	0.4	1.9
1	12	0.244	0.620	7.50	3.04	6,643	188	1.1	6.1
2	1	0.084	0.212	7.50	3.04	2,274	64	0.4	2.1
2	6	0.122	0.310	7.50	3.04	3,327	94	0.6	3.1
2	7	0.588	1.494	7.50	3.04	16,017	454	2.7	14.6
2	12	0.268	0.680	7.50	3.04	7,288	206	1.2	6.7
2 year Total						118,330	3,351	0.9	4.8

3.6.5.5 Operational Copper-enriched Rock Storage Facility

Prior to the period of time that pre-production waste rock from the WRS pad is removed to the CTF, and before production mining begins, a new copper-enriched rock stockpile facility will be constructed off of the northwest corner of the portal pad (Figure 1.3). The copper-enriched stockpile will provide mill feed when the mine is unable to provide copper-enriched rock directly to the mill. The copper-enriched rock stockpile pad will have the capacity for approximately 82,600 tons (75,000 tonnes) of rock and cover an area of 1.9 acres (0.8 ha), to a maximum height of 60 feet (18 m) in 20-foot (6 m) lifts with 17-foot (5 meter) benches (Figure 1.3). The estimated depth to the top of the groundwater table near this facility was previously discussed in Section 3.6.5.1.

The copper-enriched rock stockpile pad will be constructed like the WRS pad. It will have a 100 mil (2.5 mm, 0.1 inch) HDPE geomembrane with a minimum 12-inch (300 mm) thick protective drainage layer placed above and below it to protect from the mine fleet traffic during copper-enriched rock placement. The lower protective layer will be comprised of excavated granodiorite construction materials, whereas the upper protective layer will consist of crushed and screened pre-production waste rock.

A seepage collection system of piping will be placed on top of the pad liner within the protective drainage layer. The stockpile pad and liner will be sloped to the south towards an outlet pipe along the south edge of the pad. This outlet pipe will transfer collected precipitation and seepage through the stockpile from the top of the liner and will connect to the south to the pad run-off collection sump and culvert system and ultimately to the contact water diversion ditch. This system will be used to convey surface water from the copper-enriched rock stockpile to the CWP adjacent and to the south of the mine portal pad (Figure 1.3). Water will be temporarily stored within the CWP prior to its automatic pump transfer to the WTP. The copper-enriched rock storage pad will be used throughout the remainder of the operating mine life.

3.6.6 Process Water Pond (PWP)

3.6.6.1 PWP Design Concepts

The PWP (Figure 1.3 and Figure 3.24) will be a double-lined facility that stores all contact water from the PWP and CTF, including contact water from precipitation and run-off, and collected water from the foundation drain collection ponds. The PWP has a disturbance footprint of 23.9 acres (9.7 ha) and a maximum embankment height of approximately 50 feet (16 m). The PWP has a capacity of 549,339 cubic yards (420,000 m^3) to provide storage for mill water recycle and storm storage. The depth to the groundwater table in this area is ranges from 19.7 feet (5 m) to 59 feet (18 m) below the base elevation of the PWP excavation based on Figure 2.8 and Figure 3.28.

The PWP is designed with an operational capacity of as much as 261,600 cubic yards (200,000 m^3). This maintains a sufficient volume of water to offset evaporation, while providing a minimum of four months of process water supply. Normal operational storage level requirements for the pond will be between 104,600 to 209,300 cubic yards (80,000 to 160,000 m^3). Under average climatic conditions, the PWP will have as much as 104,600 cubic yards (80,000 m^3) of capacity to allow for temporary water storage caused by variances in operations. The operational volumes have been optimized such that wetter than average year conditions will still not encroach on the storm storage above 200,000 m^3 (261,600 cu yds.) in the PWP. There is an additional 261,600 cu yds. (220,000 m^3) of capacity built into the PWP capacity that will allow for storage of water from a PMF storm event (as defined in Section 3.5.3. Because of these excess storage volumes, the PWP operationally should never be more than half full (Figure 3.24) unless a major storm event has occurred.

3.6.6.2 PWP Liner and Seepage Reclaim Water System

The PWP will be a double-lined impoundment that has two layers of 100 mil (2.5 mm, 0.1 inch) geomembrane with a 0.3 inch (7.6 mm) high flow geonet layer sandwiched between the geomembrane layers (Figure 3.25). The geonet will act as a conduit for potential leakage through the upper geomembrane. Any seepage into the geonet will be directed via gravity to a sump and pump reclaim system at a low point in the PWP basin. Water collected in the sump will be pumped through a riser pipe to the embankment crest, and back into the PWP. An underlying sub-grade bedding layer will be installed to protect the lining system.

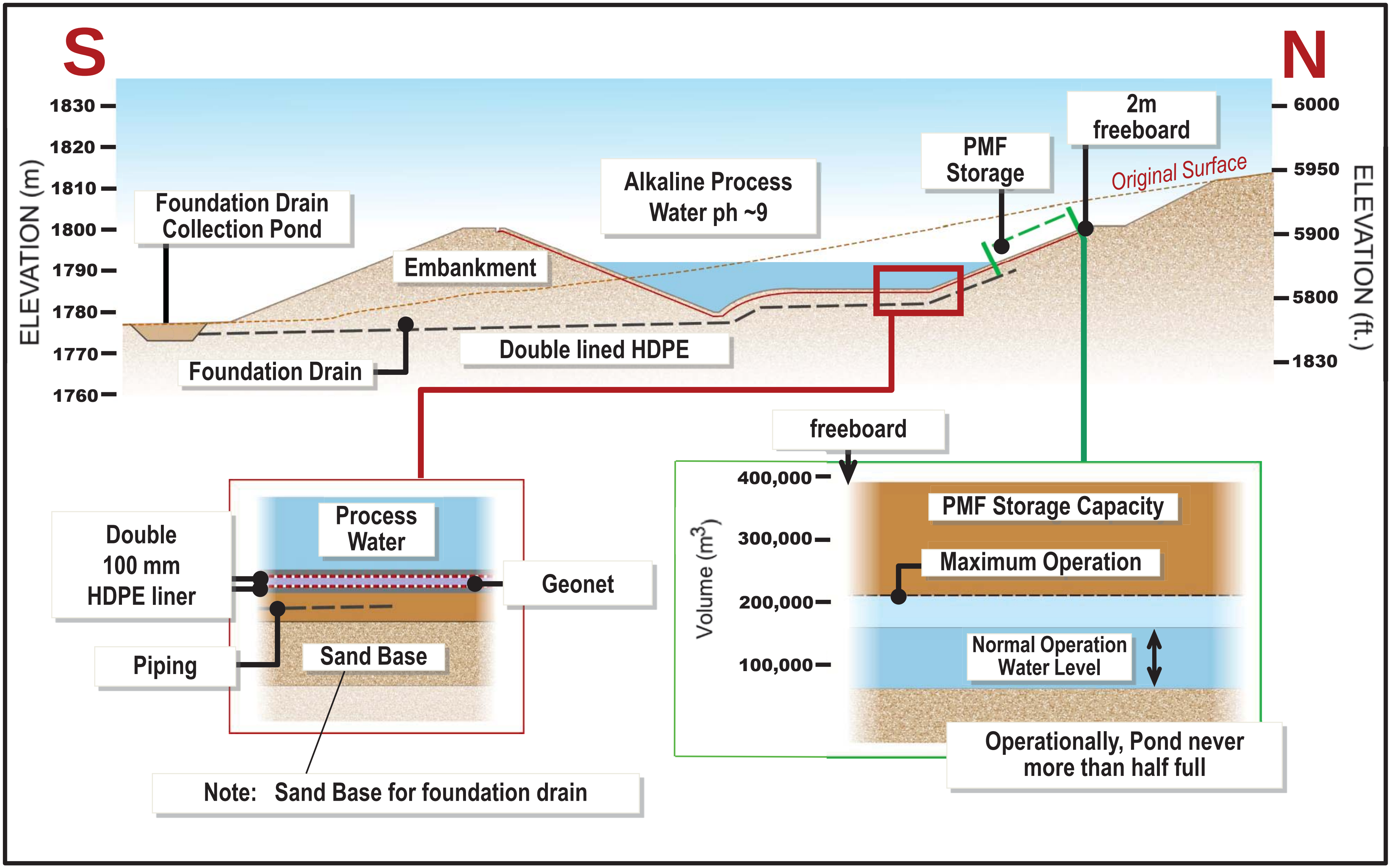
The seepage reclaim system between the HDPE geomembrane layers will consist of a sump filled with drainage gravel that will be deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. The bottom of the pipe will be perforated (in the sump) for pump operation. An additional drain pipe will be included for redundancy. The pump will have a high / low water level primer to control pumping (it will switch on when the water level reaches a high water mark and switch off when the water level reaches the low water mark). Potential seepage through the lower geomembrane will be intercepted by the PWP Foundation Drain System, as discussed in Section 3.6.6.3.

3.6.6.3 PWP Foundation Drain System

The PWP facility is expected to be built entirely above the regional groundwater table. Never-the-less a PWP foundation drain has been designed to collect groundwater flows below the PWP geomembrane should it occur, and convey all collected flows to a collection and recycle pond downstream of the PWP. Its construction will be started early, and will become operational shortly after initiating construction of the PWP. The foundation drain comprises an interconnected dendritic system of pipes, embedded in granodioritic drainage gravel, sourced from either the CTF or PWP excavation footprints that is designed to collect and funnel groundwater flows to a downgradient foundation drain collection pond. The PWP foundation drain system has the following components:

- Drains on the PWP basin floor, installed prior to the installation of the geomembrane,
- Drains beneath PWP embankments, and
- Outlet drain to the foundation drain collection pond.

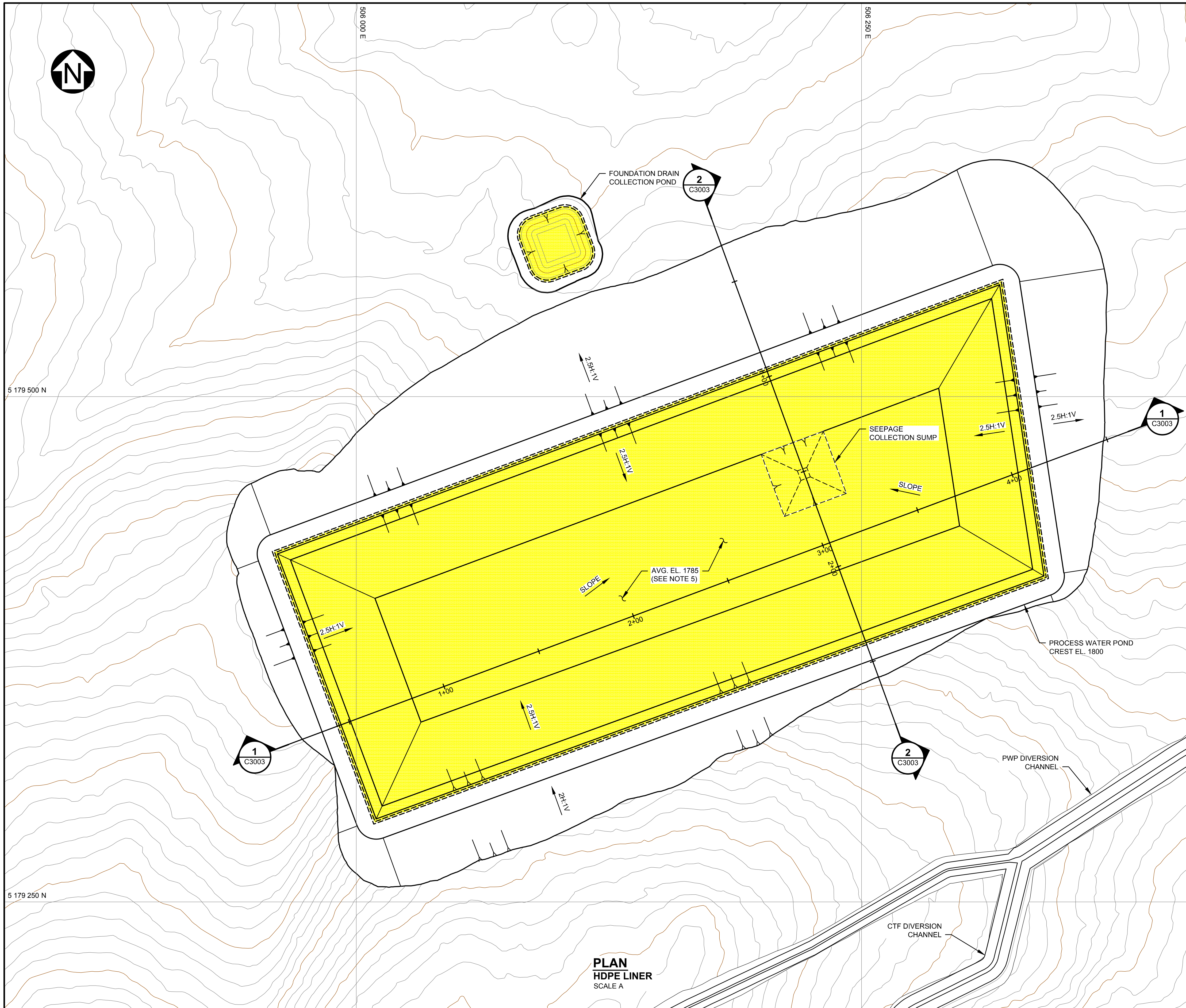
A detailed drawing of the PWP Foundation Drain System is presented in Figure 3.26 and other PWP Foundation drain details are provided in Drawing number C3008 of Appendix K of this report.



Prepared by Tintina Resources from Knight Piesold designs (2016, Appendix K)

TINTINA RESOURCES

Figure 3.24
Process Water Pond Schematic Cross-Section
Mine Operating Permit Application
Meagher County, Montana



LEGEND:

HDPE LINER

LINER SYSTEM ANCHOR TRENCH

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC., DATED FEB 03, 2011.
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. HDPE LINER CONFIGURATION SHOWN ON DRG. C3005.
6. PLEASE SEE DRAWING C3003_r1 IN APPENDIX K OR FIGURE 3.28 IN THE MOP APPLICATION SHOWING THE CROSS-SECTIONS

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.25
PROCESS WATER POND
HDPE LINER AND SEEPAGE COLLECTION
LAYOUT PLAN

C3001	PROCESS WATER POND GRADING PLAN

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C3002_r0

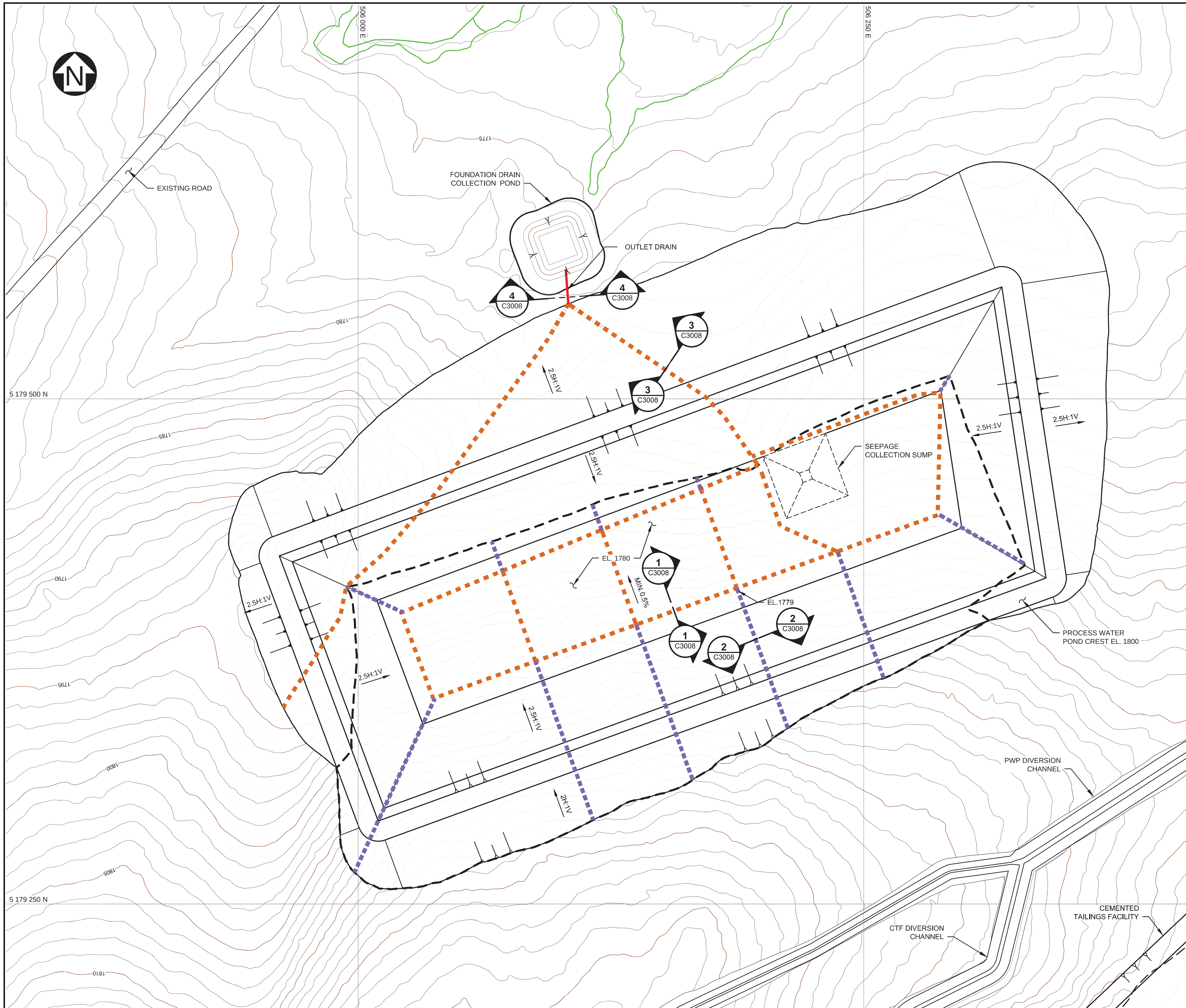
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP	KDE	KDE

REVISIONS

REVISED DATE:

MAY 2016

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.25 PWP HDPE Liner and Seepage Collection Layout Plan (C3002_r0), PRINTED: 4/26/2017 3:53:41 PM



LEGEND:

- 6" N12 WT PE OUTLET PIPE
- 6" N12 ST PE DRAIN PIPE (BASIN FLOOR)
- 4" N12 ST PE DRAIN PIPE (SLOPE)
- CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. FILL CONTOURS NOT SHOWN FOR CLARITY.
5. DRAIN TRENCHES WILL BE SLOPED TOWARDS OUTLET PIPE CONNECTION AT A MINIMUM GRADE OF 0.5%.
6. LAST 10m OF OUTLET PIPE WILL BE SOLID PIPE BACKFILLED WITH IMPERMEABLE MATERIAL.
7. OUTLET PIPE WILL EMPTY INTO A WEIR TO MEASURE PIPE FLOW.

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

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MEAGHER COUNTY, MT

FIGURE 3.26
PROCESS WATER POND
BASIN FOUNDATION DRAIN SYSTEM PLAN

C3008	PROCESS WATER POND FOUNDATION DRAIN DETAILS

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C3004_r0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE:

MAY 2016

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.26 PWP Basin Foundation Drain System Plan (C3004_r0), PRINTED: 5/26/2016 4:23:58 PM

Operationally, groundwater, meteoric water, and seepage (if any) infiltrating the foundations of the facility will be collected by the foundation drain system and directed into the foundation drain collection pond. The foundation drain collection pond is a small facility requiring only a 0.4 acre (0.16 ha) construction footprint and is located downstream (north) of the PWP embankment (Figure 3.26). The foundation drain pond will contain only small volumes of water and may often be dry. Collected water will be pumped back to the PWP. The foundation drain pond will be a 100 mil HDPE geomembrane lined pond with a submersible turbine pump. A HDPE pipeline will convey the flows back to the PWP. Details of the PWP Foundation Drain System are shown on Figure 3.26. In addition, details of the PWP foundation pump back system are shown in Design Drawings C6300, C6320, and C6330 in Appendix K. In closure the PWP foundation drain will be directed to an infiltration basin constructed beneath the foundation drain collection pond once it is reclaimed.

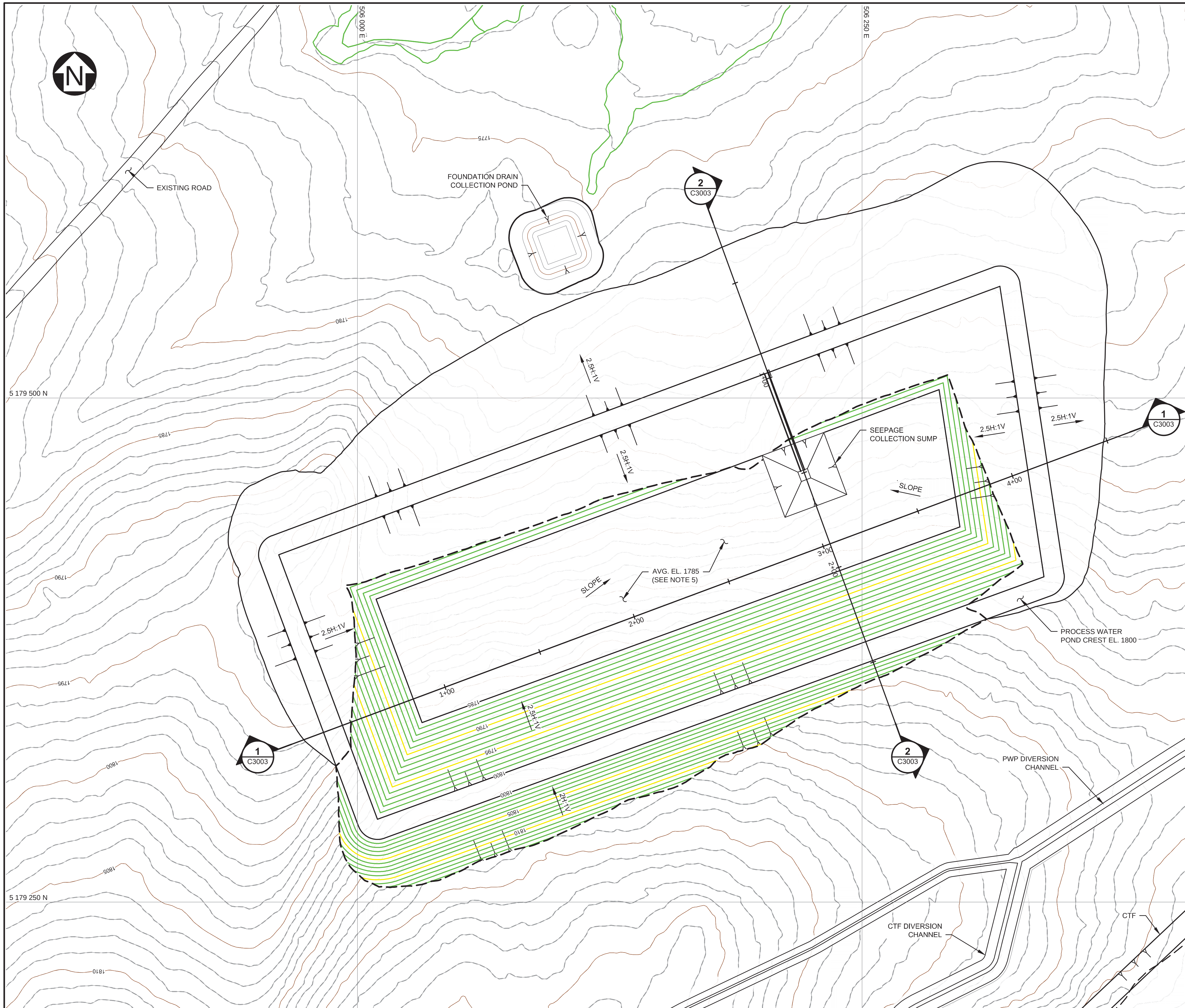
3.6.6.4 PWP Embankment Construction and Cross-section

The PWP will be constructed prior to the start of milling operations. The embankment will be a locally excavated, homogeneous rock fill embankment. The internal (upstream) slope of the impoundment will be constructed at a 2.5H:1V slope to facilitate geomembrane placement. The external slope (downstream) will be constructed at a 2.5H:1V slope to facilitate reclamation of the downstream slopes, which can be completed shortly after construction. The crest width will be 33 feet (10 m) to allow working space for pipelines and traffic. The maximum embankment height will be approximately 75 feet (23 m).

The majority of embankment fill will be sourced from excavation as part of the cut-fill balance for the PWP impoundment shaping. The remainder of the fill will come from excess material excavated from the CTF facility. The embankment material will consist of fresh to moderately weathered rock fill, separated during excavation of the CTF and PWP, and will be placed selectively and compacted to 95% Modified Proctor laboratory density as described in Section 3.4.2.1 of the revised MOP. Organics and loamy overburden material will be removed and placed on the topsoil and subsoil stockpiles.

The geomembrane will be placed on prepared sub-grade bedding fill material that will provide a protective layer between the geomembrane and natural ground or other fill materials. The fill will be primarily sourced from weathered granodiorite bedrock and select fresh rock that meets the required material specifications. General rock fill will be processed as necessary to meet the material specifications. Non-woven geotextile fabric will be placed between the geomembrane and sub-grade bedding.

The PWP plan is shown on Figure 3.27. Sections and details are shown on Figure 3.28.



LEGEND:

EXCAVATION CONTOURS

CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. FILL CONTOURS NOT SHOWN FOR CLARITY.
5. BASIN TO BE GRADED AT A MINIMUM 0.5% TOWARDS SEEPAGE COLLECTION SUMP.
6. PLEASE SEE DRAWING C3003_r1 IN APPENDIX K OR FIGURE 3.28 IN THE MOP APPLICATION SHOWING THE CROSS-SECTIONS

SCALE A 20 10 0 20 40 60 80 100 m

TINTINA RESOURCES

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MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.27
PROCESS WATER POND GRADING PLAN

C3003	PROCESS WATER POND SECTIONS

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C3001_r0

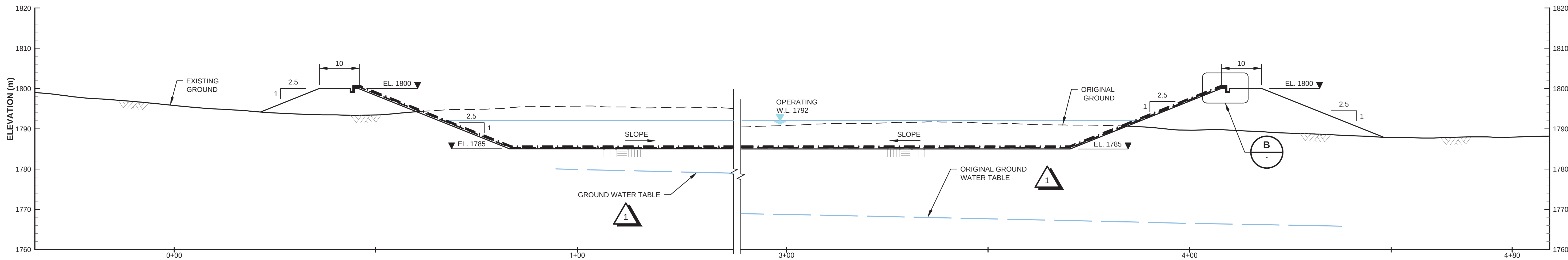
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

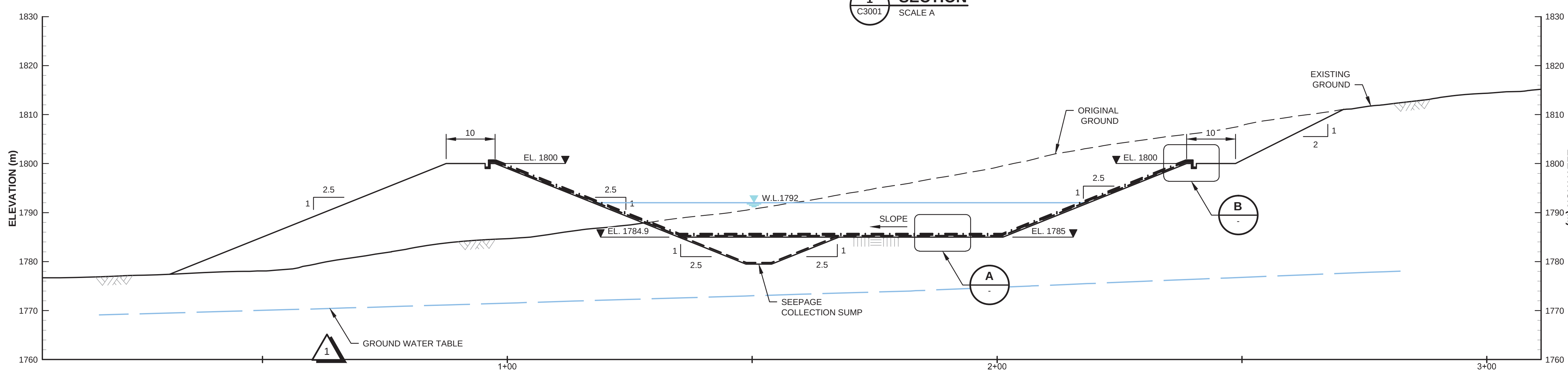
REVISED DATE:

MAY 2016

SAVED: O:\T-Z\TBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.27 PWP Grading Plan (C3001_r0), PRINTED: 6/10/2016 9:52:44 AM



1 C3001 **SECTION**
SCALE A

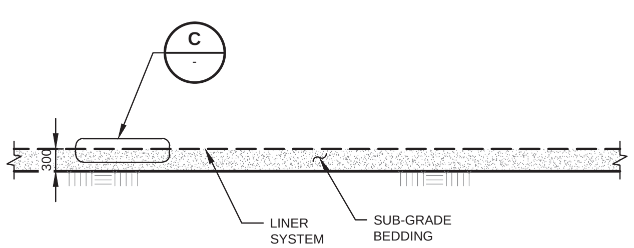


2 C3001 **SECTION**
SCALE A

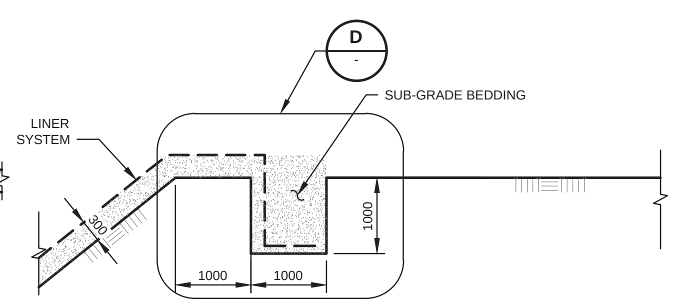
NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. PLEASE SEE DRAWING C3001 IN APPENDIX K OR FIGURE 3.27 IN THE MOP APPLICATION SHOWING THE CROSS-SECTION LINES IN PLAN.

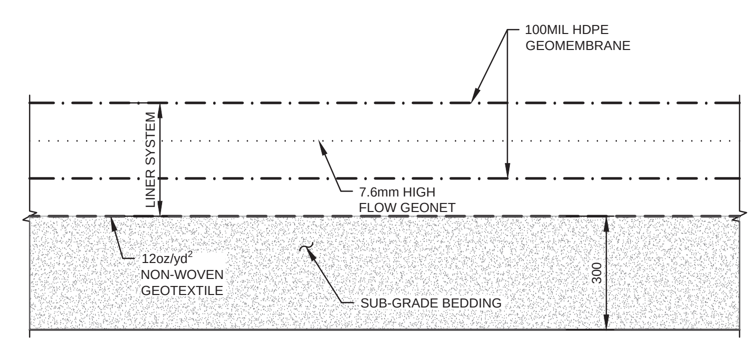
SCALE A: 10 5 0 10 20 30 40 50 m
SCALE A: 25 0 25 50 75 100 125 ft



A **N.T.S.**
LINER SYSTEM PLACEMENT DETAILS
N.T.S.



B **DETAIL**
LINER SYSTEM ANCHOR DETAILS
N.T.S.



C **DETAIL**
LINER SYSTEM DETAILS
N.T.S.

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MEAGHER COUNTY, MT

FIGURE 3.28
PROCESS WATER POND EMBANKMENT AND SECTIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	29APR'16	GROUND WATER TABLE ADDED	GIM	RAP		
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

REVISED DATE:
MAY 2016

C3001	PROCESS WATER POND - GRADING PLAN

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C3003_r1

3.6.6.5 *Process Water Pond Embankment Freeboard*

The PWP has been designed to maintain a minimum of 6.6 feet (2 m) of freeboard at all times (Figure 3.24). The purpose of the minimum 6.6 feet (2 m) freeboard is to provide an allowance for wave run-up generated from wind. The 6.6 feet (2 m) freeboard is not intended as an allowance for storing excess process water. Therefore the PWP includes sufficient capacity to contain the required amount of process water, run-off, precipitation, and the design storm event (PMF) reporting directly to the PWP. Additionally, run-off and precipitation reporting to the CTF for storm events up to and including the 1 in 500 year 24-hour storm event will be pumped into the PWP for storage, recycled use or water treatment.

Monitoring and mitigation measures are recommended to manage possible icing damage of the PWP during the operational and early closure stages. The 100 mil HDPE liner is thick and durable and will provide significant protection against puncturing and thorough QA/QC inspections during construction will ensure that all welds are completed to standards and are as durable as possible. Annual inspections after the ice thaws would be used to check for liner damage. If damage is observed it is a simple process to lower the pond level to provide access for liner repair.

3.6.6.6 *Process Water Pond Water Reclaim System*

The PWP supplies process water to the reclaim tank located at the mill. The reclaim system has been sized to provide the annual requirement of 5,401,836 cubic yards (4,130,000 m^3) of process water during full production. A 20% design factor has been included in the design flow rate to allow for operational flexibility.

The intake for the reclaim system includes a 29 HP vertical turbine submersible pump located on a pad on the crest of the PWP embankment, at the northeast corner. A stand-by pump will be provided as back-up. The pump intake line will be installed down the side of the pond.

An 18-inch (45.7 cm) ND 450 mm (DR21) HDPE pipeline conveys the flows from the PWP to the reclaim tank. The pipeline alignment follows the access road, and will be installed on the left side of the road and anchored with earthen berms as required. The pipeline will discharge into the top of the reclaim tank at the mill site.

3.6.6.7 *PWP Alternative Locations Evaluated*

Six alternative locations were evaluated for the PWP prior to selection of the final facilities locations (see Section 3.6.13 and Figure 3.13). The final selection process was influenced primarily by impacts to wetlands.

3.6.7 Contact Water Pond (CWP)

3.6.7.1 *CWP Design Concept*

The CWP is designed to collect surface run-off from the mill area, portal pad, WRS pad, copper-enriched rock storage pad, CTF road north of the mill, and from the CWP itself, as well as water from underground mine dewatering (Figure 1.3 and Figure 3.29). This water is called contact water because it could come in contact with potentially contaminated source material from the facilities. BMPs for preventing the co-mingling of unaffected surface and groundwater (non-contact water) with contact water will be implemented.

The CWP will be located directly south of the portal pad (Figure 1.3). The western end of the CWP facility will have a compartmentalized sub-cell or brine pond, separated by a berm, to store all brine generated as a byproduct from the water treatment plant (Figure 1.3 and Figure 3.29) that will be stored separately from contact water in the rest of the pond. The brine will be transferred to the PWP after the construction of the PWP is complete. The combined surface disturbance for both the CWP and the brine pond is 8.9 acres (3.6 ha). The depth to the groundwater table in this area is approximately 43 feet (13 m) below the base elevation of the CWP excavation based on Figure 2.8 and Figure 3.30 and monitoring well MW-8, which lies about 613 feet (187 m) to the south of the CWP.

Both the CWP and brine pond will be operational during surface construction, pre-production, and operations, and initially during closure. The CWP will be kept drained to the greatest degree possible when temporary storage is not required.

The CWP contact water cell will be a single-lined facility with a capacity to store a total of 91,557 cubic yards (70,000 m^3, 18,492,043 gallons) of water. The construction phase storage capacity required includes run-off from the above mentioned facilities and WTP brine and solids storage. Contact water run-off will be separated from brine in separate cells during this period by a central berm. The eastern end downstream embankment height is about 26 feet (8 m) as shown on the section in Figure 3.30. A 3.2 foot (1 m) freeboard is included above the maximum CWP pond elevation which is 1,769.0 m (5,804 feet).

The brine segment of the CWP will be a double-lined cell with an integrated seepage collection and recycle system with a design capacity to store a total of 27,467 cubic yards (21,000 m^3, 5,547,613 gallons) of brine (Figure 3.29) during pre-production with an additional capacity of 4,000 m^3 (1,056,688 gallons) to accommodate operational variances or direct precipitation from a 1 in 200-year storm event. The design water level elevation for the brine pond is 1,768.0 m (5,800 feet) (Figure 3.30). The top elevation of the berm separating the brine pond from the CWP pond is 1,770.0 m (5,807 feet).

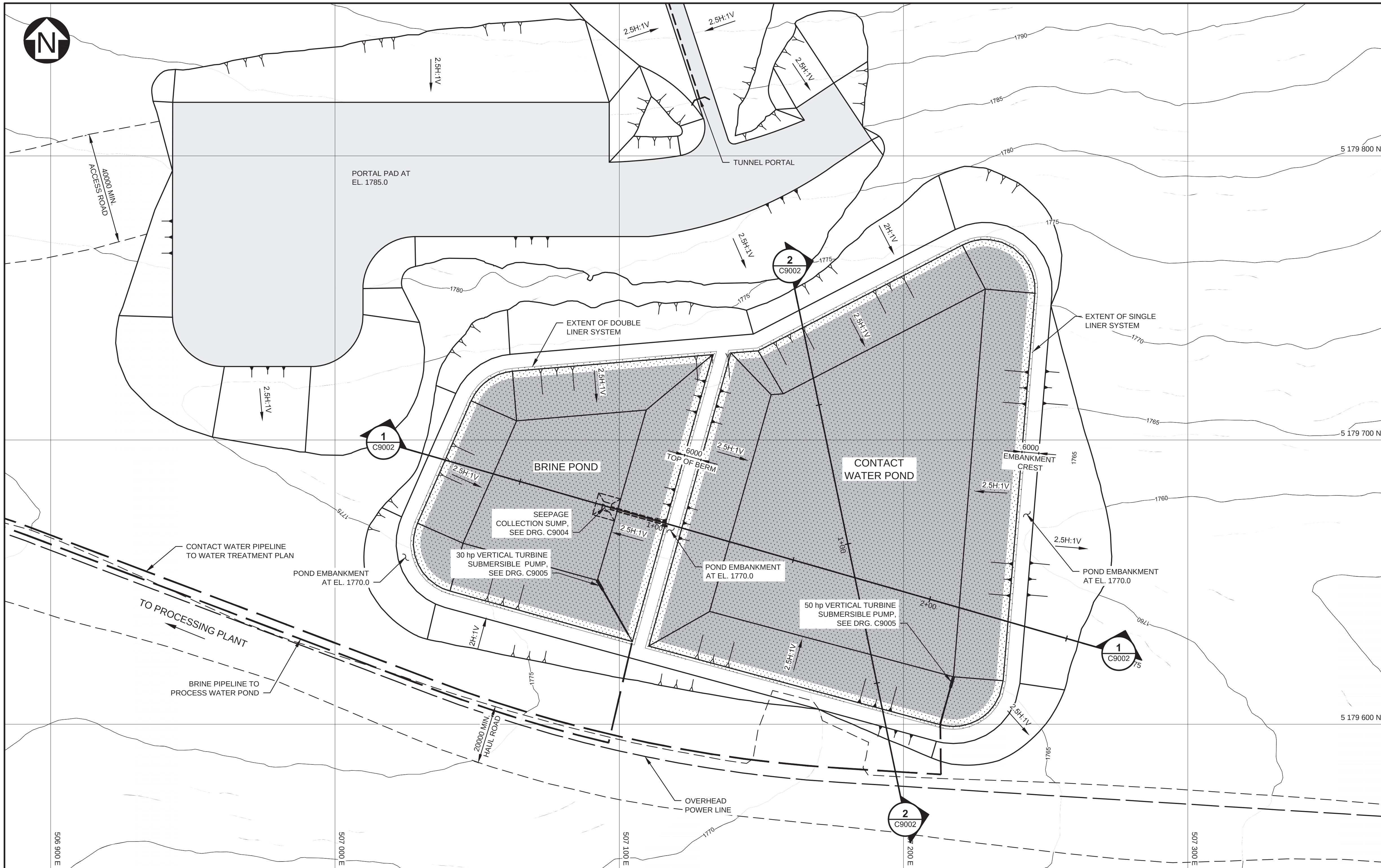
As with the PWP, monitoring and mitigation measures are recommended to manage possible icing damage of the CWP during the operational and early closure stages. The 100 mil HDPE liner is thick and durable and will provide significant protection against puncturing and thorough QA/QC inspections during construction will ensure that all welds are completed to standards and are as durable as possible. Annual inspections after the ice thaws would be used to check for liner damage. If damage is observed it is a simple process to lower the pond level to provide access for liner repair.

The grading plan for the CWP and brine pond is shown in Figure 3.31. The CWP and adjacent brine pond were originally designed by Tetra Tech for the December 2015 MOP Application document. Knight Piésold has redesigned the CWP and brine pond for this revised MOP Application document (see Appendix K-1 by Knight Piésold (Knight Piésold, 2017c).

Because the brine cell on the contact water pond may contain elevated metals and have high salinity (approximating that of seawater) and birds not used to saline water can occasionally develop salt poisoning, Tintina proposes to place bird netting over the approximately 3 acre (1.2 ha) brine pond.

3.6.7.2 <u>Management during Routine Operations</u>

Contact water will be delivered to the CWP during operations along rock-lined drainage channels underlain with an 30 mil HDPE (see Map Sheet 6) or in HDPE pipelines. Run-on drainage ditches would be cut and fill ditches that are designed for the 10 year / 24 hour event peak flow (similar to Knight Piésold's diversion structures shown in Drawing C5003 in Appendix K but considerably smaller). Water in the CWP will be pumped to the WTP prior to disposal to the underground infiltration galleries. The pump will have a high / low water level primer to control pumping (switched on when the water level reaches a high preset water level water and switched off when the water level reaches a low water mark). As a result of this pump back capability, the CWP will operationally contain little or no water, and at many times of the year may be dry.



PLAN

SCALE A

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12N.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC, DATED (FEB 03, 2011).
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS ARE SHOWN IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. POND DESIGN CRITERIA:
   BRINE POND:
   - INVERT = 1763.0 m
   - DESIGN WATER LEVEL = 1768.0 m
   - DESIGN CAPACITY = 21,000 m^3

   CONTACT WATER POND:
   - INVERT = 1763.0 m
   - DESIGN WATER LEVEL = 1769.0 m
   - DESIGN CAPACITY = 70,000 m^3 (revision 1)
6. PLEASE SEE DRAWING C9003_r1 IN APPENDIX K OR FIGURE 3.30 IN THE MOP APPLICATION SHOWING THE CROSS-SECTIONS.

SCALE A 15 7.5 0 25 50 75 m

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FIGURE 3.29
BRINE AND CONTACT WATER POND
GENERAL ARRANGEMENT

C9005	BRINE & CONTACT WATER PONDS - WATER MAN. SYS. PIPING & INST. DIAGRAM
C9004	BRINE POND - SEEPAGE COL. & REC. SYS. - PLAN,PROF, SECT & DETL.
C9003	CONTACT WATER POND - GENERAL ARRANGEMENT - SECTIONS AND DETAILS
C9001	CONTACT WATER POND - GRADING PLAN

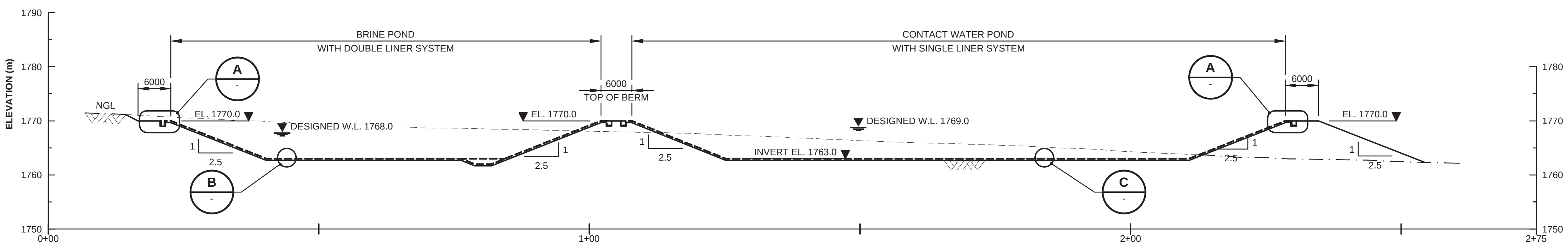
DRAWING BY KNIGHT PIESOLD: Report No. VA16-00684

SOURCE FIGURE NUMBERS: C9002_r1

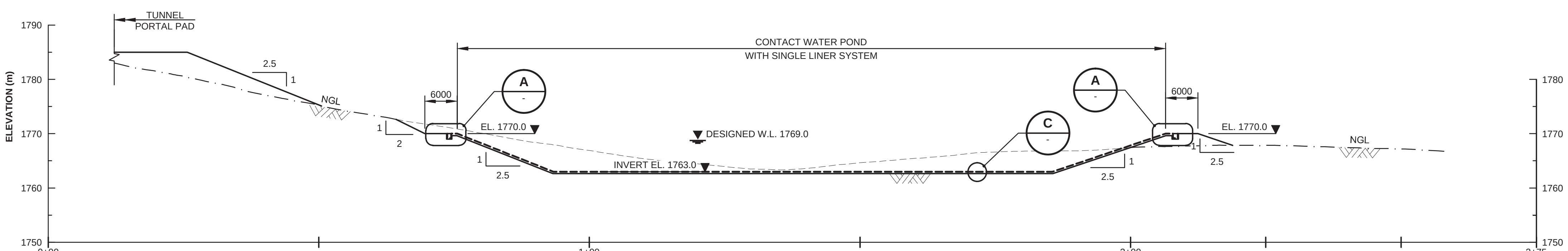
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	20MAY'16	REVISION TO NOTE 5	JEF	KJM		
0	29APR'16	ISSUED FOR INFORMATION	GIM	RAP	KDE	KDE

REVISIONS

REVISED DATE:
MAY 2016



1 C9001 1 C9002 **SECTION**
SCALE A

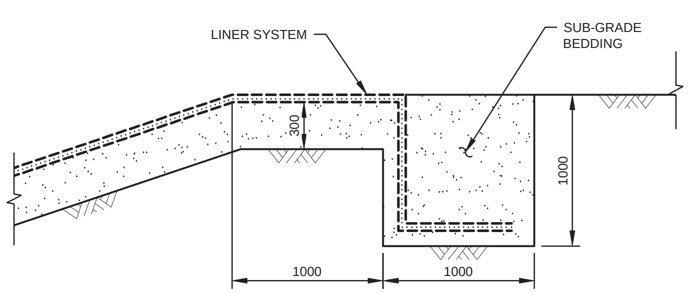


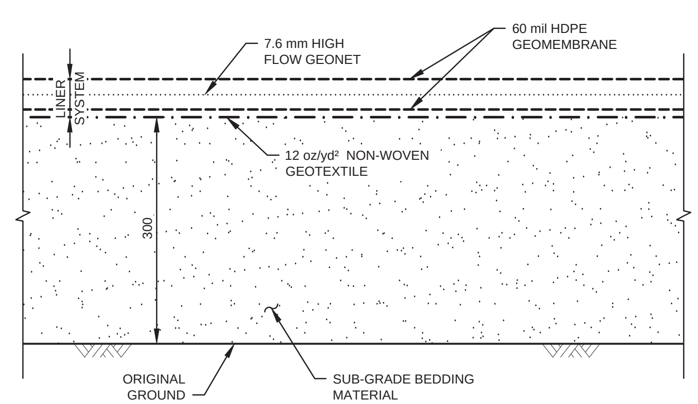
2 C9001 2 C9002 **SECTION**
CONTACT WATER POND
SCALE A

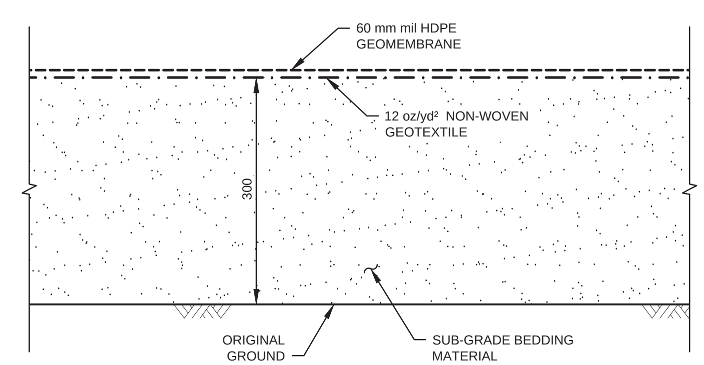
NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12N.
2. ORIGINAL GROUND PROFILE BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC, DATED (FEB 03, 2011).
3. DIMENSIONS ARE SHOWN IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. SEE DRAWING C0003 FOR CONSTRUCTION MATERIAL SPECIFICATIONS.
5. PLEASE SEE DRAWINGS C9002_r1 AND C9002_r1 IN APPENDIX K OR FIGURES 3.29 AND 3.31 IN THE MOP APPLICATION SHOWING THE CROSS-SECTION LINES IN PLAN.

SCALE A 10 5 0 10 20 30 40 50 m
SCALE A 25 0 25 50 75 100 125 ft







A - **TYPICAL DETAIL**
LINER SYSTEM ANCHORING TRENCH DETAIL
N.T.S.

B - **DETAIL**
DOUBLE LINER SYSTEM
N.T.S.

C - **DETAIL**
SINGLE LINER SYSTEM
N.T.S.

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FIGURE 3.30
BRINE AND CONTACT WATER POND
GENERAL ARRANGEMENT
SECTIONS AND DETAILS

C9002	CONTACT WATER POND - GENERAL ARRANGEMENT - PLAN
C9001	CONTACT WATER POND - GRADING PLAN

DRAWING BY KNIGHT PIESOLD: Report No. VA16-00684

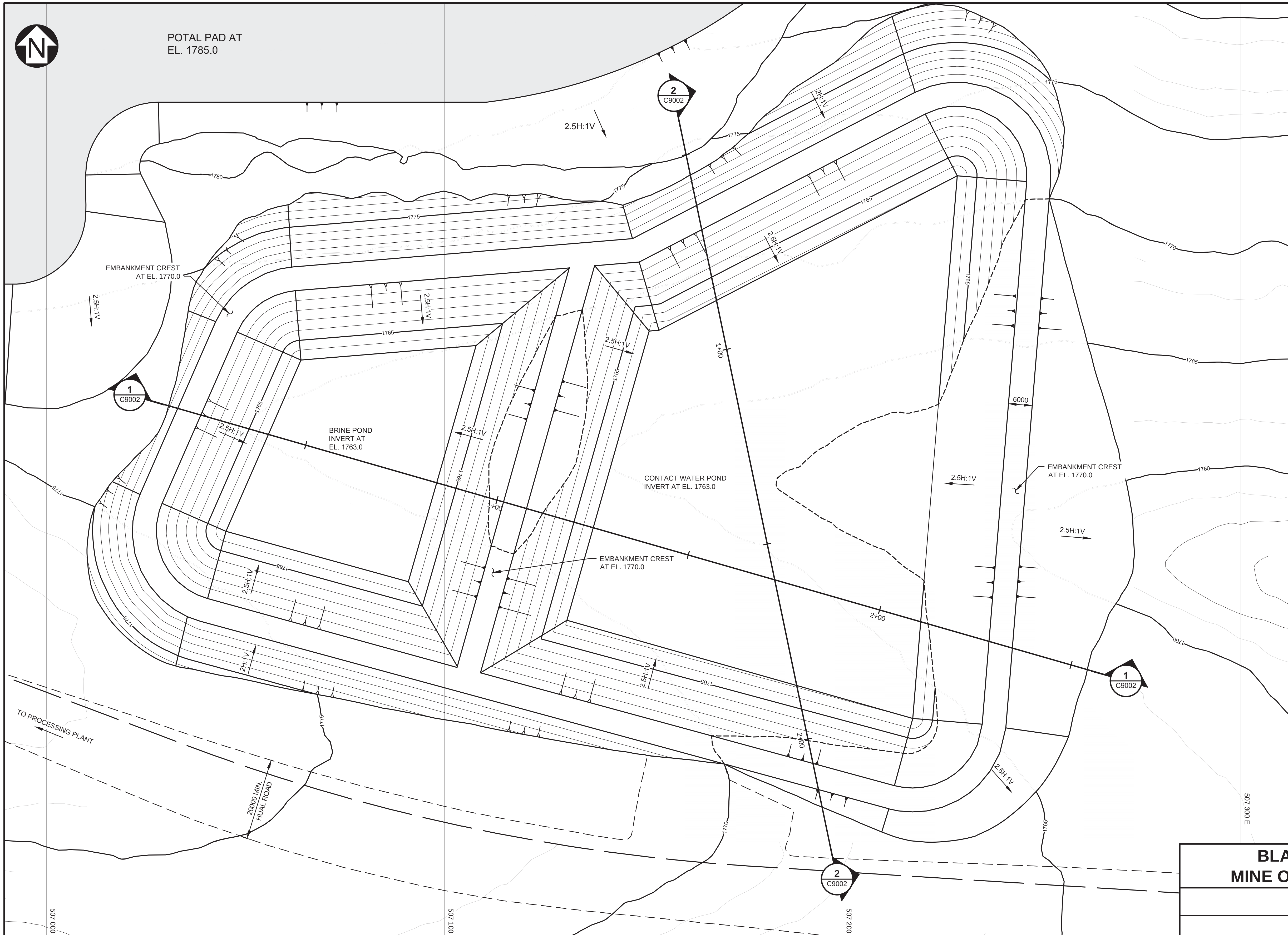
SOURCE FIGURE NUMBERS: C9003_r1

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	20MAY'16	ISSUED FOR INFORMATION	GIM	KJM		
0	29APR'16	ISSUED FOR INFORMATION	GIM	RAP	KDE	KDE

REVISIONS

REVISED DATE:
MAY 2016

SAVED: O:\T-Z\TTBozeman\114-71030\1A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.30 Brine and CWP General Arrangement Sections and Details (C9003_r1), PRINTED: 6/13/2016 1:58:43 PM



PLAN
SCALE A

LEGEND:

EXCAVATION CONTOURS

CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12N.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC, DATED (FEB 03, 2011).
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS ARE SHOWN IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. EXCAVATION VOLUMES:
   - TOTAL CUT VOLUME - 103,500 m³
   - TOTAL FILL VOLUME - 26,700 m³
6. PLEASE SEE DRAWING C9003_r1 IN APPENDIX K OR FIGURE 3.30 IN THE MOP APPLICATION SHOWING THE CROSS-SECTIONS.

SCALE A 10 5 0 10 20 30 40 50 m

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MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.31
BRINE AND CONTACT WATER POND
GRADING PLAN

C9003	CONTACT WATER POND - GENERAL ARRANGEMENT - SECTIONS AND DETAILS
C9002	CONTACT WATER POND - GENERAL ARRANGEMENT - PLAN

DRAWING BY KNIGHT PIESOLD: Report No. VA16-00684

SOURCE FIGURE NUMBERS: C9001_r1

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	20MAY'16	ISSUED FOR INFORMATION	GIM	RAP-PP		
0	29APR'16	ISSUED FOR INFORMATION	GIM	RAP	KDE	KDE

REVISIONS

REVISED DATE:

MAY 2016

SAVED: O:\T-Z\TBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.31 Brine and CWP Grading Plan (C9001_r1), PRINTED: 6/13/2016 2:01:13 PM

3.6.7.3 Management during Mine Start-up

During initial development mining, the mine workings will encounter groundwater flow that will require treatment before brine can be sent to the PWP for storage. Water pumped from underground during this period of time will be sent to the CWP or directly to the construction stage WTP located on the portal pad. The construction stage WTP includes a sophisticated two stage reverse osmosis (RO) treatment system capable of treating water to non-degradation standards for groundwater (see Section 3.7.3.3). During the construction period, prior to the completion of the PWP, brine storage is limited to the brine cell of the CWP, therefore the standard double-pass RO treatment system will be supplemented by VSEP RO system to further reduce brine volumes (see Section 3.7.3.2). Treated water will be sent to the underground infiltration galleries, and the remaining brine fraction resulting from the water treatment process (supplemented by VSEP) will be temporarily stored in the compartmentalized brine cell or pond of the CWP. The flow rate from the underground workings is expected to be minimal during the first year of mining (because mining is above the regional groundwater table), and increase to about 250 gpm by the end of the second year of mining. During this two-year period, the VSEP system will reduce the volume of brine that requires further storage management from approximately 22 million gallons (83 million liters) (produced by the RO system alone) to approximately 3.3 million gallons (12.5 million liters). The total storage capacity of the brine cell of the CWP is about 21,000 m3 (5.6 million gallons). Once the PWP is completed in about year two of construction, brine will be sent directly to the PWP. The water levels in the CWP fresh water cell will be maintained at minimal levels in construction and operationally and will have ample storage for the 1:200-year storm event.

3.6.7.4 CWP Liner and Reclaim System

The CWP cell will be a single-lined impoundment with one layer of 60 mil (1.5 mm, 0.06 inch) HDPE geomembrane liner placed over a 1 foot (300 mm) thick protective layer of granodioritic sub-grade bedding material. Details of the CWP liner system may be found in Figure 3.30 in this MOP Application and Drawing C9004 in Appendix K-1 (Knight Piésold, 2017c).

The CWP reclaim system is designed to pump water to the water treatment plant, from full capacity to empty, over a two week period. The intake for the reclaim system includes a 50 HP vertical turbine submersible pump, located at the southeast corner of the contact water pond. A stand-by pump will be provided as back-up. The pump intake line will be installed down the side of the pond. A section showing the CWP water reclaim system is shown in Drawing C9005 in Appendix K-1 (Knight Piésold, 2017c).

A ND 200 mm DR21 HDPE pipeline in an HDPE-lined ditch will convey contact water to the water treatment plant (Drawing C9005 and C9006 in Appendix K-1) (Knight Piésold, 2017c). The pipeline alignment follows the mine site access road (Figure 3.43). The pipeline will be anchored with earthen berms as required.

3.6.7.5 Brine Pond Liner and Seepage Reclaim

The brine pond will utilize a double liner system with an integrated seepage collection and recycle system (Figure 3.30). The liner system is a double liner that comprises a layer of high flow 7.6 mm geo-net placed between two layers of 60 mil HDPE geomembrane. A 300 mm protective layer of sub-grade bedding material made up of granodiorite sourced from the CTF excavation will be placed below the HDPE liner system. Details of the liner system are shown on Figure 3.30 and Drawing C9003 in Appendix K-1. Sub-grade bedding material specifications are included on Drawing C0003 also in Appendix K-1 (Knight Piésold, 2017c).

The brine pond seepage collection and recycle system will collect seepage through the upper HDPE geomembrane and direct it through the geonet, via gravity, to a sump and pump system at a low point along the east side of the brine pond cell. Water collected in the sump will be pumped through a riser pipe to the embankment crest and returned to the brine pond. An underlying granodiorite subgrade bedding layer will be installed to protect the lining system. The sump and pump system between the HDPE geomembrane layers will consist of a sump filled with drainage gravel that is deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. The bottom of the pipe will be perforated (in the sump) for pump operation. An additional pipe is included for redundancy. The pump will have a high / low water level primer to control pumping (switch on when the water level reaches a high water mark and switch off when the water level reaches the low water mark).

Details of the brine pond seepage collection and recycle system are shown on Drawing C9004 in Appendix K-1 (Knight Piésold, 2017c). Material specifications for drainage gravel to be used in the CWP and brine pond construction materials are included on Drawing C0003 in Appendix K-1 (Knight Piésold, 2017c).

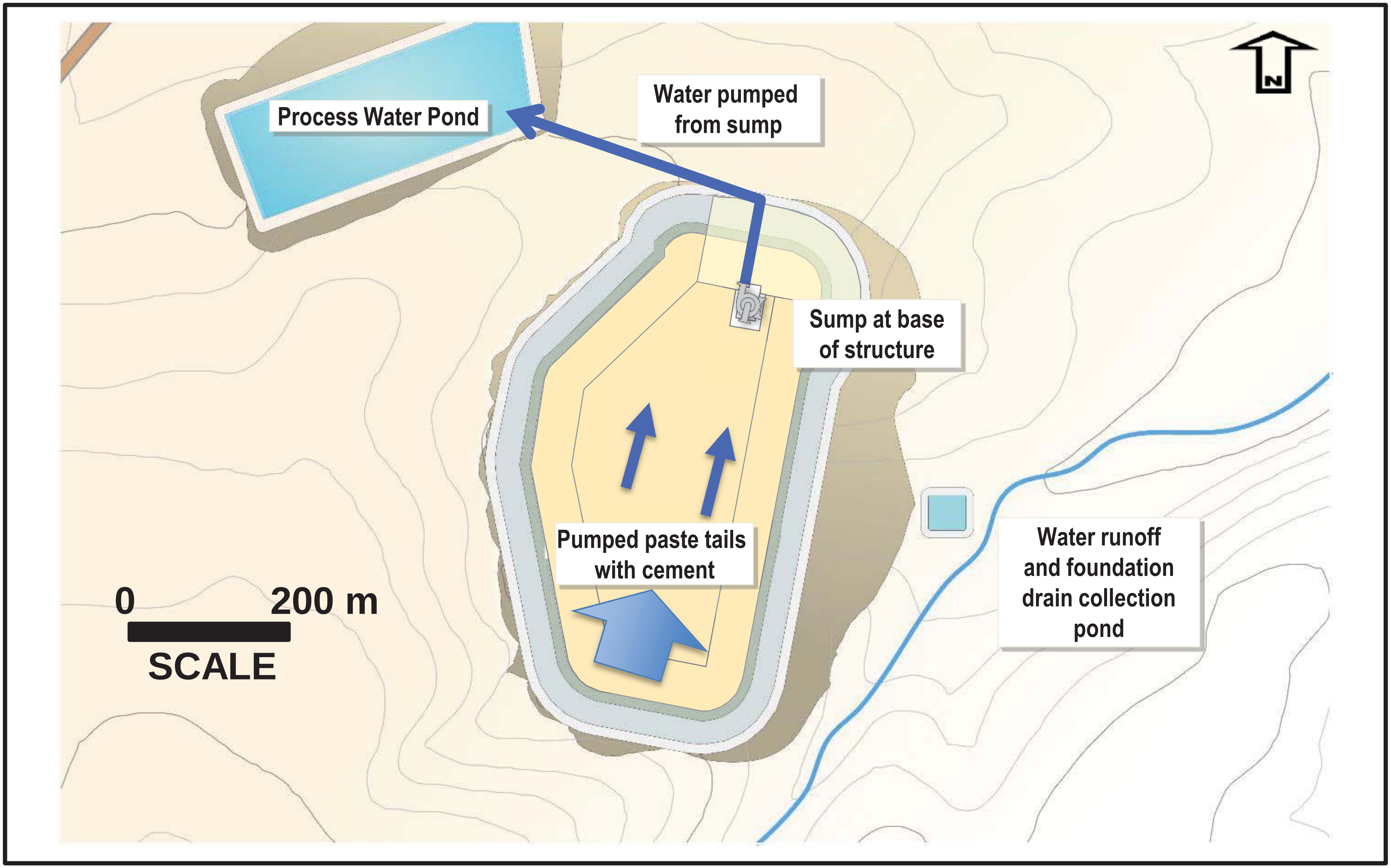
As with the CWP reclaim system the brine pond reclaim system is designed to pump brine to the PWP, from full capacity to empty, over a two-week period. The intake for the reclaim system includes a 30 HP vertical turbine submersible pump, located at the southeast corner of the brine pond. A stand-by pump will be provided as back-up. The pump intake line will be installed down the side of the pond.

A ND 100 mm DR17 HDPE pipeline in an HDPE-lined ditch will convey brine to the PWP (See Drawing C9005 in Appendix K-1) (Knight Piésold, 2017c). The pipeline alignment follows the mine site access road, and crosses the main haul road between the mill and PWP. The pipeline will be anchored with earthen berms as required. The pipeline will discharge off the crest of the PWP. Plans and details of the brine pond pump system and pipeline alignment are shown on Drawings C9005 and C9006 in Appendix K-1 (Knight Piésold, 2017c).

3.6.8 Cemented Tailings Facility (CTF)

3.6.8.1 CTF Design Concepts

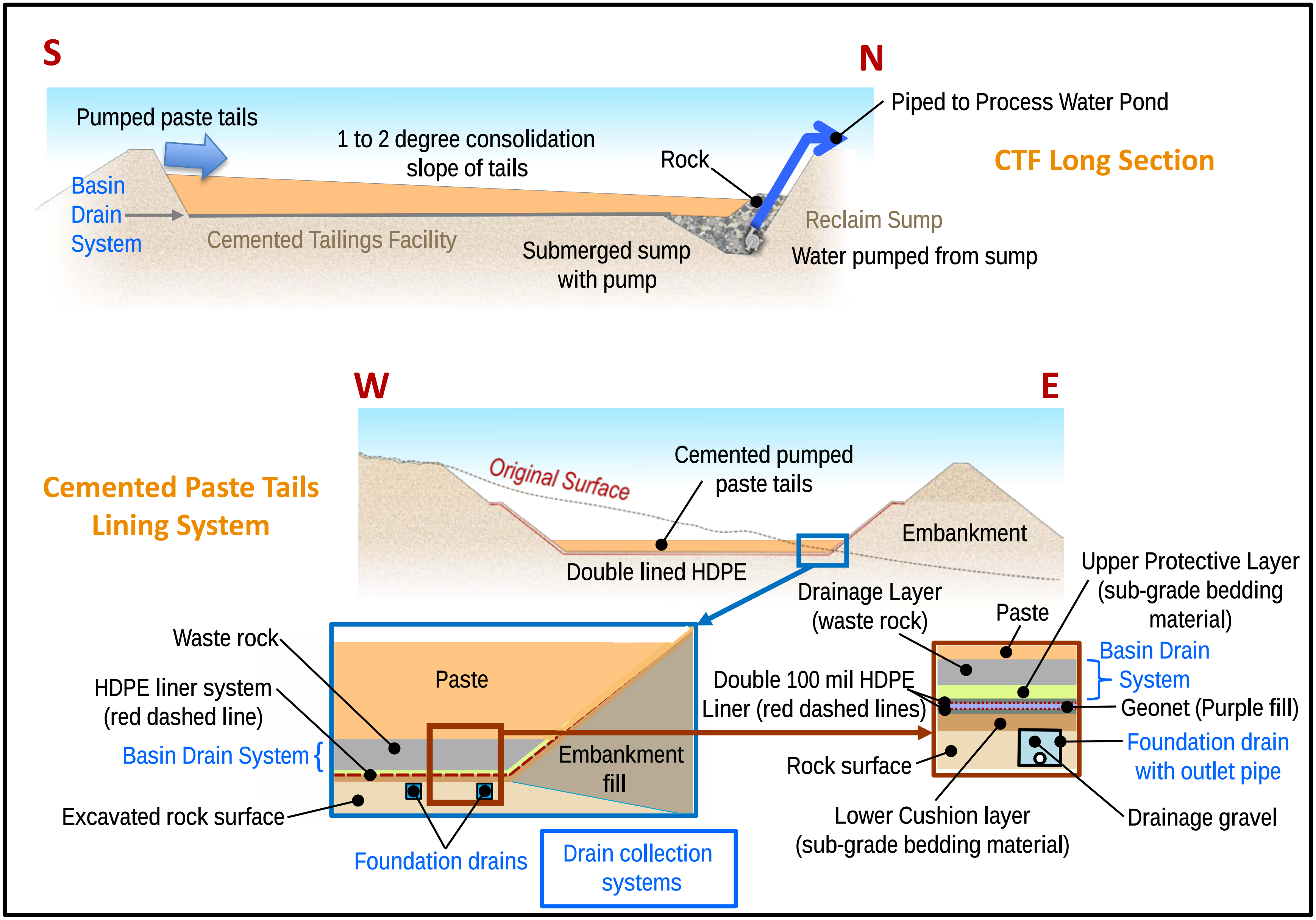
The CTF is designed to store 55% of all tailings generated in the mill over the 15-year active mine life and 100% of waste rock above the HDPE liner system. The CTF (Figure 1.3) has a storage capacity of 5.6 million cubic yards (4.3 Mm^3). This includes 4.7 million cubic yards (3.56 Mm^3) of cemented tailings (7.85 million tons or 7.12 Mt at a settled density of 2 t/m^3), and 0.46 million cubic yards (0.35 Mm^3) of waste rock (0.8 million tons, 0.7 Mt at a density of 2.0 t/m^3). Capacity for an additional temporary storage of storm water up to and including the PMF flood event of 0.4 million cubic yards (0.3 Mm^3) has been included in the 5.6 million cubic yard total. The volume of tailings stored also accounts for the removal of approximately 1.55 million tons (1.41 Mt) of concentrate from the 14.5 million tons (13.2 Mt) of copper-enriched rock. Figure 3.32 and Figure 3.33 are schematic Plan and Sections views of the CTF, respectively. Figure 3.34 is a grading plan for the CTF. The cemented tailings facility has a disturbance footprint of 71.9 acres (29.1 ha). The depth to the groundwater table in this area ranges from 6.6 feet (2 m) below the CTF base excavation elevation to 31 feet (9.5 m) above the CTF base excavation elevation based on Figure 2.8 and Figure 3.36 and monitoring well number MW-10, which lies inside the CTF excavation footprint.



Prepared by Tintina Resources from Knight Piesold designs (2016)

TINTINA RESOURCES

Figure 3.32
CTF Schematic Plan View
Mine Operating Permit Application
Meagher County, Montana



Prepared by: Geomin using a Knight Piesold design (2017)

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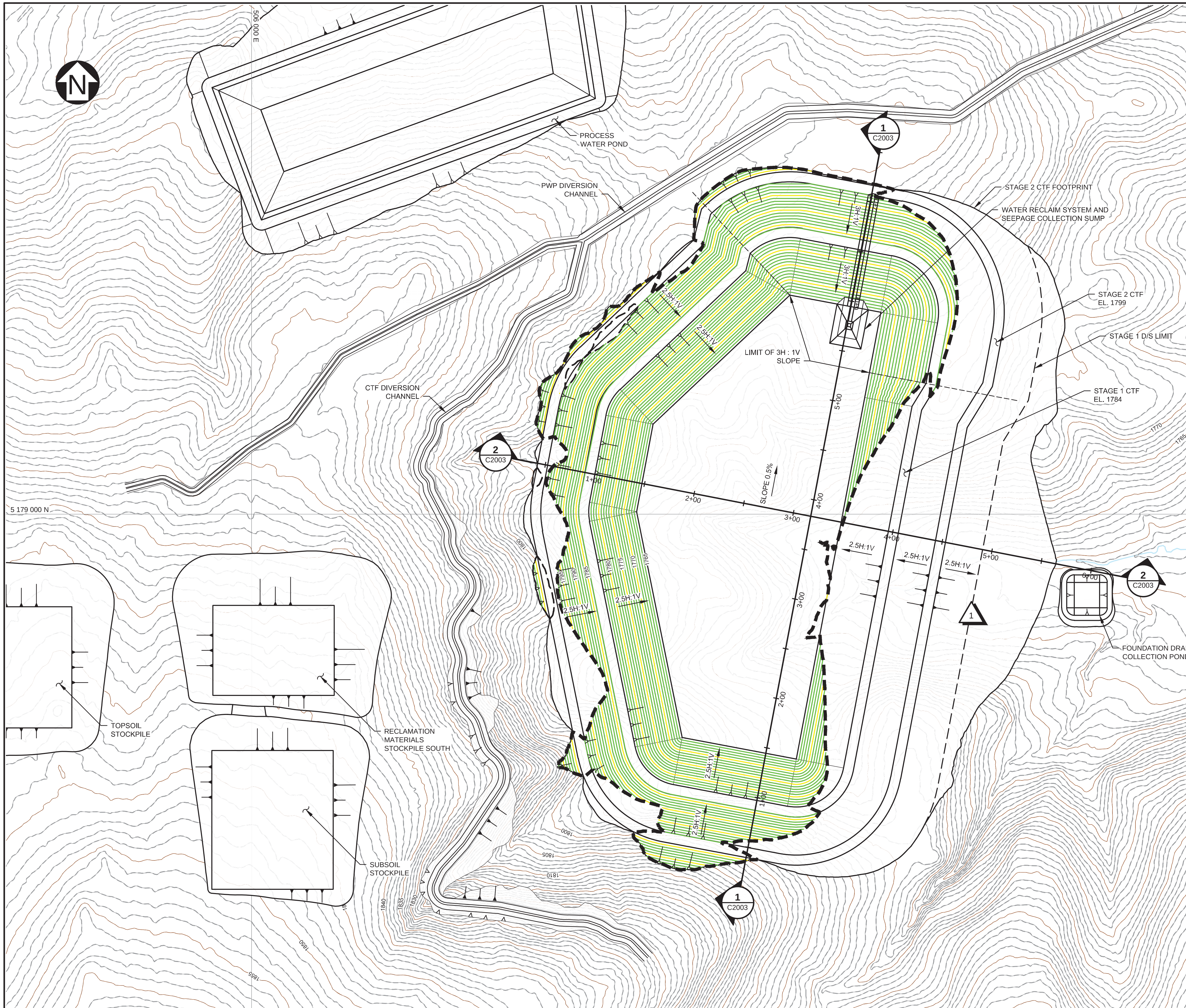
Figure 3.33
Schematic CTF Sections with Lining System
Mine Operating Permit Application
Meagher County, Montana

See Design Drawings C2003 in Appendix K for CTF basin drain system sections
See Design Drawing C2006 in Appendix K for CTF foundation drain sections



LEGEND:

- EXCAVATION CONTOURS
- ORIGINAL STRIPPED GROUND CONTOURS TO BE REGRADED
- CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES, DATED (FEB 03, 2011).
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. FILL CONTOURS NOT SHOWN FOR CLARITY.
6. PLEASE SEE DRAWING C2003_r1 IN APPENDIX K OR FIGURE 3.36 IN THE MOP APPLICATION SHOWING THE CROSS-SECTIONS.

SCALE A 40 20 0 40 80 120 160 200 m

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MEAGHER COUNTY, MT

FIGURE 3.34
CEMENTED TAILINGS FACILITY
GRADING PLAN

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	29APR'16	CTF FOUNDATION POND REVISED	MAP	RAP		
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

C2003 CEMENTED TAILINGS FACILITY SECTIONS

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C2001_r1

REVISED DATE:

APRIL 2017

SAVED: O:\T-Z\TBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.34 CTF Grading Plan (C2001_r1), PRINTED: 4/25/2017 1:50:45 PM

The PWP is designed to store additional water from the CTF for a 24-hour storm up to and including the 1 in 500 year event. A wet well sump and pump system within the CTF will be used to transfer water from the CTF to the PWP, and will be designed to pump out water from the 1 in 100 year 24-hour storm event over a 10-day period. The CTF will have capacity to store run-off and direct precipitation from the PMF event (as defined in Section 3.5.3) until there is capacity in the PWP to pump the water from the CTF.

3.6.8.2 CTF Foundation Drain System

The CTF foundation drain system is shown in Figure 3.35 and Drawing C2004, will be constructed early, and will become operational shortly after commencing construction of the CTF. Groundwater, meteoric water, and seepage (if any) infiltrating the foundation of the facility will be collected by the foundation drain system and directed into the foundation drain collection pond. A flow meter will be installed on the foundation drain pipeline. Water will be pumped back from the pond directly to the RO WTP or alternatively if the RO plant is down for repair or maintenance to the PWP or CTF sump. The CTF foundation drain comprises an interconnected dendritic system of pipes, embedded in drainage gravel (crushed and screened and sourced from CTF granodioritic excavation materials) that is designed to collect and funnel the predicted groundwater flows to a downgradient foundation drain collection pond.

The CTF foundation drain system has the following three components:

- Drains on the CTF Basin Floor,
- Drains beneath CTF Embankments (areas of fill), and
- Outlet drain to the foundation drain collection pond.

Details of the first two foundation drain components (bullets) listed above are detailed in Drawing C2006 in Appendix K. The foundation drain collection pond shown in Drawing C6310 of Appendix K is a small facility requiring only a 0.7 acre (0.3 ha) construction footprint and is located at the downstream toe of the CTF embankment (Figure 3.35). Collected water will be pumped directly to the WTP or alternatively transferred to the PWP as shown in Figure 3.43. The collection pond will be a 100 mil (2.5 mm, 0.1 inch) HDPE geomembrane lined pond with a submersible turbine pump. An HDPE pipeline in a lined ditch will convey the flows from the pond to the WTP or if the RO plant is down for repair or maintenance to the PWP or CTF sump. Details of the CTF foundation drain system, including pipeline lengths, sizes, and minimum required thicknesses of drainage gravel are shown on drawing C2006 in Appendix K.

3.6.8.3 CTF Embankment Construction and Cross-sections

The CTF will have a single embankment to close off the east end of the impoundment, allowing for natural topographic containment to the west. The CTF will be constructed using a cut-fill technique, where excavated materials from impoundment shaping will provide the required storage capacity and fill material for the confining embankment. The CTF will create a considerable amount of excess fill material that will in part be used to construct other facilities (see Tables 3-14a and 3-14b).

The embankment will be a homogeneous rock fill embankment. The internal (upstream) slope of the embankment will be constructed at a 2.5H:1V slope to facilitate geomembrane placement. The external (downstream) slope will also be constructed at a 2.5H:1V slope to facilitate concurrent reclamation of the embankment during operations (Figure 3.37). Both the internal and external slope embankments have also been shown to provide long term geotechnical stability (Section 3.5.5.4, CTF Stability analysis). The embankment crest width will be 33 feet (10 m) to allow working space for tailings and reclaim water pipelines and traffic. The maximum embankment height will be approximately 132 feet (40 m) for the Stage 2 crest at El. 5,900 feet (1,799 m).

The embankment fill will be general fill sourced from excavation as part of the CTF impoundment shaping. The grading plan for the CTF is presented in Figure 3.34 and Design Drawing C2001 in Appendix K. These figures show that the CTF basin floor will be graded at a minimum of 0.5% towards the wet well sump (the wet well sump is described below in Section 3.6.8.10 (Figure 3.34).

The embankment material is expected to consist of fresh to moderately weathered *Ynl Ex* and *Tgd* rock fill and will be placed and compacted to 95% Modified Proctor laboratory density as described in Section 3.4.2.1. Topsoil (including organics and loamy overburden material) and subsoil will be removed and placed on the topsoil and subsoil stockpiles that lie to the west of the CTF, respectively.

3.6.8.4 CTF Sub-grade Bedding Layer below the HDPE Liner System

A layer of sub-grade bedding will be placed above the excavated bedrock surface (and above the basin floor foundation drains as shown in Drawing C2006 of Appendix K) and below the HDPE geomembrane system (described in detail below in Section 3.6.8.5) as shown in Section "A" of Figure 3.36 or Drawing C2003). This sub-grade bedding material will provide a protective layer between the geomembrane and natural ground, or embankment fill materials as shown in Section "A" of Figure 3.36 or Drawing C2003 in Appendix K. The sub-grade bedding layer will be 1 foot (300 mm) thick and require crushing and screening (3/8-inch; 1 cm) as per the sub-grade bedding specification shown in Drawing C0003 in Appendix K. The volume of sub-grade bedding material below the HDPE liner system is listed in Table 3-14b and will be sourced from weathered and select fresh granodiorite bedrock that is processed to meet the required material specifications.

3.6.8.5 CTF Lining System and Seepage Control

The CTF will be fully lined with a double liner system that consists of a layer of 0.3 inch (7.6 mm) high-flow geonet sandwiched between layers of 0.1 inch (100 mil) HDPE geomembrane (Figure 3.36). The HDPE liner system will also be placed upon the upstream embankment face. As previously stated, the entire CTF basin where the HDPE liner system is installed will be covered with an underlying prepared subgrade-bedding layer comprised of material obtained from impoundment shaping.

The seepage control measures incorporated into the CTF are as follows:

- Two layers of 0.1 inch (100 mil) HDPE geomembrane sandwiching a layer of high-flow geonet will cover the entire CTF basin and upstream face of the embankment. The geomembrane is intended to be impermeable, with seepage only possible through defects that may occur during fabrication and / or installation. Any seepage through the upper geomembrane will be collected and transferred to a seepage collection sump and pump system at the north end of the embankment (See Design Drawing C6210). This seepage water is piped up to the CTF embankment crest via a riser pipe and discharges the water back into the CTF (see Design Drawing 6200 in Appendix K) to be collected by the water reclaim system (described below). The "riser pipe" designation is just a term indicating that the pipe rises in elevation and has no specific technical designation.
- The tailings will be comprised of very fine-grained clay-sized particles (94% to 99% less than 75 microns) with very low permeability. The hydraulic conductivity of cemented paste tailings containing 2% binder will be on the order of 1.6×10^{-8} m/sec (flow rate of about 500 millionths of a foot per second) based on laboratory testing (Amec Foster Wheeler, 2015a; also see Table 3-29). The tailings are highly thickened prior to deposition, and it is expected that most of the remaining interstitial water will remain trapped in the tailings, with limited bleed water.

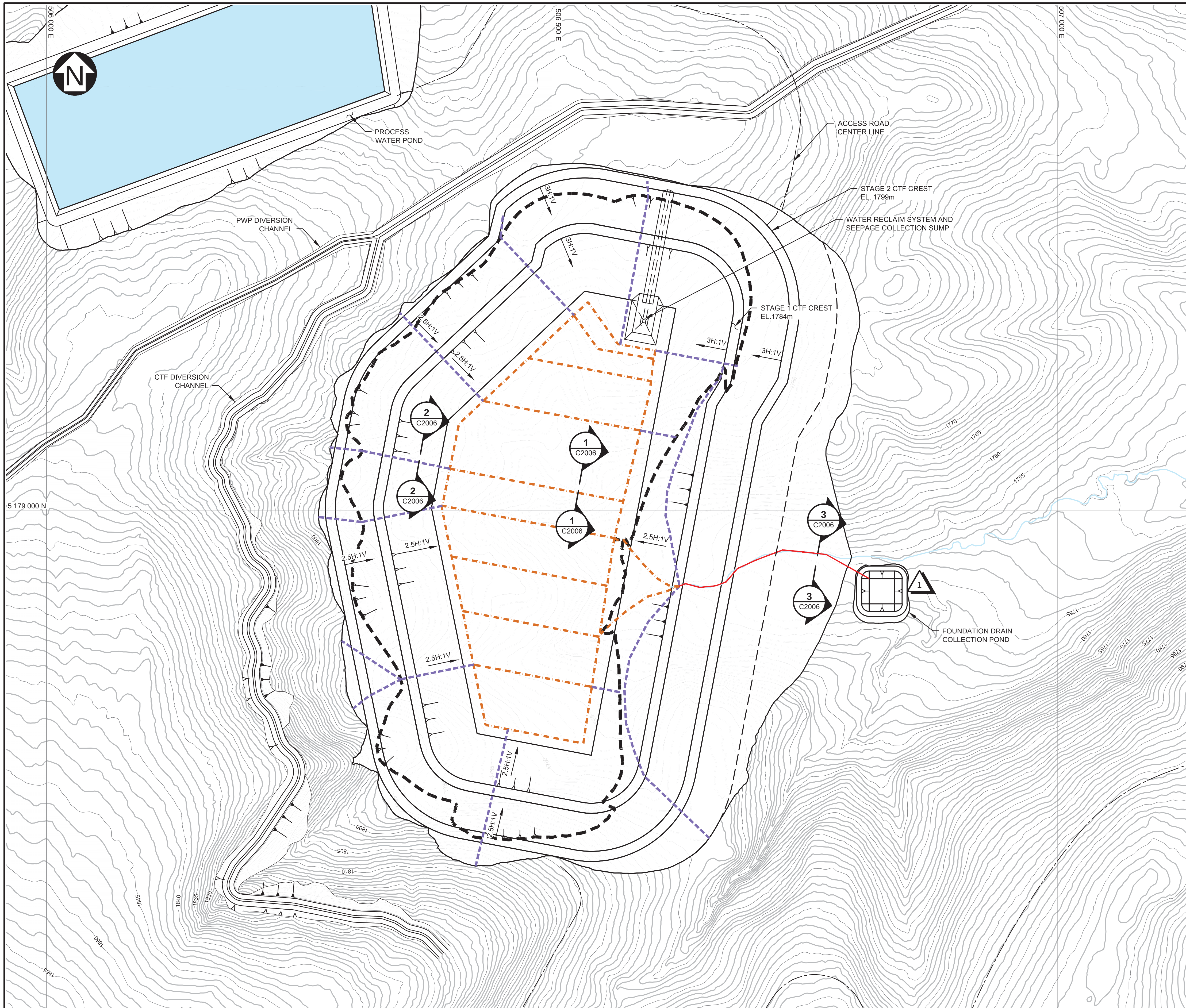
- A basin drain system (described below) will be constructed above the HDPE liner system (geomembrane) (Figure 3.36) and will include the sub-grade bedding layer overlying the geomembrane and the drainage layer overlying the protective layer to maintain low head on the geomembrane, thereby minimizing the potential for seepage.
- Little water will collect in the facility. There will likely be no, or rarely a small surface pond, and the facility will often have only small volumes of water stored in the footprint (130 x 160 feet; 40 x 50 m) of the sloping CTF sump. Run-off, precipitation and limited bleed water from the tailings will be directed to a water reclaim system (described below) within the impoundment, which is different from the seepage collection and recycle system.

3.6.8.6 CTF Seepage Collection Sump (and Recycle System)

The purpose of the seepage collection sump is to collect any seepage through the upper HDPE geomembrane and direct it through the geonet, via gravity, to a sump and pump system at a low point in the CTF basin. Water collected in the seepage collection sump will be pumped through a riser pipe to the embankment crest and back to the CTF (see Design Drawing C6200 showing the CTF seepage collection and recycle system) to be collected by the CTF water reclaim system (described below).

The seepage collection sump between the HDPE geomembrane layers (see detail B in Design Drawing C6230) will consist of a sump filled with drainage gravel deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe (see Drawings C6230 and C6200). The bottom of the pipe will be perforated (in the sump) for pump operation. An additional drain pipe will be included for redundancy. The pump will have a high/low water level primer to control pumping (switched on when the water level reaches a high water mark and switch off when the water level reaches the low water mark). Drawings showing the details of the seepage collection sump are presented in Drawings C6210, C6220 and C6230 of Appendix K of this report.

Potential seepage through the lower geomembrane will be intercepted by the CTF Foundation Drain System (Figure 3.35). Detailed sections of the CTF Foundation Drain System are presented in Drawing C2006 of Appendix K of this report.



LEGEND:

- 250mm (10") N12 WT PE OUTLET PIPE
- 200mm (8") N12 ST PE DRAIN PIPE (BASIN FLOOR)
- 100mm (4") N12 ST PE DRAIN PIPE (CUT SLOPES)
- CUT/FILL TRANSITION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. DRAIN TRENCHES WILL BE SLOPED TOWARDS OUTLET PIPE CONNECTION AT A MINIMUM GRADE OF 0.5%.
5. LAST 10m OF OUTLET PIPE WILL BE SOLID PIPE BACKFILLED WITH IMPERMEABLE MATERIAL.
6. OUTLET PIPE WILL EMPTY INTO A WEIR TO MEASURE PIPE FLOW.

SCALE A 40 20 0 40 80 120 160 200 m

TINTINA RESOURCES

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MEAGHER COUNTY, MT

FIGURE 3.35
CEMENTED TAILINGS FACILITY
FOUNDATION DRAIN SYSTEM

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	29APR'16	CTF SEEPAGE POND REVISED	MAP	RAP		
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

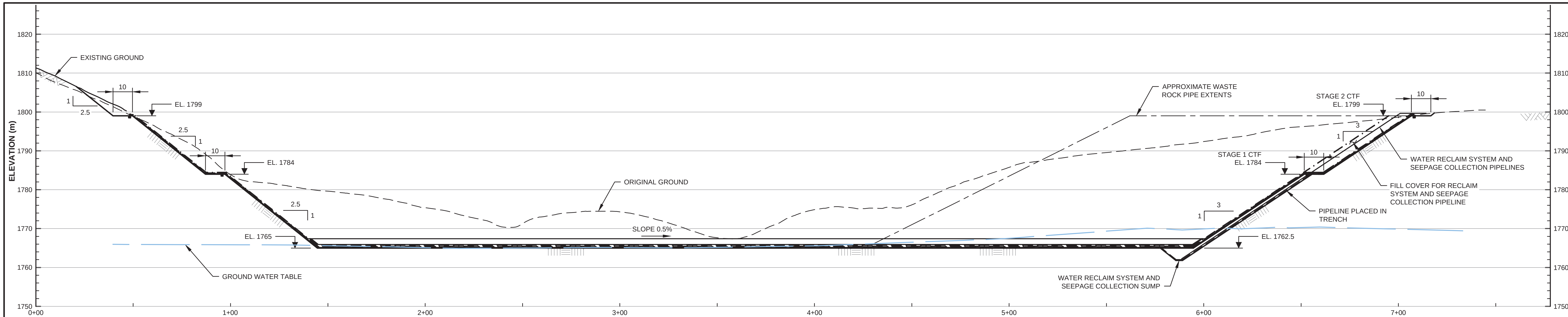
REVISED DATE: MAY 2016

C2006	CEMENTED TAILINGS FACILITY FOUNDATION DRAIN SYSTEM SECTIONS

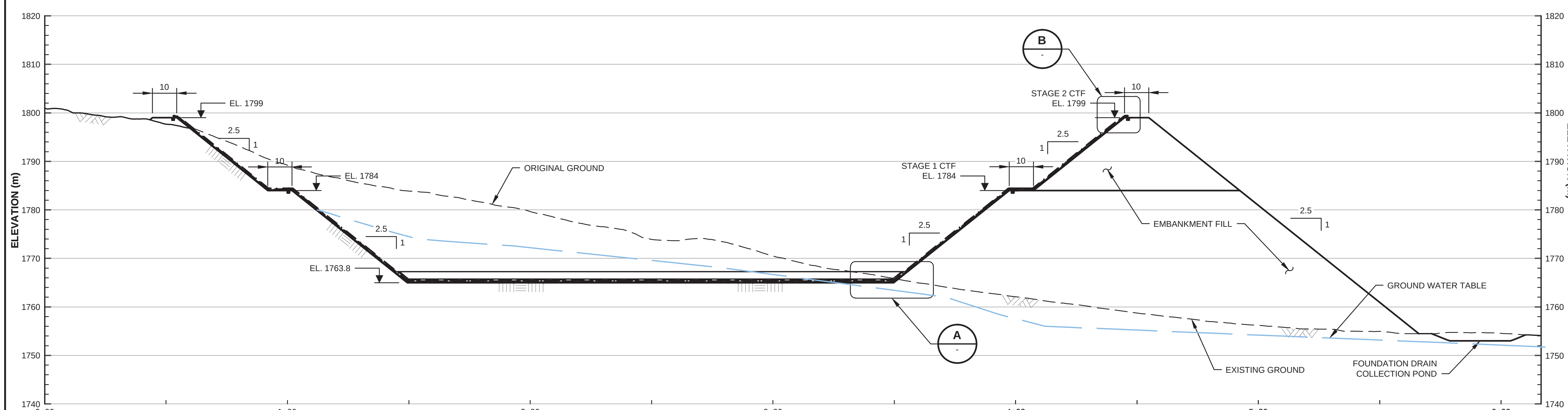
DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C2004_r1

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.35 CTF Foundation System Plan (C2004_r1), PRINTED: 6/15/2016 8:48:10 AM



1 SECTION (C2001)
HORIZONTAL: SCALE A
VERTICAL: SCALE B

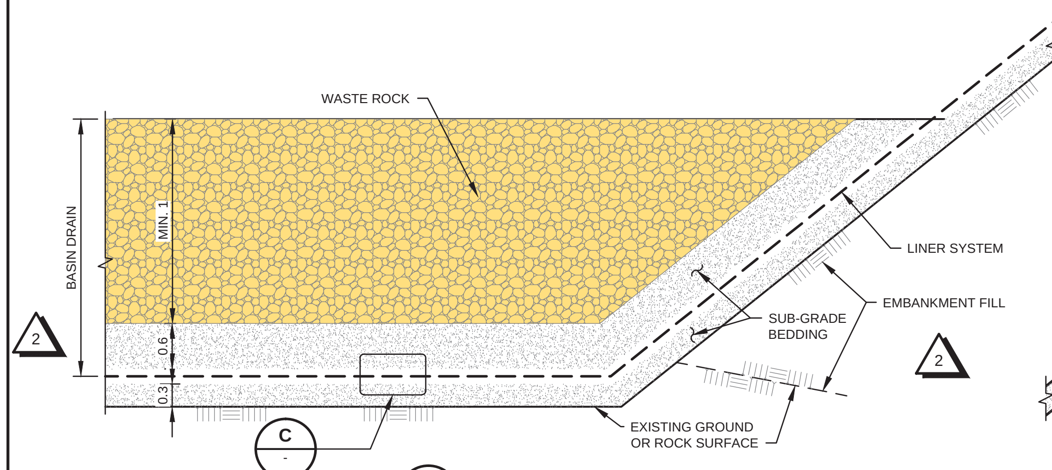


2 SECTION (C2001)
HORIZONTAL: SCALE A
VERTICAL: SCALE B

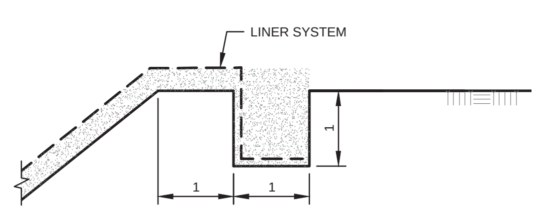
NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. BASIN DRAIN THICKNESS BASED ON AVAILABLE WASTE ROCK VOLUME. THE WASTE ROCK LAYER IN DETAIL 'A' HAS NO MATERIAL OR COMPACTION SPECIFICATIONS.
3. PLEASE SEE DRAWING C2001_r1 IN APPENDIX K OR FIGURE 3.34 IN THE MOP APPLICATION SHOWING THE CROSS-SECTION LINES IN PLAN.

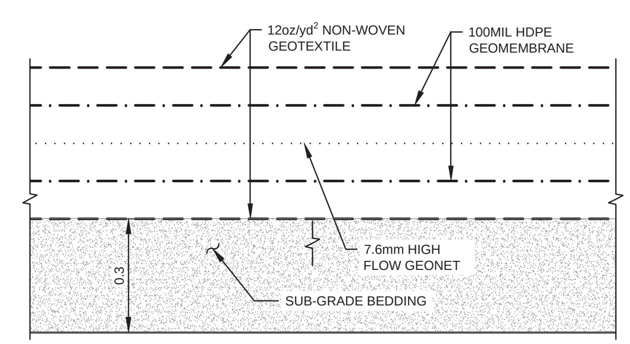
SCALE D: 0.2 0.1 0 0.2 0.4 0.6 0.8 1 m
SCALE C: 1 0.5 0 1 2 3 4 5 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 20 10 0 20 40 60 80 100 m



A SECTION
BASIN DRAIN
SCALE C



B DETAIL
ANCHOR TRENCH DETAIL
SCALE C



C DETAIL
LINER SYSTEM DETAILS
SCALE D

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MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.36
CEMENTED TAILINGS FACILITY
SECTIONS AND DETAILS

C2005	CEMENTED TAILINGS FACILITY DETAILS
C2001	CEMENTED TAILINGS FACILITY GRADING PLAN

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 7

SOURCE FIGURE NUMBERS: C2003_r1

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
2	20APR17	NOTES AND LABELS REVISED	GIM	RAF		
1	29APR'16	GROUND WATER TABLE ADDED	GIM	RAP	KDE	KDE
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KJB	KJB

REVISIONS

REVISED DATE:
MAY 2016

3.6.8.7 CTF Sub-grade Bedding Protective Layer above the HDPE Liner System

A 2 foot (600 mm) thick layer of sub-grade bedding material will be placed above the CTF HDPE liner system and will require crushing and screening (3/8-inch; 1 cm) as shown in Drawing C0003 in Appendix K. The estimated volume of sub-grade bedding material above the liner is listed in Table 3-14b and the source of the material will consist of excavated granodiorite rock (*Tgd*) from the CTF basin. As an alternative, *Ynl Ex and/or pre-production* waste rock may be used for the sub-grade bedding layer above the HDPE liners in the CTF. One part of the CTF basin drain system (as defined in Section 3.6.8.8) will consist of the sub-grade bedding layer above the HDPE liner system.

3.6.8.8 CTF Basin Drain System

The CTF basin drain system is defined in Section "A" of Design Drawing C2003 in Appendix K and in Figure 3.36, and consists of the CTF HDPE liner system (as defined in the Section 3.6.8.5 above), the overlying sub-grade bedding layer (as defined in the above Section 3.6.8.7), and the "drainage layer." The drainage layer is described below. The CTF basin drain system will be connected to the CTF water reclaim system (wet well sump or reclaim sump) and pump system located in the northern part of the CTF (Figure 3.38) and which will be described below in Section 3.6.8.10. The basin drain system will collect tailings bleed water and any water that percolates through the tailings mass, and convey it to the water reclaim system sump to be pumped to the PWP (Figure 3.32). This will facilitate a low phreatic level within the tailings mass and will reduce the head on the geomembrane. This is an effective measure to minimize potential seepage through defects that may be present in the geomembrane.

The drainage layer portion of the basin drain system will be constructed of pre-production waste rock as shown in Section "1" of Drawing C2006 in Appendix K. The waste rock will have the same material specifications as the Embankment Fill as shown in Drawing C0003, and therefore will act as a free-draining material. The CTF basin floor will be graded at a minimum of 0.5% towards the wet well sump as shown in Figure 3.34 and Drawing C2001 in Appendix K.

The waste rock drainage layer portion of the basin drain system will be a minimum of 3.28 feet (1,000 mm) thick as shown in Drawing C2006 in Appendix K and will be placed over the sub-grade bedding layer that overlies the HDPE liner system across the entire basin floor to create the entire drain. The drainage layer and the underlying sub-grade bedding layer will be placed in contact with the drainage gravel in the water reclaim sump (see Drawings C6220 and C6230), creating a continuous flow path to the reclaim sump for any water that enters the basin drain system. The volumes (and tonnages) of pre-production waste rock that will be used to construct the CTF drainage layer and the haul ramp into the CTF are shown in Table 3-14b.

The hydraulic conductivity of the waste rock has not been tested. It is anticipated to vary based on the qualities of the mined rock. However both the drain sub-grade bedding layer and drainage gravel of the reclaim sump will require crushing and screening. Recommendations for preferential placement of suitable rock fill around the sump for haul ramp construction and waste rock storage will be provided during the detailed design phase and called out on final construction drawings. It is recognized that the waste rock may be PAG material, however all contact water within the CTF will be collected and removed to the PWP.

Tintina evaluated the potential for clogging of the basin drain system resulting from supersaturation dissolve constituents in the drain and determined that the actual mass of minerals that could form are highly unlikely to clog the available pore space. To evaluate this concern, Enviromin estimated the mass of mineral that could form in the basin drain/sump, using the solution described by the PHREEQC output file for the CTF solution at year 9. The output provides the moles of each solid phase that precipitates in the solution (per liter). With unit conversions (i.e., molar density of each solid phase), Enviromin calculated the volume of total solids that could precipitate, per liter of solution, and then multiplied by the 113,000 m^3 of flow per year.

The calculation suggests that 1.97 m^3 of solids could precipitate per year if the solution reaches thermodynamic equilibrium - a conservative estimate. During a 19 year mine life (including construction and closure) this would equate to about 37.4 m^3 of potential chemical precipitate. The basin drain contains about 80,000 m^3 of un-compacted run-of-mine waste rock. Assuming the porosity is similar to waste rock deposited on the WRS pad (39.7%), the available void space in the basin drain is about 31,840 m^3. Therefore for a facility as large as the CTF, the volume of potential mineral precipitate is much smaller than the available pore space.

Additional information related to the CTF water management system may be found in Section 3.6.8.6 (CTF Seepage Collection Sump) and in Section 3.6.8.10 (CTF Water Reclaim System and Construction Sequence), and in the following drawings in Appendix K: Drawing C6200 (CTF Water Management Systems Piping and Instrumentation Diagram), Drawing C6210 (CTF Seepage Collection and Reclaim System Plan and Profile), Drawing 6220 (CTF Water Management Systems Typical Sections 1 of 2), and Drawing 6230 (CTF Water Management Systems Typical Sections 2 of 2).

3.6.8.9 Embankment Staging

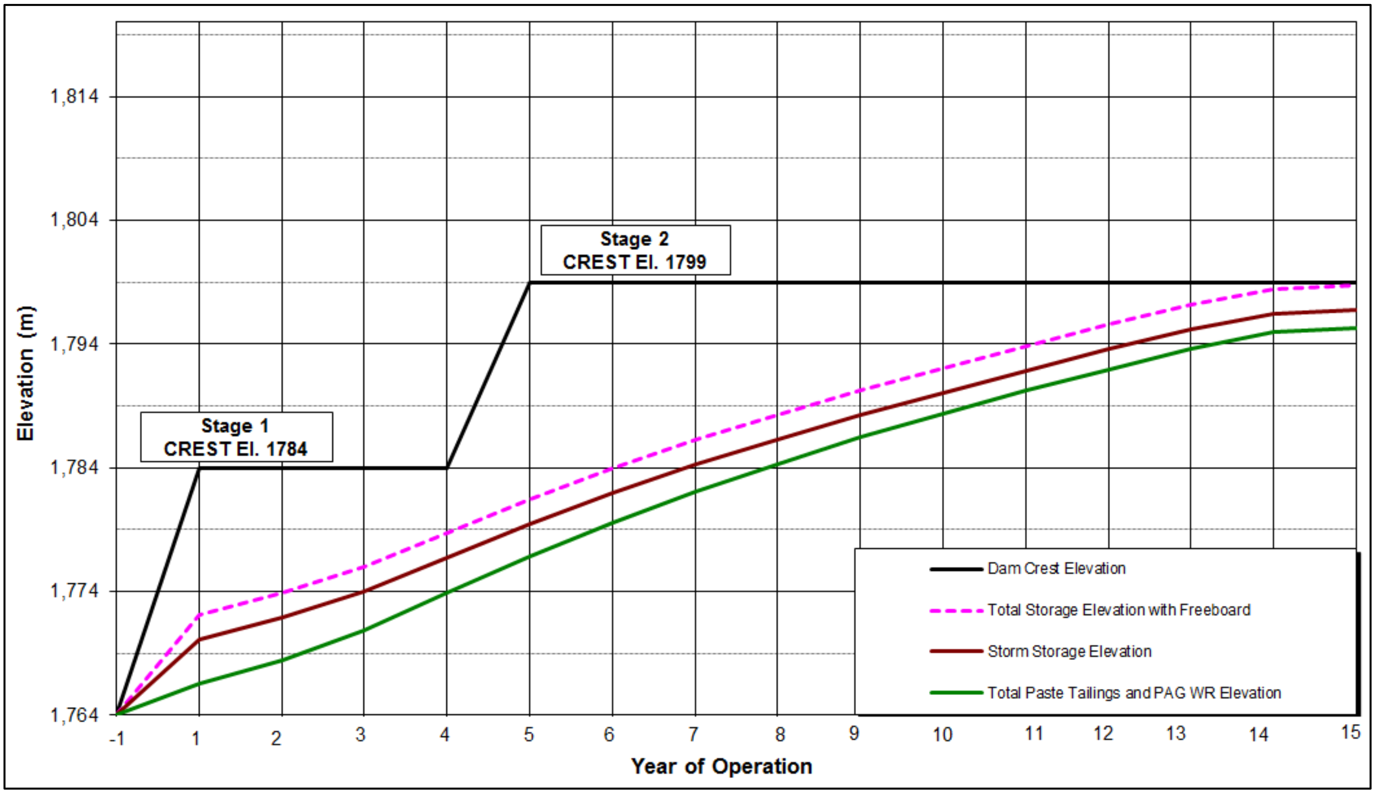
The CTF will be developed in two stages throughout the life of the mine (Figure 3.38). Stage 1 embankment will be constructed to El. 5,853 feet (1,784 m), sub-grade bedding and the liners and geonet placed, and the sub-graded bedding and basin drain system materials placed above the liners prior to commencement of milling operations. This will provide storage for four years of surface tailings deposition and waste rock placement. It is anticipated that a surplus of fill material will be available at the completion of the Stage 1 construction phase. This excess material will be placed and compacted on the CTF embankment in preparation for the Stage 2 construction to El. 5,900 feet (1,799 m). Additional excess material will be stockpiled for use in closure of the CTF in the southern excess / reclamation material stockpile (Figure 1.3).

Construction of Stage 2 will occur during years four to five. All remaining stripping and grubbing, excavation, and fill placement will occur during this time, as well as the installation of the liner system from the stage 1 embankment level to the ultimate crest elevation of El. 5,900 feet (1,799 m). The height of the embankment will be a maximum of 132 feet (40 m) above the adjacent topography.

The preliminary filling schedule and embankment stages are shown on the CTF filling schedule (Figure 3.37). The filling schedule and timing for staged expansions will be reviewed on an on-going basis during operations. The actual rate of filling may vary, depending upon a variety of operating factors including:

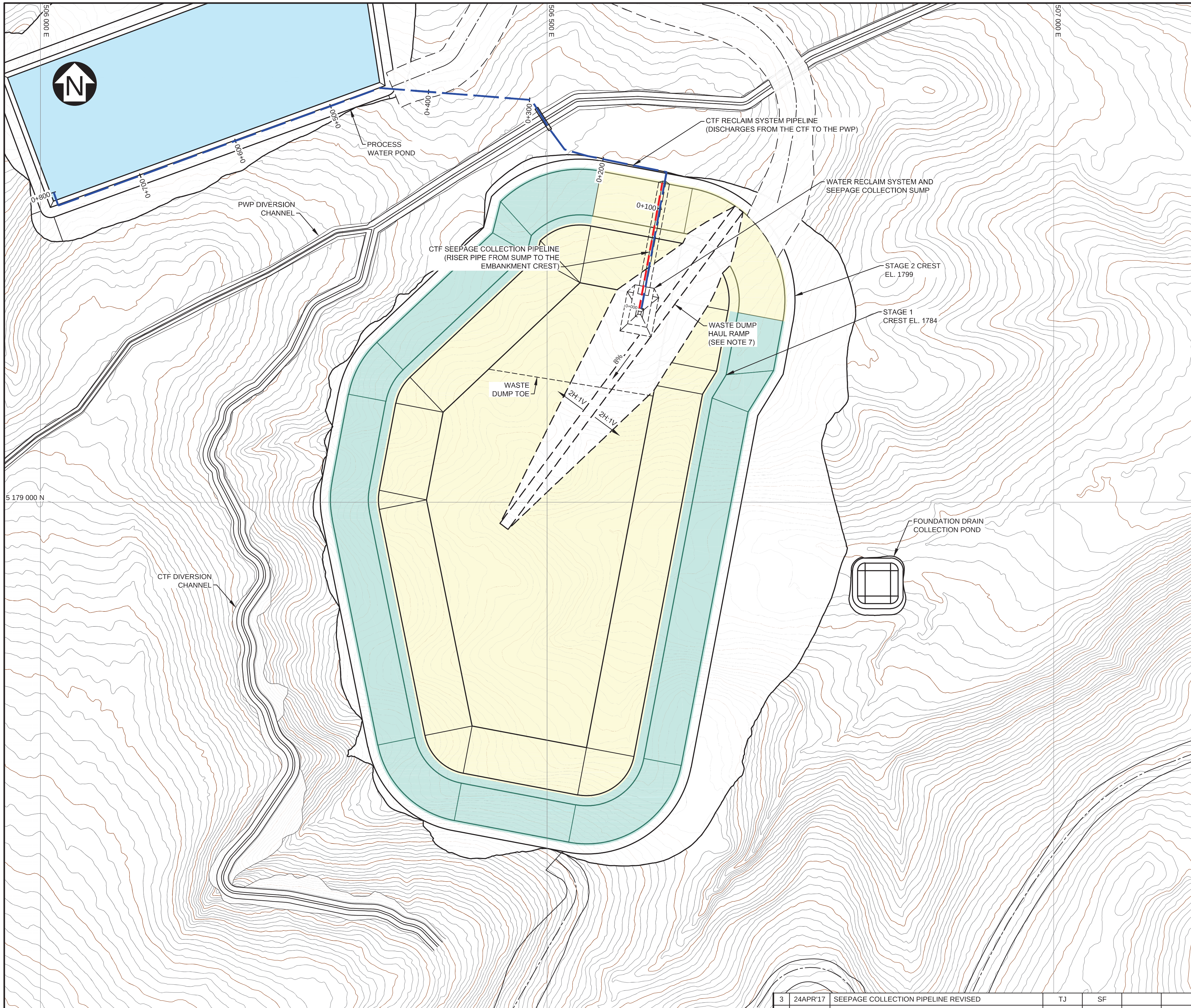
- Mill throughput,
- Settled tailings density, and
- Tailings surface slopes.

Figure 3.37. CTF Filling Schedule and Embankment Construction Stages



NOTES:

1. Filling schedule based on a preliminary production schedule from Tetra Tech (2015b) and includes storage of 55% total tailings and 0.7 Mt (771,617 tons) of waste rock.
2. Waste rock (WR) will be generated in years 1 and 2 as the mine decline is excavated, stockpiling of copper-enriched rock will begin in year 2, and mineral processing will begin in year 3.
3. Storm storage volume is estimated on the basis of containing a PMF event as defined in Section 3.5.3.
4. A minimum freeboard of 2 m will be maintained.



LEGEND:

- STAGE 1 LINER SYSTEM
- STAGE 2 LINER SYSTEM
- CTF RECLAIM SYSTEM PIPELINE
- CTF SEEPAGE COLLECTION PIPELINE

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC., DATED FEBRUARY 3, 2011.
3. CONTOUR INTERVAL IS 1 METER.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. WASTE ROCK WILL BE PLACED AROUND WATER RECLAIM SYSTEM AND SEEPAGE COLLECTION SUMP IN SUCH A MANNER AS TO PREVENT INUNDATION OF THE RECLAIM SYSTEM BY TAILINGS.
6. WASTE ROCK WILL BE PLACED OR SIDE CAST OFF HAUL RAMP AS NEEDED.
7. THE DRAINAGE LAYER IN THE BASIN DRAIN SYSTEM AND THE HAUL RAMP WILL BE CONSTRUCTED USING ALL REMAINING WASTE ROCK FROM THE WRS PAD. AT THE END OF YEAR 2 THIS VOLUME IS ESTIMATED TO BE (APPROXIMATELY 411,537 TONNES OR 205,769 m^3). THE HAUL RAMP CONSTRUCTION WILL NEED TO BE SUPPLEMENTED WITH APPROXIMATELY 154,464 TONNES (77,232 m^3) OF SURPLUS FILL EXCAVATED FROM CONSTRUCTION OF THE CTF (ALL DETAILS TO BE FINALIZED WITH MINE OPERATOR).

SCALE A 40 20 0 40 80 120 160 200 m

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FIGURE 3.38
CEMENTED TAILINGS FACILITY
BASIN DRAIN AND SUMP

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
3	24APR'17	SEEPAGE COLLECTION PIPELINE REVISED	TJ	SF		
2	20MAY'16	MINOR REVISIONS	JEF	MJC		
1	29APR'16	CTF FOUNDATION DRAIN POND REVISED	MAP	RAP	KDE	KDE
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP	KDE	KDE

REVISIONS

REVISED DATE: MAY 2016

- -

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C2008_r2

SAVED: O:\T-Z\TBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.38 CTF Basin Drain and Sump (C2008_r2), PRINTED: 4/26/2017 11:55:01 AM

3.6.8.10 CTF Water Reclaim System and Construction Sequence

The CTF will be operated with a small or more often no pond. Water will be temporarily ponded only following major storm events. The basin drain system will convey what little water percolates through the tailings mass to the water reclaim system. The water reclaim system consists of a wet well sump that extends to the surface (see Drawing C6200, in Appendix K). The CTF basin drain system will be integrated with the wet well sump to promote flow to the sump. In this manner, surface water run-off from precipitation events will report directly to the wet well sump. All collected water from the water reclaim system will be pumped to the PWP (see Design Drawing C6210 and Figure 3.38). A flow meter will be installed on the pipeline connecting the water reclaim system to the PWP.

The reclaim pumps associated with the water reclaim system will be operated on an as-needed basis to transfer all collected water from the CTF to the PWP for mill use. Minor amounts of sediment may be transferred from the CTF to the PWP. Process water stored in the PWP will be monitored on a regular basis to ensure that adequate clarification of water is taking place prior to recycling for mill use.

The wet well (or reclaim system) sump comprises a lined depression (trench) filled with drainage gravel in the low point of the CTF as shown in Drawings C6220 and C6230 in Appendix K . The sump will be filled with drainage gravel and will be deep enough to allow the effective operation of a submersible pump that can be raised and lowered through a protective pipe. In addition, the drainage gravel will be covered with waste rock to facilitate water flow to the sump and a layer of filter sand that will help prevent migration of tailings fines into the drainage gravel. The drainage gravel for the drains and sumps will be sourced from granodiorite excavated from the CTF or the PWP on site as listed in Table 3-14b, and will be required to meet the material specifications as shown on Drawing C0003 (Appendix K).

In order to construct the CTF basin drain system and water reclaim sump, a truck haul ramp and a portion of the floor of the CTF must be covered deep enough to protect the HDPE liner from truck traffic. Trucks can then install a small mobile surface crusher and screening plant within the CTF basin or at the temporary construction material stockpile during the basin excavation to produce the sub-grade bedding materials above and below the CTF HDPE liner system as defined in the scenario presented in Tables 3-14a and 3-14b. The selected contractor will ultimately decide the location(s) for the crusher and screening plant prior to construction. After construction of the upper protective layer, pre-production waste rock material would then be hauled to the CTF and spread over the floor to begin construction of the CTF drainage layer.

All of the remaining pre-production waste rock would be hauled from the temporary WRS pad and will be placed over top of the CTF drainage layer (minimum 1,000 mm thick), as shown in Figure 3.36 and Drawing C2003 in Appendix K. Once the WRS pad is empty it would be reclaimed and subsequent waste rock produced from underground would be direct hauled for deposition along the ramp access into the CTF over the remaining life-of-mine (LOM). These waste rock deposits (piles) would be completely buried by ongoing cemented paste tailing deposition over time.

Hydraulic conductivity of the Basin Drain System is anticipated to vary based on the qualities of the mined rock. However, both the drain sub-grade bedding layer and drainage gravel materials making up the water reclaim sump will consist of crushed and screened material. It is recognized that the waste rock will likely be PAG material, however all contact water within the CTF will be collected and removed to the PWP.

The bottom of the pipe will be perforated (in the sump) for pump operation. The pipe will extend in a channel on the embankment face to the embankment crest, and will be surrounded by a layer of drainage gravel to allow water infiltration into the system. An additional drain pipe will be included for redundancy. The drainage gravel will be surrounded by suitable fill material sourced from excavation of the impoundment. Sub-grade bedding layer material will be placed to protect the geomembrane. The internal slope of the CTF will be reduced to 3H:1V at the sump location to facilitate the placement of drainage gravel and sub-grade bedding fill material.

Embankment fill, sub-grade bedding, drainage gravel, and waste rock will be used to construct the wet well sump and the basin drain system such that they will be free draining as stated previously. The wet well pump will have a high / low water level primer to switch on when the water level in the sump reaches the high water level mark, and switch off when the water level reaches the low water level mark. The system has been designed to pump out a 1 in 100 year 24-hr rainfall event over a period of 10 days (approximately 5.3 gallons per second (300 gpm; 20 Lps) through a HDPE pipeline to the southeast corner of the PWP (a pipeline length of approximately 2,628 feet (801 m)).

The seepage collection sump is located in a sub-excavated zone that will underlie the elevation of the rest of the basin drain system (see Drawing C6220 for details). If the foundation drain system was extended underneath the sump then it would mean that the entire foundation drain system would need to be lowered several meters into the ground. If it was extended to these depths beneath the sump it would form a low spot and all water under the liner system in the foundation drain would pool there.

Extending the foundation drain system beneath the CTF sump is not necessary because the sump has active pumps that will drain off any pooling water, therefore the risk of seepage from that location is mitigated. Additionally, the sub-grade bedding layer beneath the liner is permeable enough to transfer water down gradient from the sump, where it will be intercepted by the foundation drain system.

3.6.8.11 CTF Tailings Delivery System

Tailings will be delivered at approximately 79% solids content (by weight) via pump and pipeline from the mill to the south end of the CTF (Figure 3.43) via an 8-inch (20.3 cm) PN150 steel pipeline. The pipeline will run along the west crest of the impoundment, and discharge tailings at the southernmost point of the CTF. The pipeline will be constructed with secondary containment to capture and contain tailings in the event of a main pipeline leak, (one alternative includes a double-walled pipeline between the mill site and the CTF and between the mill and the portal, another such as a lined trench with a cover may be more appropriate for the project. Secondary containment will not be required on the CTF crest as tailings will flow onto the liner and into the CTF in the event of a leak. The pipeline will have an internal HDPE liner to prevent corrosion.

Tailings will be deposited using spigot off-takes positioned at the southern end of the CTF. Northward sloping cemented beaches will be developed through selective spigot placement over the life of the mine that will direct surface water following precipitation events towards the wet well sump at the north end of the facility. The formation of permanent ponds on the surface of the CTF facility is not anticipated.

Details of the tailings delivery system are shown on Drawings C6100 in Appendix K (Knight Piésold, 2017a).

The Project will be operating in freezing temperatures for a significant portion of each year. The pipeline will be insulated or heat traced to protect against freezing. Additionally, the pipeline will be flushed with about 5,000 gallons of water per pumping cycle (every 6-7 days) and drained when not in use so that no standing water or tailings are left in the pipeline to freeze or set up.

Because cemented tailings are routed to the CTF and for use as backfill in the underground workings, in the event of a CTF delivery pipeline service outage or other circumstance that interrupts tailing delivery to the CTF, cemented tailings will be routed for use as backfill underground until the interruption in delivery to the CTF is corrected.

3.6.8.12 CTF Embankment Freeboard

Tailings will be deposited strategically from the embankment and southern basin perimeter (Figure 3.32). The CTF will be maintained with little or no pond (often with small volumes of water stored only in the footprint (130 x 160 feet; 40 x 50 m) of the sloping sump). The tailings surface will be developed to direct surface water toward the wet well sump and pump system (Figure 3.33).

Under these conditions, sufficient storage capacity will be available to contain all surface tailings, waste rock, run-off, and precipitation (up to and including the design storm event) while maintaining a minimum freeboard of 6.6 feet (2 m). Construction will be staged such that the minimum freeboard requirement is maintained, even during the design storm event.

3.6.8.13 CTF Waste Rock Co-disposal during Operations

Waste rock (as run-of-mine material) generated from the underground mining operations during the production mining period will be delivered to and stored within the CTF during operations (i.e. occur simultaneously with cemented tailing paste deposition). Waste rock placement will be integrated with the basin drain system and reclaim system. Waste rock generated throughout the life of the mine will be placed in the CTF around the water reclaim system, adjacent to the haul ramp, which will promote drainage into the reclaim sump. A ramp (Drawing C2008 in Appendix K, Knight Piésold, 2017a) (Figure 3.38) will be constructed into the basin of the CTF, so that waste rock can be hauled into the impoundment by haul trucks end dumped adjacent to the haul ramp and spread with a dozer (if necessary).

Waste rock will be generated throughout the life of the mine. The truck haul ramp into the CTF basin will be maintained to facilitate waste rock placement. The waste rock will extend up the slopes of the haul ramp and be placed around the sump pumping wells in a continuous column above the sump. Sub-grade bedding material made from excavated granodiorite from the CTF will be placed on the geomembrane prior to waste rock deposition in the vicinity of the liner to protect the liner system. The waste rock placement will be staged such that the working surface and water reclaim system will not become inundated by tailings deposition.

3.6.8.14 Tailings Management Alternative Selection

A total of four different alternative locations were reviewed for the location of the CTF. One was eliminated because of its location in the Butte Creek drainage, and its inability to contain the entire volume of tailings in one facility. Two others were eliminated principally because of their impacts to wetlands (5 and 11 acres each, 2.0 and 4.5 ha, respectively). Appendix Q presents an analysis of alternatives examined and the selection process for facility locations and tailings disposal options. An analysis of alternative tailing slurry pipeline locations is presented in Appendix K (Knight Piésold, 2017a), sub-Appendix E by MG Engineering (2016).

3.6.8.15 Hydrologic Assessment of the CTF

A hydrological assessment of the groundwater system in the vicinity of the proposed CTF was conducted by Hydrometrics (Appendix B-1; *Hydrologic Assessment of Proposed Cemented Tailing Facility Black Butte Copper Project*) (Hydrometrics, 2016b). The purpose of this assessment was to characterize the groundwater system beneath the CTF including the depth at which water will be encountered in the CTF excavation, quantify the amount of water moving through the CTF excavation, and establish baseline water quality.

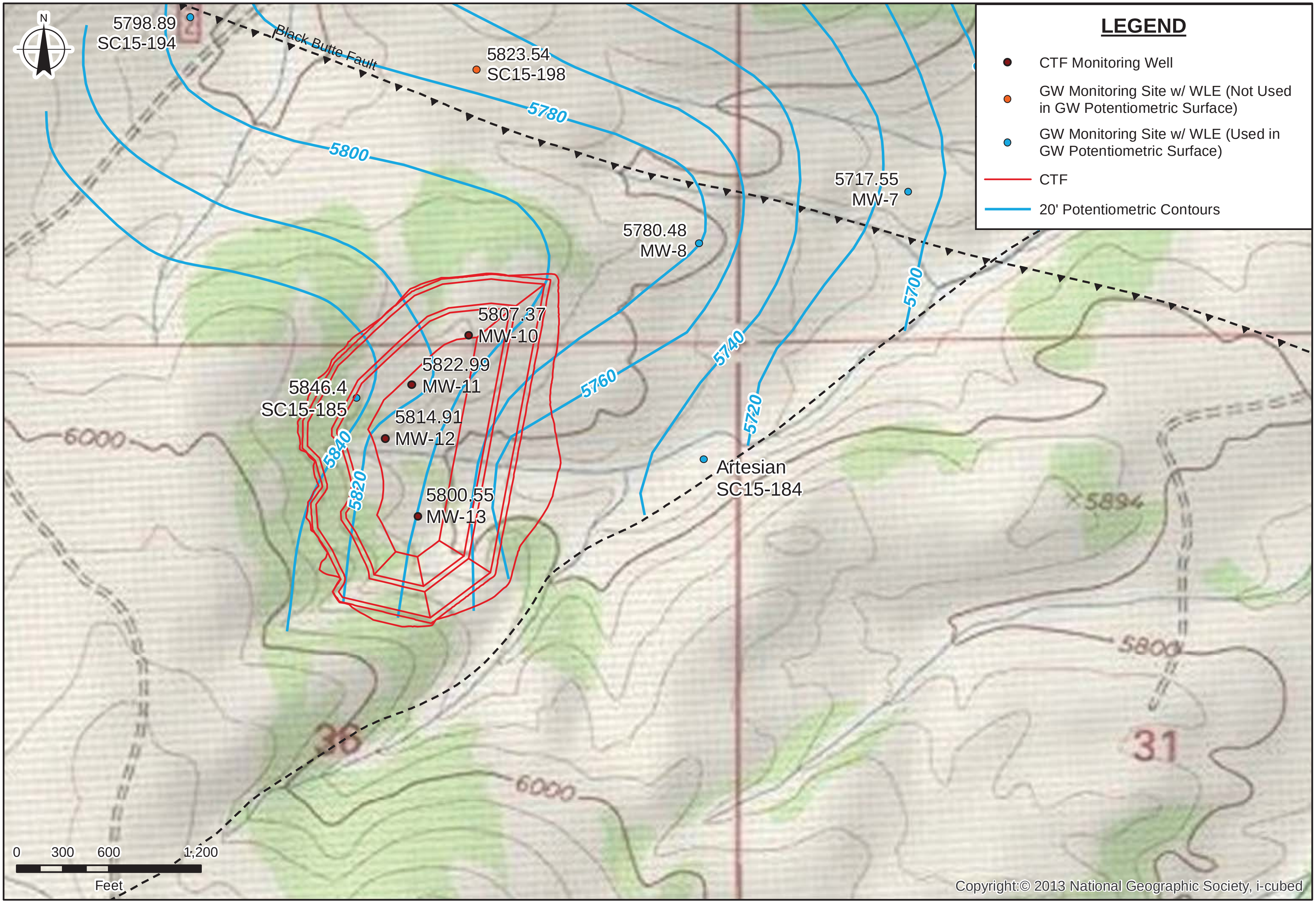
The scope of this assessment consisted of installation of four monitoring wells to the lowest depth of the CTF excavation (Figure 3.39), slug testing, groundwater level monitoring, estimating ambient flux of the groundwater system, and evaluating dewatering rates of the designed CTF drain system. Details of the assessment are presented in Appendix B-1.

The CTF investigation provides essential information related to the hydrological system that the CTF excavation will encounter and demonstrates that the foundation drain system is sufficient to dewater the groundwater beneath the CTF without creating hydrostatic heads beneath the liner system. The monitoring wells in the northern half of the CTF (MW-10 through MW-12) (Figure 3.39) were all completed in granodiorite. Wells completed in this area have a large range in hydraulic conductivity (0.001 ft. /day to 10 ft. /day) (see Appendix B-1; Hydrometrics, 2016b). Well MW-13 is located in the southern portion of the CTF and encountered moderately permeable shales, with an average hydraulic conductivity of 2 ft. /day. Although there is some evidence that groundwater may be present in the area in a series of perched zones, the water levels in the wells were used to construct a potentiometric surface map (Figure 3.39). This map in the vicinity of the CTF indicates groundwater is anticipated to range between 6.6 feet (2 m) below the CTF excavation base elevation to approximately 31 feet (9.5 m) above the base elevation of the proposed CTF excavation.

Groundwater flux through the area of the CTF and the dewatering analyses were estimated in an analytical model analysis using the software AQTESOLV 4.5 (Appendix B-1) and assume the wells are completed in a well-connected aquifer system. Ambient groundwater flux is estimated at approximately 20 gpm (1.3 Lps). The dewatering analysis estimates an inflow rate to the foundation drain system of approximately 15 gpm (0.9 Lps); which is well within the design flow rate of the foundation drain system (350 gpm). Although higher flow rates may occur seasonally, the flow rates are not anticipated to exceed the capacity of the foundation drain system based on hydraulic conductivities encountered at the monitoring wells. Because of these low flow conditions and the design of the liner and foundation drain systems, all groundwater is expected to flow beneath the CTF impoundment. In addition, the groundwater table is already below the embankment footprint, and therefore should not impact embankment stability.

Seasonal variability in groundwater levels range from approximately 4 feet (at MW-13) to 14 feet (at MW-10). These changes are relatively small, based on the low permeability of the bedrock in which the wells are completed. The relatively small, seasonal variability in groundwater levels in the vicinity of the CTF is likely due to the relatively small recharge area. When this increased head is applied to these rocks as in the analysis discussed above, the ambient groundwater flux increases to approximately 27 gpm compared to 20 gpm flow during lower water levels. Applying the increase in head to the simulated dewatering analysis, results in a dewatering rate of approximately 23 gpm during high water. The range in flow through the area of the CTF is less than 10% of the capacity of the foundation drain system during both low and high water levels.

Groundwater collected by the foundation drain system is anticipated to be of good quality based on the water quality results from the four monitoring wells. In general, the water is anticipated to be a calcium bicarbonate-type water, with possibly a small sulfate signature (31 mg/L) based on the water quality at MW-11. The baseline groundwater quality within the CTF excavation is below the human health standard for all constituents.



I:\Land Projects\1104802\GIS\1104802H011.mxd

Prepared by Hydrometrics (2016)

Figure 3.39

CTF **Potentiometric Surface Map**

Black Butte Copper Project

Meagher County, Montana

3.6.9 Non-Contact Water Reservoir (NCWR)

3.6.9.1 NCWR and Water Rights

To obtain an appropriation permit, Tintina is required to develop a mitigation plan to address depletion to surface water flows associated with the consumptive use of groundwater in its operations and submit that plan to DNRC for approval. For planning purposes, Tintina has included a NCWR (Figure 1.3) as part of the Project facilities as the most likely option for storing water for mitigation purposes. This reservoir could be filled using water rights during the irrigation period of the year, to off-set consumptive use during the non-irrigation months of the year. However, the calculated consumptive use value (210 gpm or 14 Lps) is an estimate. A table of estimated values for consumptive use of groundwater by component is provided as an inset to Figure 3.44. In addition, Tintina has yet to submit a draft mitigation plan to DNRC for their approval and it is not known how much depletion the DNRC will determine needs to be mitigated. The resolution of these final mitigation plan issues will determine the ultimate volume of water that needs to be stored in the NCWR. Therefore, for the purposes of this permit application, Tintina has assumed the maximum anticipated disturbance footprint (7.6 acres (3.1 ha)) and volume of the NCWR (470,862 cubic yards (360,000 m^3) of water on an annual basis) assuming all water rights mitigation will be conducted through the use of the NCWR.

Water to fill the NCWR could be pumped from one of several diversion points based on existing leased water rights along Sheep Creek (see Section 2.2.2) via a surface pipeline. Using existing surface water rights would require filling of the NCWR during the five-month irrigation period of the year for subsequent release to offset consumptive use on a monthly basis during the non-irrigation portion of the year.

3.6.9.2 NCWR Overview

The NCWR as illustrated on Figure 3.40 has a disturbance footprint of 4.7 acres (1.9 ha) and a design capacity of 470,862 cubic yards (360,000 m^3) of water on an annual basis. At full capacity, the reservoir will flood approximately 15.7 acres (6.4 ha) which includes approximately 1.0 acres (0.4 ha) of wetlands. There are no monitoring wells close to the NCWR facility and therefore the potentiometric surface contour lines in Figure 2.8 do not cover the NCWR footprint. However, the depth to the groundwater table in the area of the NCWR embankment may be estimated to be 10 feet (3 m) below the NCWR embankment base elevation based on Figure 3.41 and Map Sheet 2, The NCWR embankment was purposely placed in the location as shown in Figure 1.3 in an upland area between wetlands where the surface is known to be dry. No wetlands or stream channels have been identified in the planned site location of the NCWR embankment.

It is anticipated that water stored in this reservoir will be allowed to seep from the reservoir floor to the downstream catchment as required. Seepage from the NCWR is expected and is intended to offset a portion of mine site consumptive use. Analyses indicate an average seepage rate of approximately 50 gpm (273 m^3 per day). The analyses also indicate that the predicted rate of seepage from the NCWR is not high enough to fully drain the reservoir within a single year. Therefore both a floating pump system and a system that pumps from the bottom of the reservoir will be in place to dewater the NCWR. This will allow Tintina to discharge water at a suitable rate to offset mine site consumptive use on a monthly basis to an infiltration basin or underground infiltration gallery east of the spillway, and insure that is at a temperature that will not impact aquatic life.

Existing surface flows will be diverted around the NCWR as the project is located in the Upper Missouri River Basin; which is closed to new surface water appropriations. If other water sources are diverted to the reservoir for storage, it will be delivered by a pipeline discharging into the NCWR from the embankment crest onto a geomembrane liner on the upstream embankment face. A protective layer of HDPE geomembrane (rub sheet) will be placed at the discharge point to protect the geomembrane.

3.6.9.3 NCWR Embankment Fill Zones

The NCWR embankment will be constructed with general fill material sourced from the impoundment shaping of the CTF. The embankment (Figure 3.41) will be a homogeneous rock fill embankment. Aside from topsoil / subsoil removal within the embankment footprint, no impoundment shaping will be completed for the NCWR because the basin will remain an unlined facility. The total area of surface disturbance required by the embankment will be 4.7 acres (1.9 ha). The upstream face of the embankment will be lined with an HDPE geomembrane to reduce seepage, and because the embankment is constructed as a rock fill it will be free draining and not susceptible to instability due to piping. The stability modeling for all structures uses pore water pressures calculated during the seepage analysis. Therefore the hydraulic pressures forming at the edge of the liner have already been incorporated into the stability modeling. The upstream and downstream faces of the embankment will be constructed to a 2.5H:1V slope to facilitate geomembrane placement and reclamation. The height of the embankment will be 47.6 feet (14.5 m) at an elevation of 5,858 feet (1,776.5 m), and the crest of the embankment will be 32-feet (10 m) wide to accommodate traffic and pipelines. The toe of the geomembrane will be tied into dense natural ground by an anchor trench.

3.6.9.4 NCWR Spillway Configuration

The consequence of NCWR failure is less than the other mine water-bearing facilities at the Project site. A spillway is included to prevent overtopping of the embankment and safely route the design storm event through the NCWR. Water will be discharged from the spillway to the wetlands downstream (as it would if the NCWR were not there) (Figure 3.42). The spillway is sized for the 1 in 200 year 24-hour storm. HydroCAD, (a storm water modeling platform), was used to model the contributing area in order to estimate the peak instantaneous discharge associated with the 1 in 200 year storm event that will report to the spillway. The facility was conservatively modeled as full to the invert elevation of the spillway at the start of the storm.

The spillway will be constructed on the south side of the facility in the natural topography of the abutment, as shown on Figure 3.42. The invert elevation will be 5,826 feet (1,776 m), which will be 6.6 feet (2 m) below the embankment crest elevation of 5,828 feet (1,776.5 m). The maximum water level during the design storm event will be 5,822 feet (1,774.7 m), allowing 6 feet (1.8 m) of freeboard in the spillway. The outlet geometry will be a trapezoidal weir with a base width of 6.5 feet (2 m), maximum depth of 6.5 feet (2 m), and side slopes of 2H:1V, as shown on (Figure 3.42). The weir transitions into a trapezoidal channel with a base width of 3.2 feet (1 m) and depth of 3.2 feet (1 m). The trapezoidal channel discharges into the natural channel downstream of the NCWR embankment. The spillway will be predominantly cut in rock and will be lined with riprap to prevent erosion of the channel bed during high flows.

Topsoil and subsoil will be salvaged from the construction footprint of the spillway and will be used for concurrent reclamation of disturbances associated with the construction of the NCWR or NCWR embankment. The volume of soil associated with the NCWR spillway is minimal (less than 1,000 cubic yards, 765 m^3) with respect to the other major facilities and is included in the non-stockpiled soil salvage quantities in the lower part of Table 7-5. Soils will be salvaged from the NCWR spillway footprint will not be placed in the soil stockpile(s). The soils excavated from the NCWR spillway alignment will be temporarily stored within the construction footprint of the NCWR / Spillway and used for operational reclamation once construction of the NCWR facility is completed.

3.6.9.5 NCWR Seepage and Discharge Management

Seepage rates from the NCWR are anticipated to be approximately 26 to 68 gpm (1.7 to 4.3 Lps) (approx. 81,820 gallons per day; 372,000 L/day; 372 m^3/day) when the NCWR is at full capacity. The average seepage rate will be lower as the NCWR drains and the head on the ground decreases.

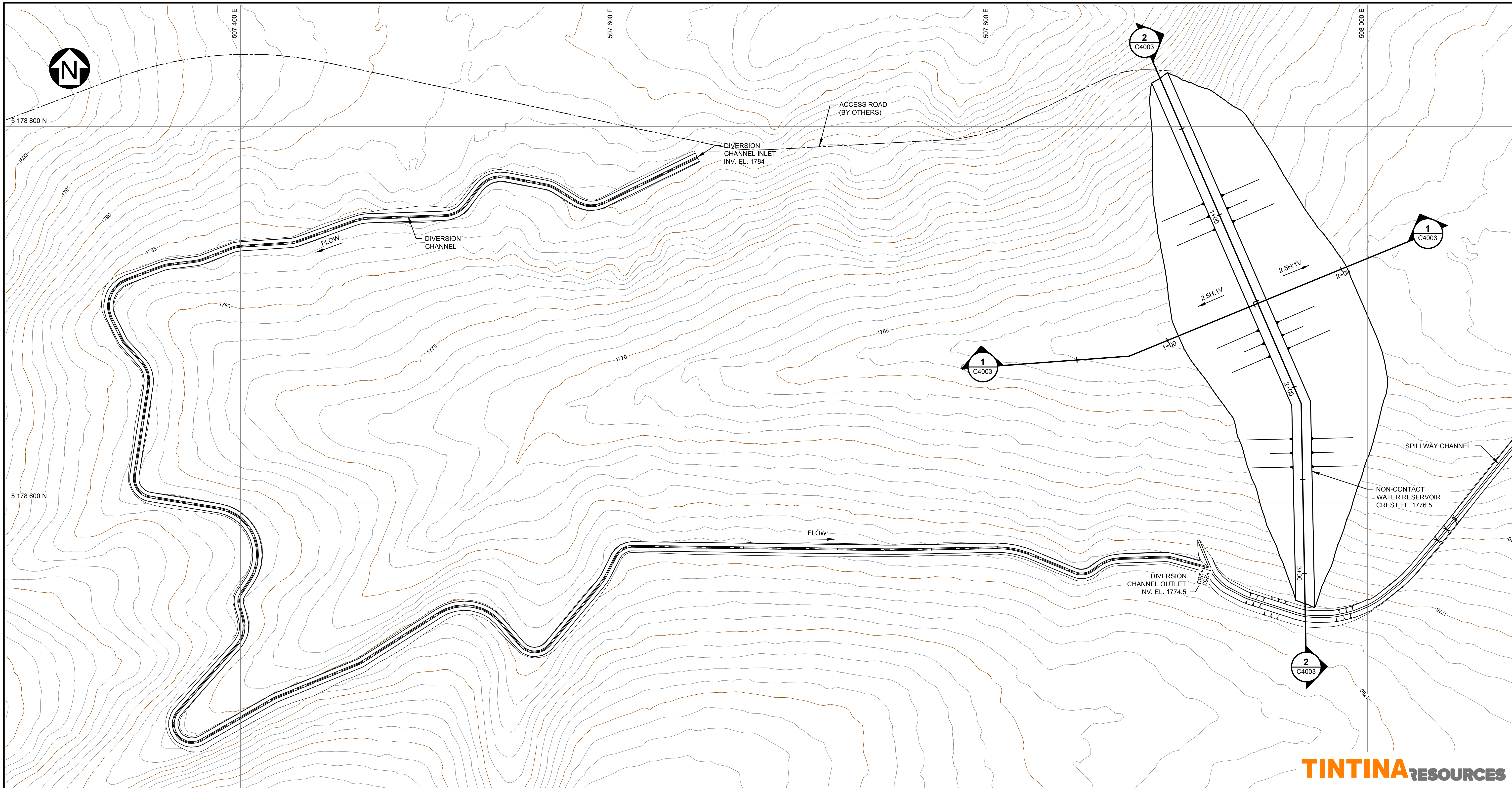
If the NCWR were to be used for storing water for mitigation purposes water could be allowed to leak or be pumped from the facility on an annual basis, as required to offset mine site consumptive water use during periods of lower precipitation. A floating pump will be located on a pad near the crest of the NCWR (adjacent to the spillway) and will draw water from the base of the reservoir and discharge into the spillway. The temperature of discharge from the NCWR will be monitored if water from the NCWR is directly discharged to surface water. Under these circumstances, the rate of seepage from the NCWR will be monitored based on pond elevation, and pumping rates will be adjusted as needed to ensure that the required volume of water is discharged from the NCWR on a monthly basis.

3.6.9.6 Basin Run-off Diversion

Run-off into the NCWR basin will be diverted around the facility and discharged. A diversion ditch (Figure 3.40) will be constructed to direct surface flows around the south side of the NCWR. The diversion channel will connect to the NCWR spillway, and water flow will discharge directly upstream of, and be allowed to infiltrate, prior to entering the downstream wetlands.

3.6.9.7 NCWR Alternative Locations Evaluated

Six alternative locations were evaluated for the NCWR prior to selection of the final facility location (see Section 3.6.13 and Figure 3.13). Largely the final selection process was influenced by impacts to wetlands.



TINTINA RESOURCES

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
4. PLEASE SEE DRAWING C4003_r0 IN APPENDIX K OR FIGURE 3.41 IN THE MOP APPLICATION SHOWING THE CROSS-SECTIONS.

SCALE A 20 10 0 20 40 60 80 100 m

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.40
NON-CONTACT WATER RESERVOIR PLAN MAP WITH DIVERSION CHANNEL

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD		

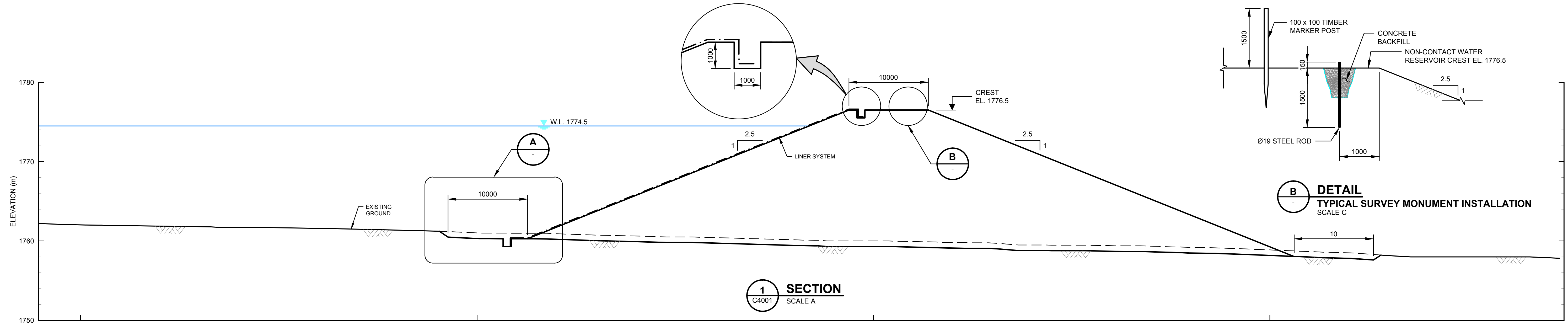
REVISIONS

C4007 NON-CONTACT WATER RESERVOIR DIVERSION DITCH PROFILE & SECTION

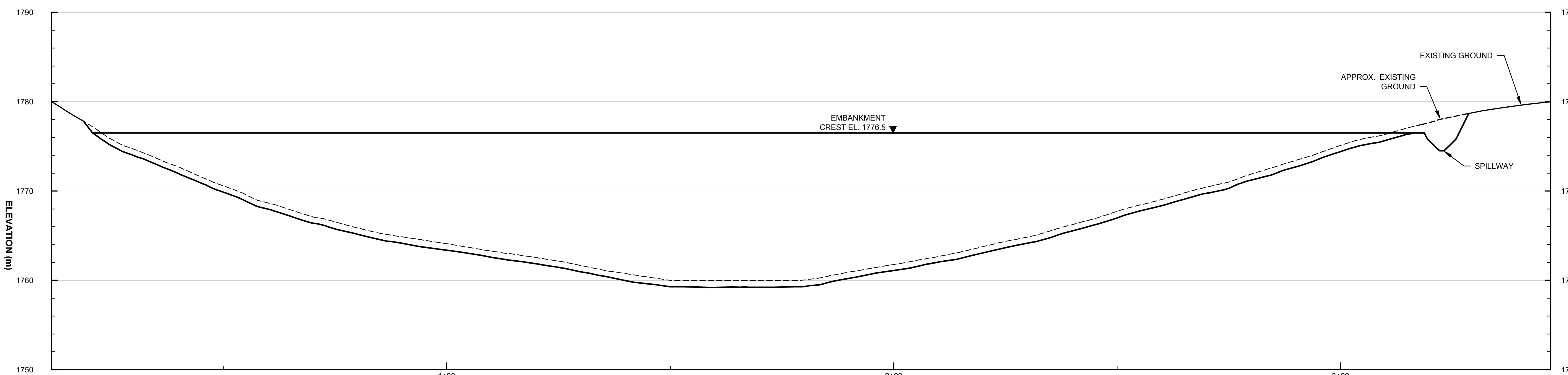
DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C4006_r0

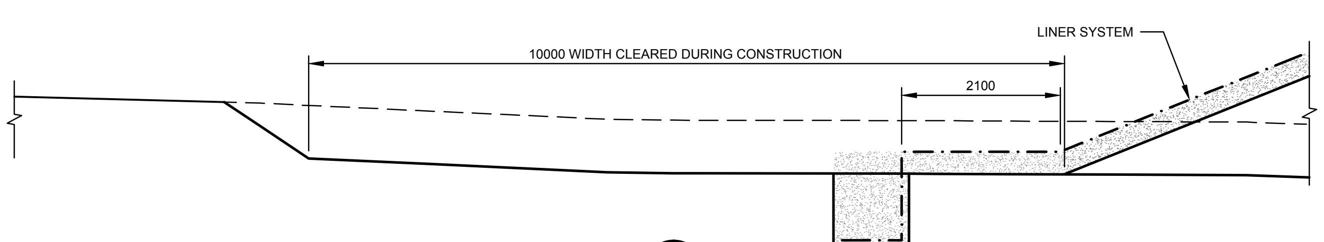
REVISED DATE:
MAY 2016



1 SECTION C4001
SCALE A



2 SECTION C4001
SCALE B



A DETAIL
SCALE C

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. TOPSOIL AND SUB-SOIL TO BE STRIPPED FROM EMBANKMENT FOOTPRINT.
3. PLEASE SEE DRAWING C4006_r0 IN APPENDIX K OR FIGURE 3.40 IN THE MOP APPLICATION SHOWING THE CROSS-SECTION LINES IN PLAN.

SCALE C 1 0.5 0 1 2 3 4 5 m
SCALE B 10 5 0 10 20 30 40 50 m
SCALE A 5 2.5 0 5 10 15 20 25 m
SCALE C 2.5 0 2.5 5 7.5 10 12.5 ft
SCALE B 25 0 25 50 75 100 125 ft
SCALE A 12.5 0 12.5 25 37.5 50 62.5 ft

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.41
NON-CONTACT WATER RESERVOIR CROSS-SECTIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	GIM	NSD	KDE	KDE

REVISIONS

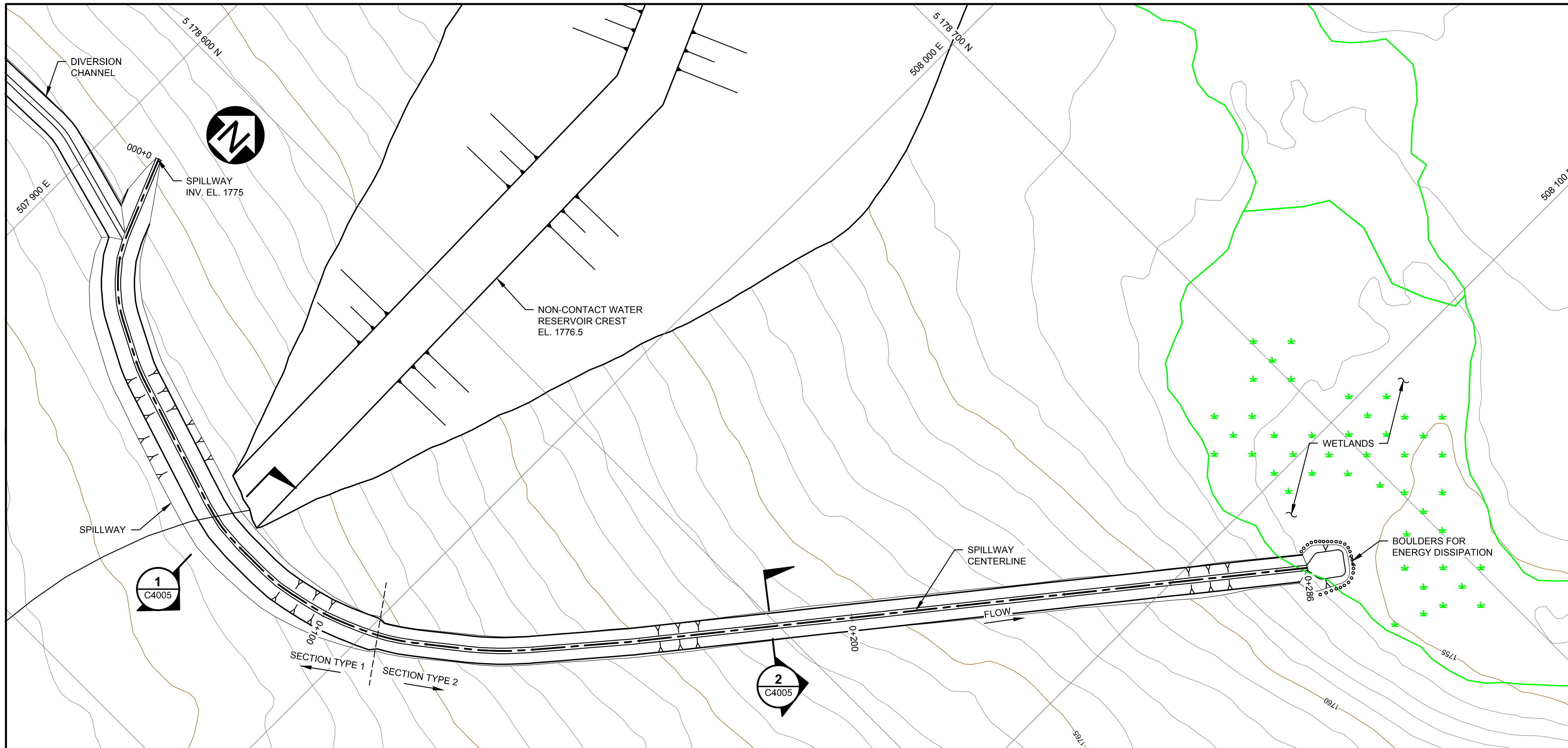
REVISED DATE:
MAY 2016

C4001 NON-CONTACT WATER RESERVOIR - GRADING PLAN

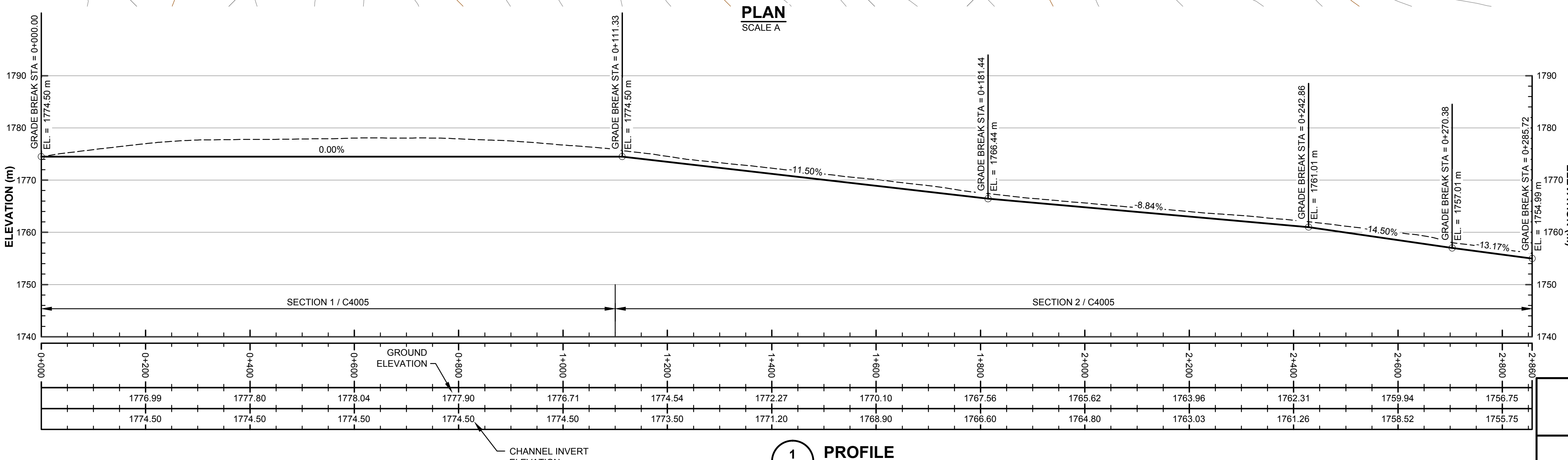
DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C4003_r0

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 3.41 NCWR Sections (C4003_r0), PRINTED: 6/15/2016 8:53:14 AM



PLAN
SCALE A



1 - **PROFILE**
ALONG SPILLWAY
SCALE A

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12.
2. CONTOUR INTERVAL IS 1 METER.
3. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE A 10 5 0 10 20 30 40 50 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 3.42
NON-CONTACT WATER RESERVOIR
SPILLWAY CHANNEL
PLAN MAP AND SECTION

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD	KDE	KDE

REVISIONS

REVISED DATE:
MAY 2016

C4005 NON-CONTACT WATER RESERVOIR - SPILLWAY - SECTIONS

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C4004_r0

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 20 CAD\SheetFiles\KP Figures\Fig 3.42 NCWR Spillway Channel Plan Map and Section (C4004_r0), PRINTED: 6/15/2016 8:54:42 AM

3.6.10 Soil, Reclamation and Construction Material Stockpiles

The total amount of soil to be salvaged and stockpiled from all construction facility disturbance areas will be approximately 510,622 cubic yards (390,399 m^3). Of the total salvaged / stockpiled, approximately, 276,082 cubic yards (211,080 m^3) will be topsoil, and the remaining 234,540 cubic yards (179,319 m^3) will be subsoil. Estimates of topsoil and subsoil stockpile volumes are presented in Table 7-5 and Table 3-34. A swell factor of 12% was used for stockpile estimates. This material will be removed from proposed disturbance areas, including a 10% construction buffer, prior to construction and will be stored in separate topsoil and subsoil stockpiles of 8.0 and 7.0 acres (3.2 and 2.8 ha) respectively (Figure 1.3). Each of these two stockpiles will be identified accordingly with signage. The amount of subsoil removed will be limited to that required by excavations for the specific facility. Soil stockpiles will be located south of the PWP and west of the CTF (Figure 1.3). These stockpiles will be surrounded by silt fences and signs will describe the material types (e.g., topsoil or subsoil). They will be graded and revegetated concurrently as the material is placed (to the extent practical), using an approved interim seed mixture (Section 7.3.5.1) to reduce soil and moisture loss, minimize erosion from water and wind, and minimize weed invasion. Additional downstream silt fences will be installed if necessary to prevent release of sediment outside of permitted soil storage areas. Larger stumps excavated during excavation, but not chipped for storage with soils, will be placed around the perimeter of the soil and reclamation material stockpiles for use in final closure.

Two separate excess excavation (reclamation) material stockpiles will be constructed: one to the west of the temporary WRS facility (Figure 1.3) with a footprint of 7.1 acres (2.9 ha), and one to the west of the CTF (Figure 1.3) with a footprint of 7.5 acres (3.0 ha). Both of these reclamation material stockpiles will be identified accordingly with signage. The material from the reclamation material stockpile located west of the WRS pad (approximately 133,268 m3 (174,308 cu. yds.)) (Table 3-14b) will largely come from the WRS excavation and will be used in year two or three to reclaim the WRS facility (see Section 3.6.5), after all waste rock is removed to the CTF. The material from the reclamation material stockpile located west of the CTF (approximately 161,680 m^3 (211,470 cu. yds.)) (Table 3-14b) will mostly come from the CTF excavation and will be used to provide part of the cover placed above the HDPE cover liner for the CTF in final closure of the facility.

All soil and reclamation material stockpiles will be constructed as trapezoidal shaped piles with 2.5:1 side slopes, a maximum height of 30 feet (9.1m), and a relatively flat but self-draining upper surface (top).

The temporary construction stockpile area will be used to temporarily store prepared construction materials during the two and a half year construction period, crush and screen granodiorite excavated from the PWP and the CTF excavation footprints, and is proposed to be located northeast of the CTF and east of the CTF haul road (Figure 1.3). It will be approximately 492 feet by 246 feet, 2.8 acres (150 m by 75 m, 1.1 ha) in size. Prepared construction material stockpiles are expected to be small as materials will be processed as they are needed for use as sub-grade bedding materials and drainage rock for various facility construction. The precise location of this stockpile area will be finalized later by the contractor during the detailed design stage.

Table 3-34. Stockpile Descriptions and Design Volumes

Stockpile Name	Material Type	Design Volume(1) (m^3)
Reclamation Material - North	Excavated bedrock (embankment fill)	133,268
Reclamation Material - South	Excavated bedrock (embankment fill)	161,680
Topsoil	Topsoil	211,080
Subsoil	Subsoil	179,319
Temporary Construction	Excavated granodiorite (*Tgd*) (embankment fill) to be crushed and screened to make sub-grade bedding and drainage gravel	54,000

Notes:

(1) The design volumes for the reclamation material stockpiles are based on the material balance Tables 3-14a and 3-14b in the MOP Application.

(2) The design volumes for the topsoil and subsoil volumes are based on the salvaged volumes in the upper table of Table 7-4 in the MOP Application.

(3) Excavated bedrock includes *Ynl Ex* and *Tgd* varieties described in Section 2.4.4 (Near-Surface Materials) of MOP Application.

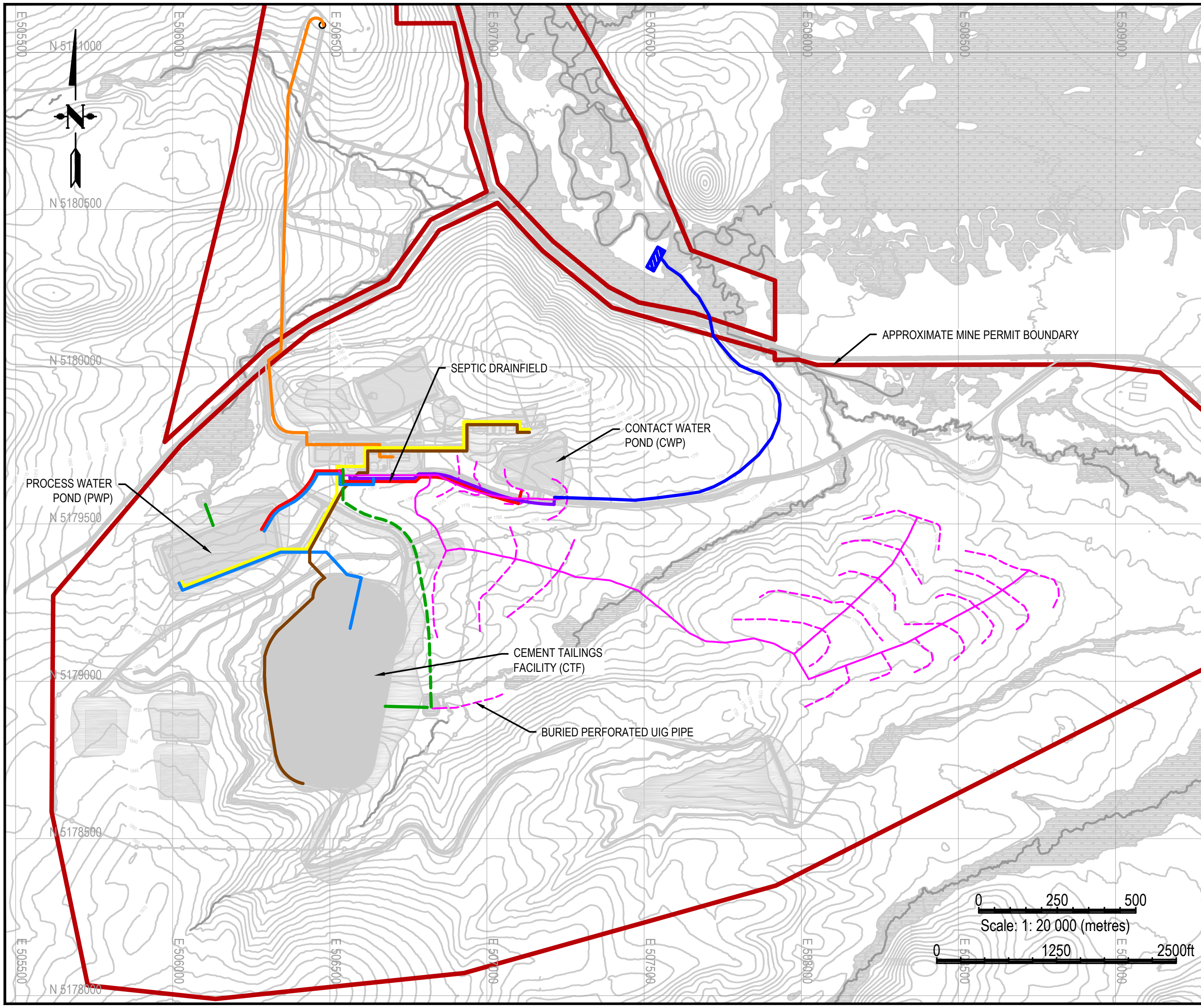
(4) The reclamation material – north stockpile is located west of the temporary WRS pad. The Reclamation material – south stockpile is located west of the CTF.

3.6.11 Pipelines

A number of pipelines will be constructed as described in the individual facilities sections. A map of pipelines including the underground infiltration gallery lines (which are shown on Figure 1.3) is shown on Figure 3.43. Lengths of surface disturbances associated with pipelines are tabulated on the acreage table (Table 3-13). Widths of surface disturbance for buried pipelines are generally estimated at 20 feet (6 m). The pipelines will be recontoured, topsoiled and reseeded shortly after construction. All pipelines carrying potentially contaminated water (WRS and copper-enriched stockpile to CWP, CTF to PWP, PWP to WTP, CWP/Brine pond to WTP, and CTF Foundation Pond to WTP or PWP) will have secondary containment. All surface HDPE pipelines will be contained in earthen bermed, HDPE-lined ditches that allows pipeline and ditches to drain-back by gravity flow to the connected facilities at both ends of the ditches / pipelines. Because it needs to cross the CTF surface water diversion ditch in a pipe bridge, the CTF to PWP pipeline will be constructed as a double-walled HDPE pipeline that allows for drain-back to the respective facilities.

3.6.12 Equipment and Contract Manpower Required for Support Facility Construction

Surface support facility construction by a subcontractor will take place in years one through three. It will require the types and amount of equipment specified in Table 3-35. The number of subcontracted personnel required on-site for surface support facility construction is estimated to reach a maximum of about 144 during the second year of the three-year construction period as noted in Table 3-36. Note that also on Table 3-36 although the total estimated number of subcontractor employees averages 144 for the three-year facility construction period, that only an average of 74 (maximum 107) will be on-site at any given time (as others are on their day's off). This total number of contact employees includes 24 mining subcontractor employees that will work on site underground for the first four years (including the first two years of pre-production mining), principally mining primary (development) and secondary (access drifts) workings to access the copper-enriched rock.



LEGEND

- TAILINGS DISTRUBUTION SYSTEM
- RECLAIM SYSTEM
- FOUNDATION DRAIN SYSTEM
- FRESH WATER SYSTEM
- MINE DEWATERING SYSTEM
- CWP TO WTP
- BURIED ALLUVIAL CONVEYANCE PIPELINE (ALLUVIAL INFILTRATION GALLERY)
- BRINE FROM CWP TO PASTE PLANT TO PWP
- UNDERGROUND INFILTRATION GALLERY (UIG) -SOLID PIPE
- UNDERGROUND INFILTRATION GALLERY (UIG) -PERFORATED PIPE
- CTF FOUNDATION DRAIN POND TO WTP

The following buried pipelines will remain in closure: All buried underground infiltration gallery pipelines (perforated and solid types except those near the former CWP and brine pond facilities), the pipeline at the CTF foundation drain pond, a small buried segment of the pipeline that goes from the CTF foundation drain to the WTP (the buried part that goes from the WTP under the access road), the fresh water system pipeline, the pipeline at the PWP foundation drain (including an infiltration basin), the northern part of the fresh water pipeline, and the alluvial conveyance pipeline (see Figure 7.8 of MOP Application).

Base map from Figure 1.3 of the MOP Application.

Prepared by Tetra Tech Inc. (Revised July 2017)

FIGURE 3.43

Pipeline Plan Map

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana

TINTINA RESOURCES

Table 3-35. Surface Facility Construction Equipment List

Surface Facility Construction Equipment	Total
Trucks, Vans	32
Bus, 35 Passenger	4
Air Compressor c/w Air Receiver	5
Bobcat c/w Sanding Unit T750	1
Boom Truck -20T	2
Concrete Trucks	4
Crane, 90 Ton RT, Man-Basket	2
Conical Crusher (Portable)	1
Haul Trucks	9
Excavators	5
Dozers	4
Fuel & Lube Truck	1
Fuel Tank (Double Wall) Volume TBD	6
Drill	4
Grader Cat 14G	4
Power Generators, Small Mobile	8
Power Generators (Diesel 545 and 320 kW)	2
HDPE Fusion Machines	1
Heater, Frost Fighter 350,000 BTU	7
Light Plant 8 kW	11
Loader c/w Bucket & Forks Cat 950	7
Man-Lift, Articulating 85'	7
Packer, Drum	3
Rectifier, Welder c/w 250' Cable	4
Scissor Lift, Man lift	12
Screen Plant	2
Snowplow and Sander	2
Temporary Power Skids	9
Tool Crib, Architectural, Electric / Mechanical	6
Vibrating Drum Roller	2
Vacuum Truck	1
Water Truck	2
Welder, Diesel Trailer, 250' Cable	6
Zoom-Booms	6
Office Trailers	8
Wash Cars	5
Cold Storage/Shop (Sprung Structures) 50' x 100'	1
Ambulance / Fire Truck	2
Spill Response Vehicle	1

Table 3-36. Facility Construction Manpower

Activities	Construction Manpower											
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
SURFACE EARTHWORKS												
Onsite	23	28	29	29	39	34	24	14	10			
Offsite	5	9	9	9	13	13	8	5	3			
Sub Total	**28**	**37**	**38**	**38**	**52**	**47**	**32**	**19**	**13**			
Mining												
Onsite	16	16	16	24	30	30	30	30	30	24	20	20
Offsite	5	5	5	8	10	10	10	10	10	8	6	6
Sub Total	**21**	**21**	**21**	**32**	**40**	**40**	**40**	**40**	**40**	**32**	**26**	**26**
Surface Construction												
Onsite						20	29	42	57	57	43	29
Offsite						7	9	14	19	19	14	10
Sub Total						**27**	**38**	**56**	**76**	**76**	**57**	**39**
Tintina Personel												
Owner/Mgmt	5	5	5	5	5	10	10	10	10	10	10	10
Aux. (first aid, security etc.)	5	5	5	5	5	5	5	5	5	5	5	5
Sub Total	**10**	**10**	**10**	**10**	**10**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Construction Total Onsite	**44**	**49**	**50**	**58**	**74**	**94**	**93**	**96**	**107**	**91**	**73**	**59**
Construction Total Roll	**59**	**68**	**69**	**80**	**102**	**129**	**125**	**130**	**144**	**123**	**98**	**80**

3.6.13 Facility Siting Alternative Analysis

A number of alternative analyses have been conducted on various facility locations and process options for the Project. These include : portal locations; surface tailings management methods, tailings facility and pipeline locations; various pond locations; waste rock storage and mill locations; water treatment process options; powerline location and permitting; and various paste options evaluated (binder types, dosage rates, and cement paste mix designs). Geotechnical site investigations were used as a significant source of data for individual site facility locations selection (Section 3.5.1). The results of the 2015 site investigations are included in Appendix K-4 (Geotechnical Site Investigation Report by Knight Piésold (2017b) and include drill hole logs, test pit logs, geology drill sections, hydrogeological data, laboratory test results for both soil and rock mechanics, and core drill hole and SPT sample photographs. The key objectives of the site investigations were to:

- Collect geotechnical and hydrogeological information to support a feasibility level design for the construction of the CTF, PWP, and NCWR;
- Collect geotechnical and hydrogeological information to characterize the conditions at the proposed plant site, portal pad, and CWP;
- Complete test pit excavations over the Project area to characterize soil depth to bedrock; and
- Potential suitability of excavated material for use as construction material borrow sources.

Table 3-37 lists the various facilities or processes evaluated, the relevant sections in this document where information can be found, relevant appendices that provide details of the analyses, and references for source material.

<u>Portal and Decline:</u> Two other portal / decline locations were evaluated prior to selecting the proposed site (Section 3.6.3.4). The selected portal location and decline alignment were selected because they allow for consolidation of all facilities into a smaller geographic area, result in mining of a lower volume of sulfide-bearing waste rock requiring surface management in order to access the copper-rich deposits, and eliminated the risk of discharge from the portal operationally and in closure.

<u>Tailings Management Methods, Facility and Pipeline Locations:</u> A detailed geotechnical site investigation by Knight Piésold (2017a) and other design evaluations (Knight Piésold, 2013, 2015a, 2015b, 2016b, 2017c, 2016a, and 2017d) have been completed at the Project for feasible alternatives for both the method used for above-ground tailings management and the location of a management facility. In addition, a large working group composed of 18 scientists and engineers from Tintina Resources, Inc., SRK Consulting, Geomin Resources Inc., Enviromin Inc., Knight Piésold, Tetra Tech Inc., and International Metallurgical Inc. was formed in 2015 to identify feasible tailings storage methods for the Project operations and rank the alternatives in order to select the most appropriate method specific to the project (see Appendix Q, Geomin Resources, 2016a). Six different management method alternatives were evaluated:

- Conventional tailings slurry deposition,
- Dry stack tailing,
- De-pyritized ultra-thickened sub-aqueous deposition,
- Two cell ultra-thickened de-pyritized and pyrite concentrate,

- Paste tailing with underground paste content of 4%, and
- Paste tailing with reduced (2%) cement content.

Four surface tailing facility locations were also evaluated: West, Central, East, and south CTF (Figure 3.13). In addition, a tailing pipeline alternatives and alternative pipeline routes were studied by MG Engineering Inc. and are presented in a final report (MG Engineering, 2016).

The south CTF site was ultimately selected as the preferred impoundment location alternative, using paste tailings with reduced cement (0.5 to 2%) content. This is because it impacts the smallest total acres of wetlands that require the placement of fill (and therefore Clean Water Act Section 404 permitting) and the lowest total catchment area disturbance. The CTF alternative footprint impacts 0.71 acres (0.3 ha) of wetlands and 87.7 acres (39.45 ha) of catchment area disturbance. The CTF site alternative was selected even though the total cost is 50 percent higher than the Central alternative.

Alternate Pond and Waste Rock Storage and Mill Locations: A number of pond locations (eight counting the tailings ponds) (Figure 3.13) were evaluated by valley size and shape, proposed function, proximity to the projects operational facilities (portal pad and mill facility), and potential impacts to jurisdictional wetlands and streams. Geotechnical drilling, soil and infiltration test pits investigation were conducted on each of these sites. Four final pond locations were selected: CTF, PWP, CWP and NCWR. In addition, two waste rock storage pads and two mill site locations were evaluated with geotechnical drilling and soils test pits prior to selection of the preferred location.

Water Treatment Process Selection: Water treatment processes were evaluated for their ability to effectively reduce the concentrations of the parameters of concern for each phase (see Section 3.7.3.4). Because few treatment methods alone are capable of effectively reducing the concentrations of all identified parameters of concern, several treatment trains were evaluated and compared. The treatment trains that were evaluated combined several treatment technologies in series, and were capable of reducing concentrations of identified parameters of concern.

Technology screening considered the following factors:

- Potential to treat parameters of concern to required levels,
- Reliability of treatment,
- Degree of application for the treatment of mining waste waters,
- Technical characteristics of the technology,
- Ease of operation,
- Ease of construction,
- Ease of implementation,
- Cost, and
- Residuals / waste stream management.

RO with pre-treatment was selected over other options because it is a more robust and reliable treatment process that has lower overall costs (capital and O&M) than other potential methods. Additionally, RO provides simultaneous treatment of the parameters concern that must be treated during each operating phase of this project.

Powerline Location and Permitting: The primary source of electricity to the site during operations will be a third-party feed using overhead powerlines provided by either Fergus Electric Cooperative or Northwestern Energy. Upgraded power lines will be permitted (including the MFSA responsibilities) and installed by the power provider, and the provider will own the line delivering power to the Mine Permit Boundary.

Paste Option: Several cemented paste options were evaluated for surface deposition into the CTF and backfill into the underground workings including:

- Locally sourced and available binders (cement, slag and fly ash) to be used with cemented paste tailings, and
- Binder dosage rates and cement tailings paste mix designs to examine different strengths and rheologies.

Most of the information on paste options is presented in Section 3.5.9 or in Appendix K-5.

Table 3-37. Mine Facilities Alternative List with References

Facility or Process	Section in MOP Application	Appendix of MOP (with section and Figure numbers from each appendix)	Reference (Company)
Portal Location	Section 3.6.3.3		Tintina, 2013; Tintina, 2016
Tailings Management Technologies		Appendix K (Sect. 3.0) Tailings Management Alternatives Appendix Q Tailings Management Alternatives	Knight Piésold, 2017a Geomin Resources, 2016a
CTF Surface Tailings Facility Locations	Section 3.6.8.14	Report Appendix K-4; Section 5.2; and Figure 3.1 Appendix Q Tailings Management Alternatives	Knight Piésold, 2013 Knight Piésold, 2017b Geomin Resources, 2016a
CTF Pipeline Locations and Types	Section 3.6.8.14	Appendix K: (sub-appendix E) Tailings Delivery System Design	MG Engineering, 2016
Pond Locations: (PWP, CWP and NCWR)	Section 3.6.6.7 (PWP Alternative Locations Evaluated) Section 3.6.9.7 (NCWR Alternative Locations Evaluated) Figure 3.13 (Geotechnical Site Investigation Drill Hole and Test Pit Locations with Facilities)	Appendix K-4; (Section 5.3 - Process Water Pond) Appendix K; (Section 3.3 – Facility Location Assessment)	Knight Piésold, 2017b Knight Piésold, 2017a Knight Piésold, 2017b
Water Treatment Processes	Section 3.7.3.4 (Water Treatment Selection Process)	Appendix V	Amec Foster Wheeler (in Tintina, 2015a; 2016) (MOP Application); 2017
Power lines Locations	Section 3.6.2 (Power and Powerline)		
Locally Sourced and Available Binders (Cement, Slag, and Fly Ash) to be used in Cemented Tailings Paste	Sections 3.5.9.2 and 3.5.9.4 Table 3-24	Appendix K-5; (Sub-appendix K5-B)	Amec Foster Wheeler, 2015a
Binder Dosage Rates (2% and 4%)	Section 3.5.9.7	Appendix K-5; (Sub-Appendix K5-B)	Multiple Laboratory Analyses including Amec Foster Wheeler (2015a)
Cement Tailing Paste Mix Designs (and physical targets)	Section 3.5.9.6 (Section 3.5.9.1)	Appendix K-5; (Sub-Appendix K5-C)	Amec Foster Wheeler Laboratory Analyses (2015a)

3.7 Water Management

3.7.1 Water Supply

Three separate water supply systems consisting of a process water supply, fresh water supply, and potable water supply will be required for the Project. Supply tanks will be located on the east side of the mill building as illustrated on Figure 3.9. Recycled water from the PWP to the process water tank will be the primary mill water source. Additional water will be provided by dewatering the mine, and from the WTP. Fresh water (from the fresh / fire water tank) will be obtained from the WTP and will be used for other milling purposes. Potable water (from the potable water tank) will be sourced from a public water supply well (PW-6; Figure 1.3), and will be treated as necessary for human consumption.

3.7.1.1 Potable Water Supply

Tintina will supply potable water to the Project at a rate of about 30 gpm for 145 people per day for drinking water, showers, and restroom facilities. The average potable water needs for the Project are therefore approximately 4,350 gallons (16,467 L/day) per day (3 gpm, 11.4 Lpm) or about 4.9 acre*feet per year. Tintina is proposing to either use the PW-6 test well (Figure 1.3) for its Public Water Supply (PWS) well, or to instead use it as a test well for permitting and to drill a new well in the vicinity. Initial water quality samples were collected from PW-6 during well development using air-lifting. Analysis showed that all of the constituents were below human health standards. It should be noted that samples collected during air-lifting are not collected using standard procedures. Tintina will collect a water quality sample using standard procedures as part of the testing for permitting the well for the PWS. The potable water supply system will include appropriate controls at all non-potable points of use where backflow prevention is required. Tintina is in the process of developing an application for a PWS well with the DEQ's Public Water Supply and Subdivision Bureau. The system will be completed in accordance with Circular DEQ-1 (DEQ, 2014). In addition, the point of diversion will be included in the groundwater right application to DNRC for the Project.

Potable water will be pumped along a 5,913 foot (1,802 m) long buried pipeline (Figure 1.3) that follows the powerline from the proposed PWS (PW-6) to the potable water treatment system located in the WTP (Figure 3.9). This water will be chlorinated and filtered if necessary. The 2.7 acre (1.1 ha) surface disturbance associated with this pipeline assumes a 20 foot (6 m) wide construction zone, which will be reclaimed immediately following construction of the pipeline. Treated water will be pumped to a covered potable water storage tank (on the east side of the mill facility) and to a potable water pump house at the truck shop complex. It will be distributed to various facilities, including the mill.

3.7.1.2 Fresh Water and Fire Water Supply

Fresh water will be derived from the WTP and piped to the fresh / fire water tank located on the east side of the mill building (Figure 3.9). Treated fresh water will be used in the mill (for cooling, pump gland lubrication, etc.), reagent preparation, fire suppression and fire protection water.

The 40-foot diameter by 20-foot high (12.5 m x 6 m) fresh water / fire water tank (total capacity 187,992 gallons; 711,627 liters) will have a reserve in the lower portion of the tank that will be drawn from below the primary water supply nozzles. The fire-fighting reserve in the tank will meet a two-hour demand at 1,000 gpm (3,785 Lpm). A fire water pump, a jockey pump, and controls will be installed. Dedicated fire mains with hydrants will be provided at the process plant, ancillary buildings, truck shop complex, and primary crushing area. Fire extinguishers will also be provided throughout the facilities. Fire hose reels and cabinets will be installed throughout the process plant building and truck shop. Sprinkler systems will be installed in the warehouse, the main office, and the truck shop complex. Fire alarm systems will report to the plant control room, which will be manned 24 hours a day.

3.7.1.3 Process Water Supply

Process water will be comprised of recycled water from the PWP (including a small component of brine) and the milling process (i.e., overflows of the copper concentrate thickeners), and as needed water from the underground mine and treated water from WTP. These water streams will be directed to a 40-foot (12.5 m) diameter by 45-foot (14.0 m) high process water tank (Figure 3.9) with a storage capacity of 422,985 gallons (1,601,172 liters), from which the water will be distributed to the process plant and other service locations.

3.7.2 Water Balance

3.7.2.1 Model Methodology

An operational water balance model for the Project was developed using the GoldSim modeling platform to assess mean hydrologic characteristics and variability of flows Appendix L (Knight Piésold, 2017d). The volume of water in the CTF, PWP, NCWR and water reporting to the CWP ("Mill Catchment Run-off", in the water balance model) were estimated on a monthly basis over 15 years (including 2 years for pre-production and 13 years of operations). The three-year reclamation period will only require water from the potable PWS well. Meteorological parameters for the model were developed using site specific data in conjunction with regional data Appendix A-1 (Bison Engineering, 2012 through 2016). The water balance model uses the determined mean monthly precipitation and evaporation values as inputs for each year. These account for rain and snow accumulation, snowmelt, evapotranspiration, and resulting run-off. The surface area was calculated for each time-step using the Depth-Area-Capacity data for the facility. Deterministic and stochastic approaches were used in the model and are summarized below.

3.7.2.2 Model Assumptions and Scenarios

The mill requirements and outputs, along with miscellaneous freshwater requirements (truck wash, dust control, etc.) were provided as annual rates occurring when the mill will be in full production. The inputs to the water balance model are shown in Table 3-38.

Table 3-38. Water Balance Inputs

Component	Units	Value	Source
Hydrometeorology			
Mean Annual Precipitation	mm	416	KP (2015b)
Mean Annual Pond Evaporation	mm	514	KP (2015b)
Run-off Coefficient (Undisturbed Ground)	mm	0.2	KP (2015b)
Run-off Coefficient (Disturbed Ground /Facility Footprints)	mm	1.0	KP (Assumes no seepage from facilities)
Copper-enriched Rock *Production*			
Copper-stockpile Water to Mill	m^3/yr.	12,000 to 52,000	TT (2015b)[1]
Tailings Production			
Nominal Mill Process rate	tonne/day	3,300	Tintina
Tailings Dry Density	tonne/m^3	2.0	Tintina
Tailings Specific Gravity	-	3.77	Tintina
Tailings Solids Content	-	74%[2]	Tintina
Tailings Water to CTF	m^3/yr.	51,000 to 221,000	TT (2015b)[1]
Tailings Water to Underground	m^3/yr.	42,000 to 186,000	TT (2015b)[1]
Water Lost to Voids	%	100%	Assumption
Mill Process			
Freshwater Requirements	m^3/yr.	44,000 to 192,000	TT (2015b)[1]
Water lost to Concentrate	m^3/yr.	4,000 to 16,000	TT (2015b)[1]
Thickener Overflow	m^3/yr.	938,000 to 4,107,000	TT (2015b)[1]
Required Water from the PWP	m^3/yr.	979,000 to 4,286,000	TT (2015b)[1]
Other Freshwater Use	m^3/yr.	49,000	TT (2015b)
Underground Dewatering (500 gpm)	m^3/yr.	995,000	Hydrometrics

NOTES:

1. Range of values for the life of mine, based on the production schedule. TT = Tetra Tech.
2. A tailings solid content of 74% was used in the water balance model to provide a conservative estimate of mill water consumption. A tailings solid content of 79% was used for all other design work.

The water balance results were calculated on a mean monthly basis as well as on an annual basis for each year. Knight Piésold has developed a site wide water balance model using the GoldSim software. The parameters used in this model can be updated as new information and real time data becomes available. Tintina commits to developing and maintaining this or another model to regularly update the water balance model using actual data as the mine enters the operational phase. The scenario modeled includes a PWP start-up minimum volume of 120,000 m^3 (156,950 cu yds.), with mean monthly precipitation conditions for the life of mine. The PWP has been designed for a maximum allowable operating volume of 200,000 m^3.

Three separate scenarios were modeled using the life-of-mine (LOM) water balance in order to obtain an understanding of the water requirements of the mill facility on the PWP volumes during operations. The model was run deterministically for the mean case, and stochastically for the wet (95th percentile) and dry

(5th percentile) cases. The estimated monthly volumes reporting to the proposed mine site, and the resulting effects on the volumes in the PWP are presented in terms of probabilities of occurrence for the three different climatic scenarios:

- **Scenario 1 – Mean**: The model was run deterministically and the results correspond to mean monthly climatic conditions.
- **Scenario 2 – 95th Percentile (Wet)**: The results correspond to abnormally wet conditions, and represent the climatic conditions to be exceeded once every 20 years, on average.
- **Scenario 3 – 5th Percentile (Dry)**: The results correspond to abnormally dry conditions, and represent the climatic conditions expected to be exceeded 19 years out of 20, on average (i.e. volumes will not exceed these values once every 20 years, on average).

The objective of the water management plan is to maintain a minimum monthly pond volume of approximately 120,000 m^3 (156,950 cu yds.) in the PWP, while not encroaching on the storm storage that exists above a volume of 200,000 m^3 (261,600 cu yds.). The total maximum capacity of the PWP is 549,399 cubic yards (420,000 m^3).

3.7.2.3 Model Results

The results for all 3 climatic scenarios during the 15 year mine operating life are outlined in detail in Appendix K (Knight Piésold, 2017a).

Table 3-39 below shows the pond operating volume ranges and average annual surface water volume transferred from the PWP to the WTP for the three climatic scenarios. The main conclusion from this analysis is that the average annual make-up required to sustain the minimum pond volume will be 213,200 cubic yards (163,000 m^3).

Table 3-39. Water Transferred from the PWP to the WTP for the Three Climatic Scenarios

Climatic Scenario	PWP Operating Volume Range (m^3)[a]	Average Annual Water Volume Transferred from the PWP to the WTP (m^3)
Scenario 1: Mean Conditions	120,000 – 170,000	110,000
Scenario 2: 95th Percentile (wet)	120,000 – 170,000	232,000[b]
Scenario 3: 5th Percentile (dry)	120,000 – 170,000	34,000

(a) This analysis assumes a minimum allowable PWP design volume of 120,000 m^3 (156,950 cu yds.) and a maximum allowable design volume of 200,000 m^3 (261,600 cu yds.) that defines the operating range.
(b) Even though this value is larger than the maximum pond operating range value in the table, the excess volume will be treated in the WTP and discharged to the underground infiltration galleries in compliance with non-degradation criteria.

Direct precipitation on the PWP facility will not contribute sufficient water to offset the mill water requirements while maintaining the minimum PWP pond volume of 120,000 m^3 (156,950 cu yds.). Therefore, it will be necessary to supplement the PWP with either the RO brine (preferred method) or water from the underground mine workings. No make-up water will be required in year one or two, as no production facilities will be in operation.

The estimated PWP pond volume prior to the water transfer to the WTP and make-up brine / water transfer to the PWP was modeled in all three climatic conditions. The volume trends in this analysis indicate that there is sufficient storage capacity in the PWP during abnormally wet year scenarios (95th percentile), and in a dry year (5th percentile). The groundwater source will be used as make-up water in the later dry year scenario.

The PWP pond volume after surface water transfer to the WTP and make-up brine / water transfer to the PWP in this analysis indicates that the pond volume for each scenario is similar after the water transfer is included in the model. The amount of brine / water transferred to the WTP and released to the environment by discharging after treatment is greater than the amount required to keep the pond volume within the mean scenario operating range under dry and abnormally wet conditions.

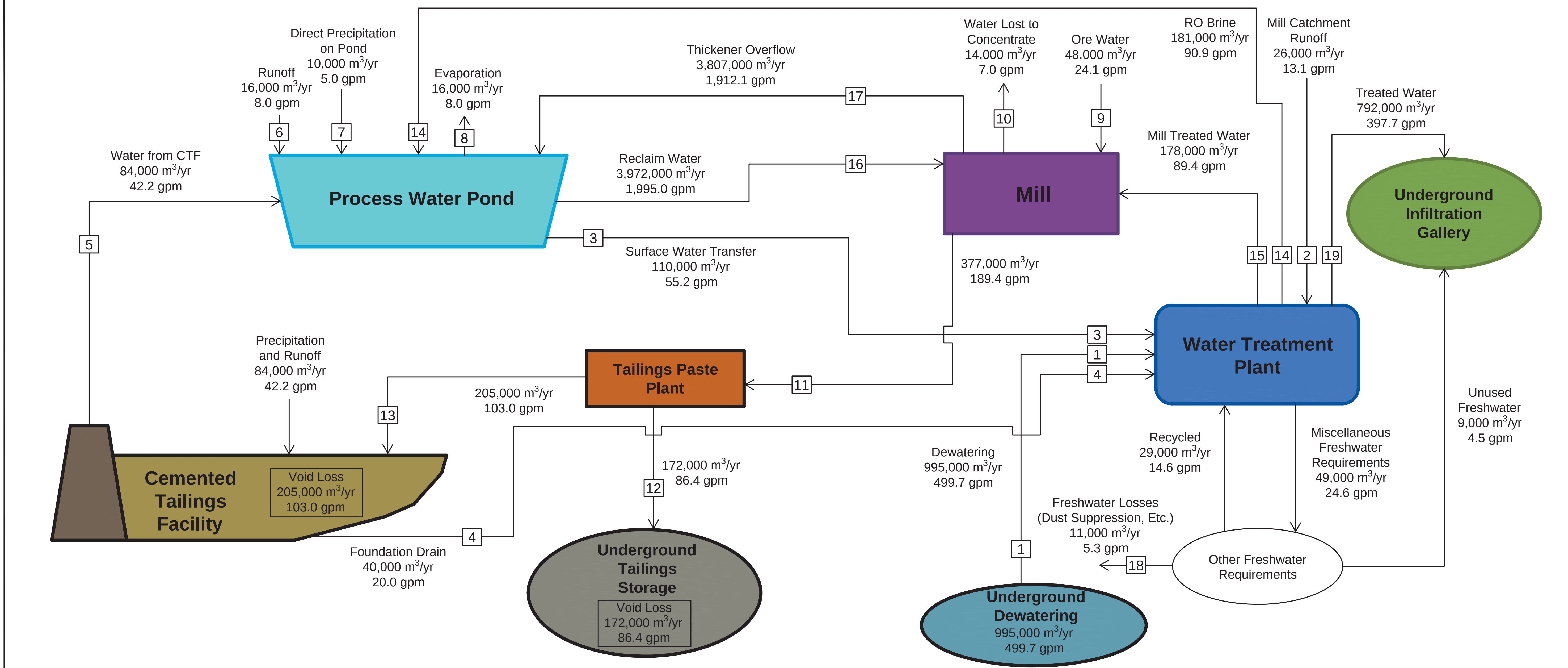
A detailed summary of the water balance is provided in the Knight Piésold report Appendix L (Knight Piésold, 2017d). Minor changes to the water management plan have been implemented since the water balance model was finalized. These changes include RO brine replacing the use of water from the underground mine for make-up water and the CTF foundation drain being diverted to the water treatment plant. The water collected in the CTF foundation drain was not included in the original water balance and the RO brine will replace the exact volume of make-up water that was originally used from underground; therefore, the water balance model was not re-evaluated as the total flow to the PWP do not change under the new preferred water management plan. The water balance schematic shown on Figure 3.44 was used as the basis for model development and shows in some detail the annual inflows and outflows to and from the facilities during year six of production (year 6) under mean climatic conditions. The deterministic results of the detailed site water balance are broken down by facility component as they relate to Figure 3.44. Flow rates or volume transfers between facilities are reported in m^3/year and gallons per minute in this figure.

The generalized site water management plan is described below.

- The sources of water for the mining and milling operation come from dewatering of the underground mine.
- The primary source of reclaim water for the mill is the PWP.
- Direct precipitation and precipitation run-on to the CTF will be collected by the water reclaim system and immediately transferred to the PWP.
- Direct precipitation and precipitation run-on to the PWP, including that transferred from the CTF, will be transferred to the WTP where it will be treated prior to discharge to the underground infiltration galleries. Variations in actual climatic fluctuations will therefore be addressed and compensated for monthly, by required mitigation of consumptive use implemented under water rights as a part of normal operating procedures.
- Water from the CTF foundation drain pond will be pumped directly to the water treatment plant unless the plant is down in which case it will be directed to the PWP.

Additional make-up water required by the mill is assumed to be supplied from the RO brine or underground dewatering and stored in the PWP. Make-up water required by the PWP is assumed to be untreated if it comes from underground dewatering. Fresh water required by the mill is assumed to be treated by the WTP.

A table of estimated values for consumptive use of groundwater by component is provided as an inset to Figure 3.44.



Estimated Groundwater Consumptive Use Components

Water Use	Consumptive Use		
	m^3/yr	gpm	acre*ft/year
PWP Evaporation	16,000	8	13
CTF Void Loss	205,000	103	166
Underground Tailings Void Loss	172,000	86	139
Water Loss to Concentrate	14,000	7	11
Freshwater Losses	11,000	6	9
Total Consumptive Use	**418,000**	**210**	**339**

NOTES:

1. ALL WATER VOLUMES ARE EXPRESSED IN UNITS OF CUBIC METRES PER YEAR AND GPM EQUIVALENTS.
2. WATER IN TAILINGS PASTE IS ASSUMED TO BE UNRECOVERABLE.
3. SEEPAGE IS ASSUMED TO BE ZERO AS THE FACILITIES ARE LINED.
4. THE NUMBERS IN THE BOXES CORRESPOND TO TABLE V-1 in APPENDIX V.

Reference: Modified after Knight Piesold (2017a): Report No. VA101-46-/3-2

Prepared by Tetra Tech Inc. (March 2017)

FIGURE 3.44

Annual Water Balance Schematic for Mean Case - Year 6

Mine Operating Permit Application

Black Butte Copper Project

Meagher County, Montana

TINTINA RESOURCES

3.7.3 Water Treatment

Tintina evaluated the need and the potential methods for water treatment at the Project. The following sections describe the basis of design, the screening process used for assembling and evaluating water treatment alternatives, and the proposed water treatment processes for various stages of the life cycle of the mine.

3.7.3.1 Basis of Design

The basis of design for water treatment was based upon the planned development of the Project, the water budget for the Project, the characteristics of the water that requires management, and the effluent treatment goals. Figure 3.44 provides a schematic of critical portions of the water flow path at the project site.

3.7.3.2 Operating Phases and Design Flows

Water will require management during three phases of the mine life cycle. Each phase will have different design flows and raw water quality. Those phases are detailed below.

Construction Phase (Figure 3.45) Groundwater from mine dewatering and water collected in the CWP will require treatment at an estimated maximum flow rate of approximately 250 gallons per minute (gpm) (946 Lpm) during the second year of construction (Section 4.1.6.2; Table 4-6) (there is no flow predicted for almost all of year one as mining is above the water table). This flow rate will not exceed the capacity of the water treatment plant, and storage will be used to provide steady state feed flow rates to the system. During the latter part of the construction phase (between years 2 and 2.5), the flow rate may exceed 250 gpm. If this occurs, flows in excess of the 250-gpm treatment capacity will be stored in the CWP (available about 0.5 year into construction) and PWP (available about 2.5 years into construction) or treated in the operational phase WTP (expected to be available near the end of the construction phase). Based on analytical data from *UCZ* groundwater samples, groundwater will have several parameters of concern that must be addressed before discharge (Section 3.7.4). Treated water will be discharged under a MPDES permit to UIGs, which will be constructed early in the Project. Liquid residuals from water treatment will be stored in a compartmentalized portion of the CWP for later on-site disposal in the PWP. The management of solid residuals from water treatment during the construction phase are discussed below in Section 3.7.3.5.

Operational Phase (Figure 3.46) The operational phase WTP will have an influent capacity of 588 gpm (2,226 Lpm), which is equal to the maximum annual average influent rate (see Figure 3.44 and Section 4.1.6.2). However, not all of this water is treated by the RO system. Approximately 89 gpm will be delivered to the Mill for pump gland lubrication. The remaining 497 gpm will be treated by the RO system, producing 406 gpm permeate and 91 gpm RO brine concentrate. In addition, Tintina will keep the construction phase RO treatment system on-site for standby purposes, providing an additional 250 gpm (946 Lpm) of treatment capacity if needed. If higher flows continue for longer than anticipated, the excess water will be stored in the PWP, and additional treatment equipment for the front end components will be rented or purchased to provide additional treatment capacity for long-term treatment.

Treated water will meet discharge standards and will be discharged to the underground infiltration galleries, and liquid and solid treatment residuals will be disposed on-site using the PWP and CTF, respectively.

Closure Phase (Figure 3.47) Prior to decommissioning, water from the PWP and other sources will be treated in the WTP using similar processes as the operational phase. The flow rate for water treatment during closure (Section 4.1.6.2) will be a maximum of about 502 gpm (1,900 Lpm), which is the capacity of the RO system (500 gpm, or 1,893 Lpm) plus water in the sludge removed in the clarifier ahead of the RO system (about 2 gpm, or about 7.5 Lpm). Treated water will be used to flush the underground workings as discussed in section 7.3.3.2. The brine section of the CWP will be used for brine storage prior to shipment off-site for disposal. Solid and liquid water treatment residuals will be disposed on-site if suitable facilities are available. Otherwise, these residuals will be disposed of off-site.

These three phases of mine life will have the same effluent goals. However, the water sources, flow rates, influent water quality, and facilities available for disposal of treatment residuals will vary.

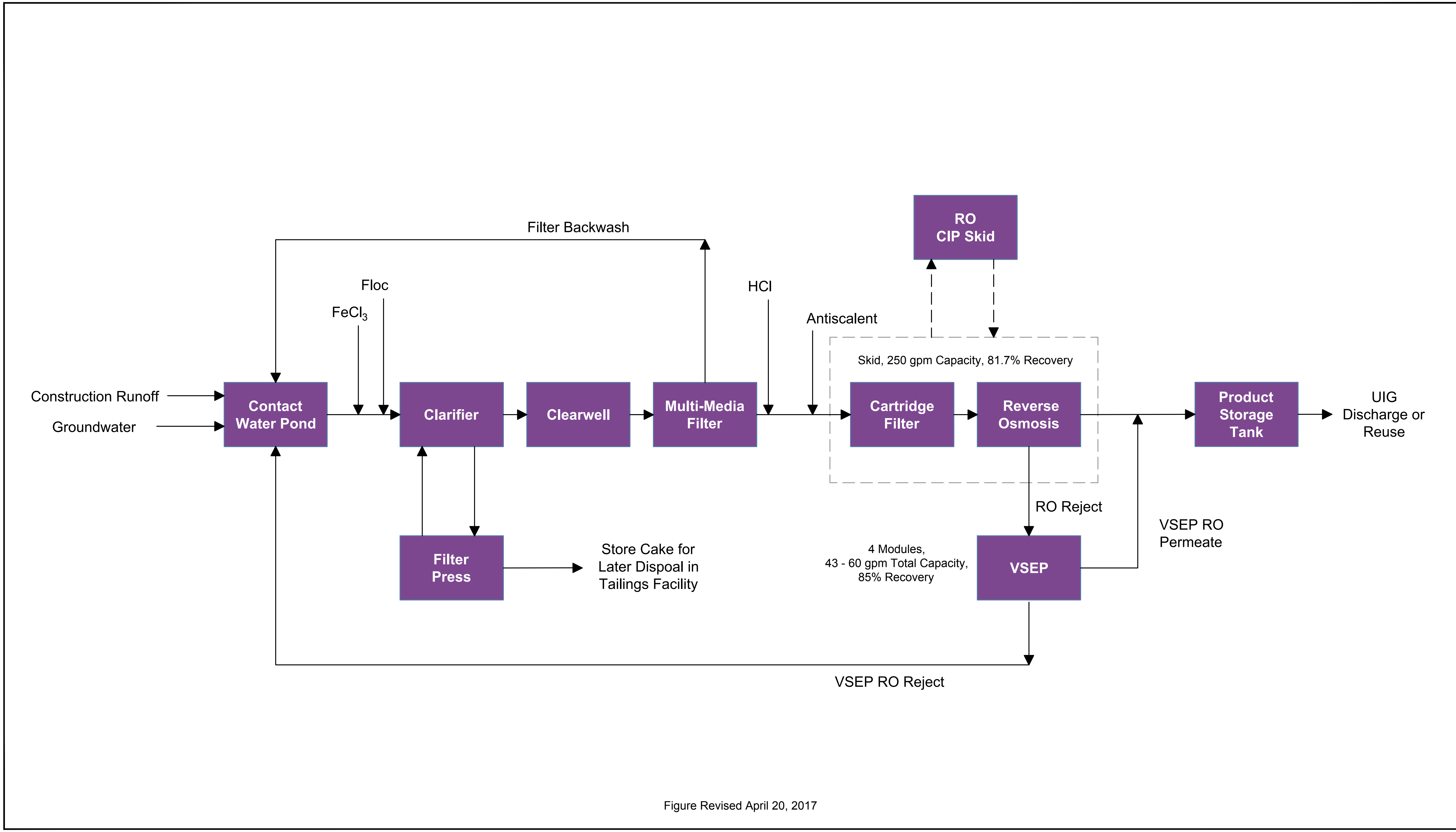


FIGURE 3.45

Water Treatment Construction Phase Process Flow Diagram

Black Butte Copper Project

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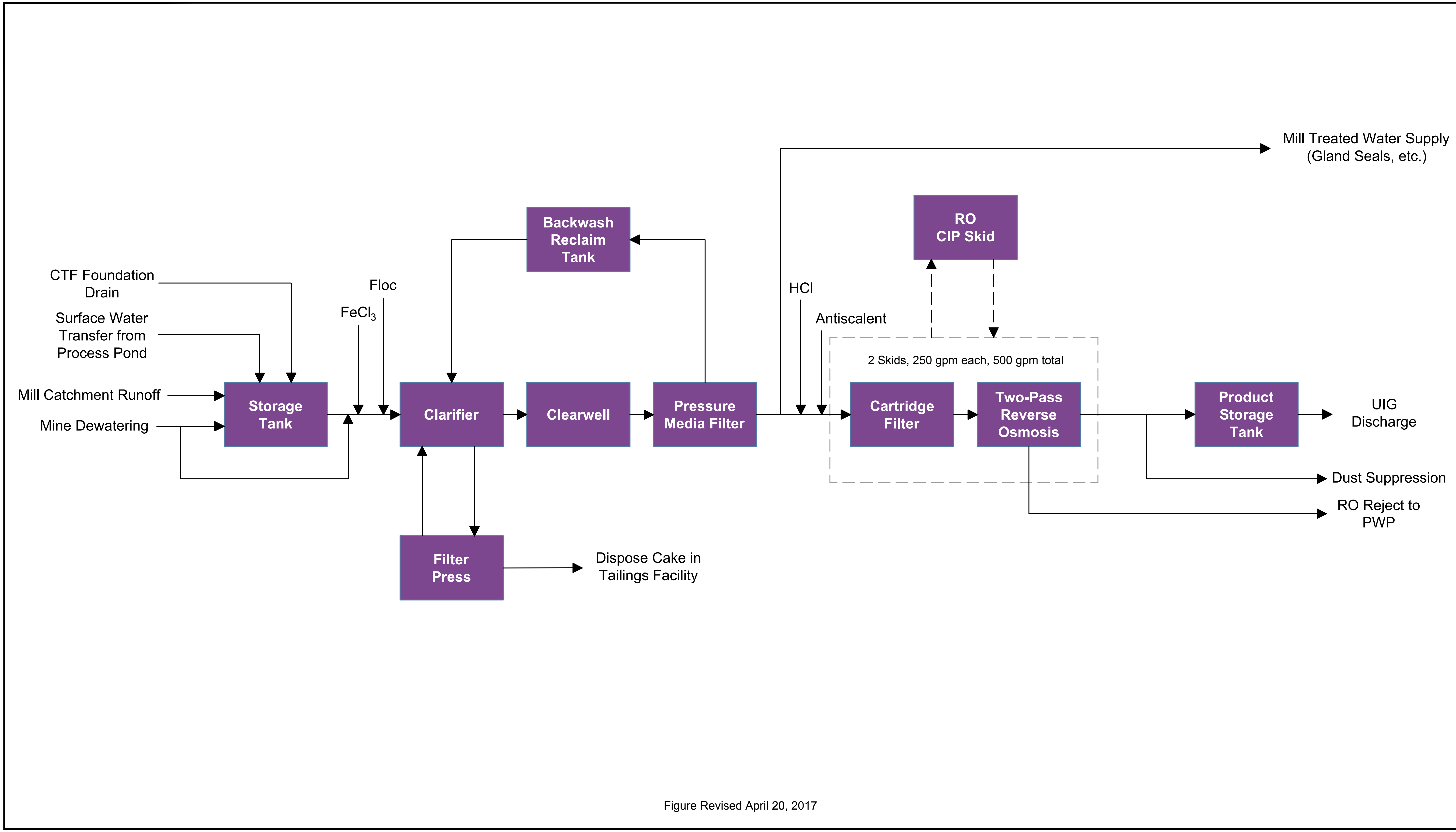

FIGURE 3.46

Water Treatment Operational Phase Process Flow Diagram

Black Butte Copper Project

Mine Operating Permit Application

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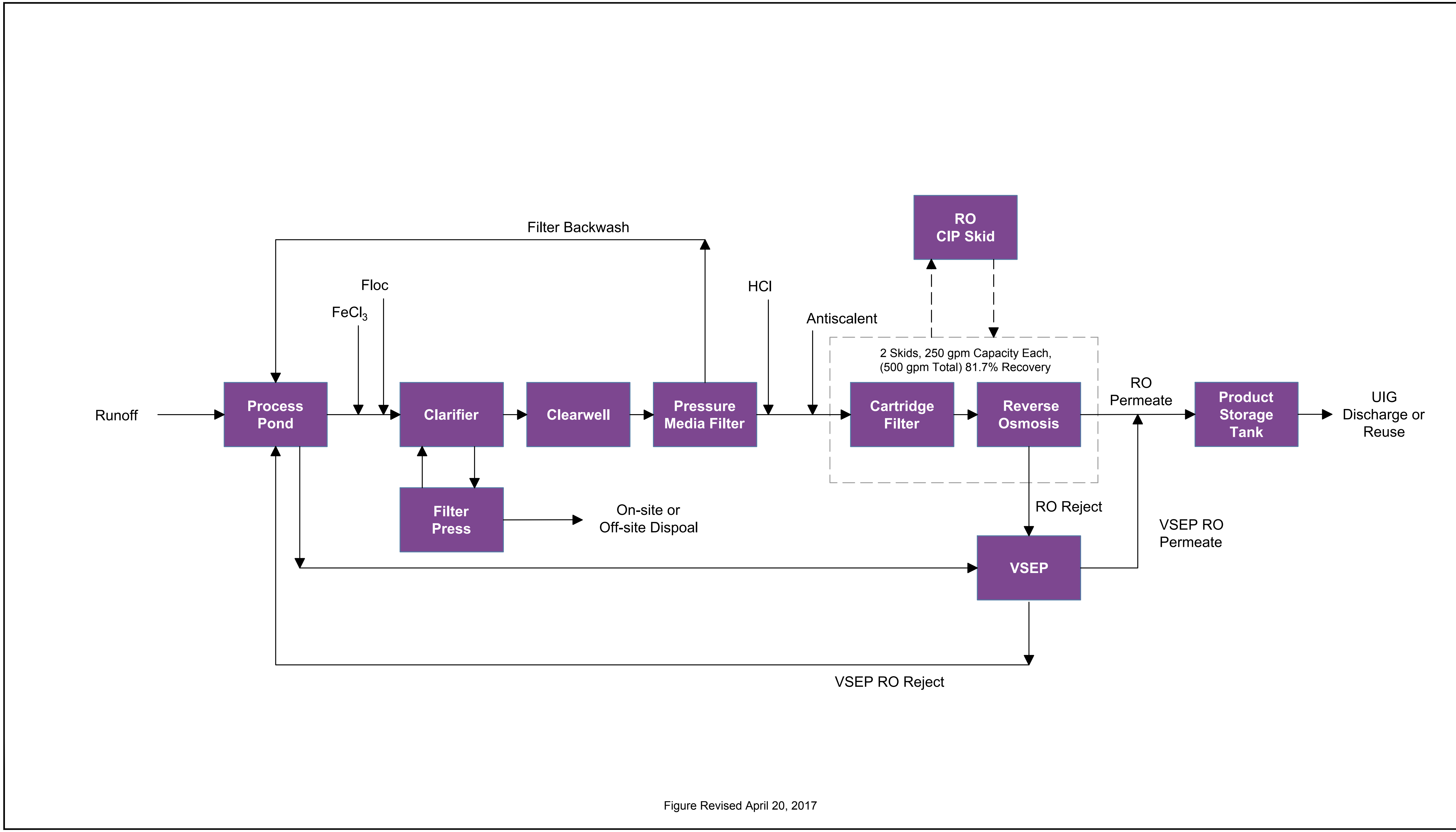

FIGURE 3.47

Water Treatment Closure Phase Process Flow Diagram

Black Butte Copper Project

Mine Operating Permit Application

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3.7.3.3 Raw Water Quality, Treatment Goals, and Treatment Parameters

The raw water quality of the many streams used to estimate the water quality of the water treatment plant influent during operations were derived from geochemical modeling of the underground dewatering, PWP, and CTF (see Appendix N) along with estimated water quality for rain water and the mill catchment runoff. The source and / or assumptions of the raw water quality used for each stream (see numbered flow streams on Figure 3.44 that correspond to Table V-1 in Appendix V of the MOP Application) is summarized below:

- Geochemical model of underground dewatering was used for Mine Dewatering (1) and Ore Water (i.e. moisture and/or pore water in the copper-enriched rock) to Mill (9);
- Geochemical model of CTF Sump was used for Water From CTF to PWP (5) (also see Appendix N);
- Geochemical model of PWP was used for Surface Water Transfer (3); Water Loss to Concentrate (10), and Cemented Paste Void Loss (13), with exception to the nitrate concentration which was based on mass balance modeling;
- Water from the CTF foundation drain pond to the PWP (4); the average water quality from MW-12 was used for the water originating from CTF Foundation Drain Pond;
- Estimated water qualities for the Mill Catchment Runoff (2) is based on average water quality of the UCZ; and
- Water quality for Net Runoff to the PWP (6) was assumed to be similar to rain water with a small amount of dissolved salts.

For each phase, treated water will be discharged to the underground infiltration gallery disposal areas under a MPDES permit. To allow for all of the discharges to meet MPDES non-degradation standards the effluent will not exceed the Estimated Maximum Allowable Effluent Concentration (EMAEC), which are presented in Table 3-40. The estimated non-degradation criteria for the proposed MPDES permit is summarized in Appendix V-1 of the MOP. These are the non-degradation maximum treatment levels for each constituent. Parameters of concern (POC) for each phase were established by comparing the expected raw water quality to the EMAECs. The POC that need to be addressed by water treatment systems during the Construction, Operations, and Closure Phases are similar, but differ slightly due to the different mixtures of raw water sources. The EMAECs values (Table 3-40) are provided as estimates of non-degradation criteria only; actual values will be calculated and reported by DEQ Water Protection Bureau as part of the formal MPDES permitting process.

<u>Construction Phase</u> Water that must be managed during the Construction Phase will be a mixture of underground water from mine dewatering and water from the waste rock and copper-enriched rock storage pad (if any). The quality of the groundwater produced was based on the results of the geochemical model which summarized in Appendix N. Based on a comparison of the modeled underground raw water quality to EMAECs, the parameters of concerns for the Construction Phase are arsenic, lead, strontium, and thallium in produced groundwater. Total suspended solids (TSS) and nitrogen species (nitrate, nitrite, and precursors (i.e. ammonium)) will also be parameters of concern. All of these parameters of concern will require treatment before discharge of water.

<u>Operational Phase</u> Water that must be managed during the Operational Phase will be primarily a mixture of water from underground, process water, and contact water. Parameters of concerns (POCs) were established by comparing the maximum concentrations of each constituent in modeled underground

water quality to EMAECs. If a constituent had a maximum concentration that exceeded its EMAEC, it is considered a parameter of concern. Based on this analysis, the parameters of concern for water treatment of the Operational Phase are pH, dissolved metals (antimony, arsenic, copper, lead, nickel, strontium, and thallium), nitrogen species (nitrate, nitrite, and precursors), and TSS.

Table 3-40. Estimated Water Treatment Standards Based on Groundwater Non-Degradation Criteria

Parameter	Units	Receiving Waters Effluent Limits				Maximum Allowable Effluent
		Alluvium	Bedrock	Alluvium/ Surface Water	Bedrock/ Alluvium/ Surface Water	
Dissolved Oxygen	mg/L	NA	NA	8.0	8.0	**8.0**
pH - Field	s.u.	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	**6.5-8.5**
Specific Conductance	uhoms/cm	654	639	915	910	**639**
Total Dissolved Solids	mg/L	361	367	535	532	**361**
Alkalinity as CACO3	mg/L	752	598			**598**
Chloride	mg/L	35	30	193	194	**30**
Fluoride	mg/L	0.72	0.61	3.90	3.91	**0.61**
Sulfate	mg/L	51	88	194	193	**51**
Nitrate + Nitrite as N	mg/L	9.81	7.80	11.29	11.35	**7.80**
Total Nitrogen (Persulfate Method)	mg/L	NA	NA	0.61	0.61	**0.61**
Total Phosphorus	mg/L	NA	NA	0.035	0.035	**0.035**
Aluminum	mg/L	0.014	0.013	0.463	0.466	**0.013**
Antimony	mg/L	0.0010	0.0009	0.0031	0.0031	**0.0009**
Arsenic	mg/L	0.001	0.003	0.001	0.001	**0.001**
Barium	mg/L	0.138	0.153	0.392	0.395	**0.138**
Beryllium	mg/L	0.001	0.001	0.001	0.001	**0.001**
Cadmium	mg/L	0.00009	0.00008	0.00013	0.00013	**0.00008**
Chromium	mg/L	0.017	0.015	0.048	0.048	**0.015**
Copper	mg/L	0.254	0.203	0.006	0.006	**0.006**
Iron	mg/L	0.03	0.11	0.74	0.76	**0.03**
Lead	mg/L	0.010	0.002	0.001	0.001	**0.001**
Mercury	mg/L	0.000005	0.000005	0.000007	0.000007	**0.000005**
Nickel	mg/L	0.019	0.016	0.052	0.053	**0.016**
Selenium	mg/L	0.0097	0.0078	0.0044	0.0044	**0.0044**
Silver	mg/L	0.0195	0.0156	0.0026	0.0027	**0.0026**
Strontium	mg/L	0.73	0.62	3.73	3.75	**0.62**
Thallium	mg/L	0.0003	0.0003	0.0025	0.0025	**0.0003**
Uranium	mg/L	0.008	0.008	0.008	0.008	**0.008**
Zinc	mg/L	0.39	0.31	0.11	0.11	**0.11**

Closure Phase With the exceptions of TSS and nitrogen species, water quality data from three locked cycle tests completed by SGS (2015) were used to estimate the expected raw water quality for the treatment of process water during mine closure. For each parameter, the design raw water quality of process water requiring treatment during mine closure was calculated as the greater of the maximum detected concentration and the highest limit of detection of all non-detects. For TSS and nitrogen species, prior experience was used to arrive at raw water quality levels for these parameters. A typical value of 20 mg/L was assumed for TSS, and concentrations of nitrogen species were assumed to be similar to those estimated for the treatment of mine water during operations.

Based on this analysis, the Closure Phase parameters of concern are pH, antimony, arsenic, copper, lead, nickel, nitrogen species (nitrate, nitrite and precursors), strontium, thallium, and TSS.

3.7.3.4 Water Treatment Selection Process

Water treatment processes were evaluated for their ability to effectively reduce the concentrations of the parameters of concern for each phase to below their respective EMAECs. Because few treatment methods alone are capable of effectively reducing the concentrations of all identified parameters of concern, several treatment trains were evaluated and compared. The treatment trains that were evaluated combined several treatment technologies in series, and were capable of reducing concentrations of identified parameters of concern to below EMAECs.

Technology screening considered the following factors:

- Potential to treat parameters of concern to required levels,
- Reliability of treatment,
- Degree of application for the treatment of mining waste waters,
- Technical characteristics of the technology,
- Ease of operation,
- Ease of construction,
- Ease of implementation,
- Cost, and
- Residuals / waste stream management.

Treatment processes were initially evaluated based on cost and effectiveness. Some processes were eliminated from consideration due to lack of effectiveness or high capital or operating and maintenance (O&M) costs, but not on high cost alone.

Biological treatment processes could be used for treating nitrogen species (aerobic nitrification to convert ammonia to nitrate, and anoxic denitrification to reduce nitrate to nitrogen gas), but will have limited effectiveness for dissolved metals and would potentially be inhibited at low temperatures. Media-based treatment methods that utilize synthetic or natural (e.g., zeolite) ion exchange media are capable of effectively removing most of the dissolved constituents of concern. However, due to the wide range of contaminants that must be treated, multiple reactors in series would be required for complete treatment, and regeneration processes would produce large volumes of brine that must be treated or disposed.

RO with pre-treatment was selected over other options because it is a more robust and reliable treatment process that has lower overall costs (capital and O&M) than other potential methods. RO systems apply water under pressure to semi-permeable membranes. Clean water permeates through the membrane, whereas dissolved constituents are retained by the membrane in a reject stream (RO reject is also referred to as brine because it contains salts that are concentrated from the feed water). RO provides simultaneous treatment of the parameters of concern that must be treated during each operating phase of this project. Projected influent concentrations for each phase are presented in Section 3.7.3.3, and the RO systems for each phase are discussed in detail in subsequent sections (Section 3.7.3.5 for the Construction Phase and Section 3.7.3.6 for the Operational Phase).

The treatment trains that are described below for each phase are similar and will meet effluent goals, given the specific constraints of each phase. Each treatment train is also designed to allow flexible operation and to effectively treat influent with varying flow rates, water temperatures, and constituent concentrations, with a high degree of redundancy and uptime. Each treatment train relies on clarification and filtration to reduce TSS concentrations, followed by reverse osmosis (RO) to remove dissolved parameters of concern.

3.7.3.5 Water Treatment for the Construction Phase

As described in Section 3.4.2, the mine and most support facilities will be constructed over approximately two years. The Construction Phase will include development of surface facilities, as well as development and advancement of the underground decline. Groundwater produced during mine dewatering will be pumped to the CWP which is designed with two storage cells. The storage cell used for treatment has a capacity of 18.5 million gallons (70,000 m^3) and is used to collect pumped groundwater, seepage and contact water from the WRS and copper enriched stockpile pad. Water from the CWP will be treated to maintain a low pond level and meet non-degradation discharge goals. RO reject (brine) will be stored in the brine cell of the CWP, which has a capacity of 5.56 million gallons (21,000 m^3). Treated water will be discharged to the UIG system or beneficially reused at the site, while treatment residuals will be stored on-site for further treatment and / or disposal during the Operational Phase.

The main components of the Construction Phase water treatment train (Figure 3.45) are as follows:

- **Contact Water Pond:** This two compartment (cell) pond will receive pumped groundwater and WRS run-off, and will provide equalization of flows and concentrations prior to treatment. A second cell on the CWP pad will store RO reject (brine).
- **Clarifier:** Water will be pumped from the CWP at a steady rate to a clarifier to remove the majority of the TSS. Ferric chloride ($FeCl_3$) and an anionic flocculent will be added ahead of the clarifier to improve solids removal in the clarifier; these chemicals may also partially remove some dissolved metals and arsenic by co-precipitation. Lime will also be added, as needed, to raise the pH for precipitation of iron and other metals. The clarifier overflow will have an estimated average concentration of 15 to 20 mg/L TSS. The clarifier overflow will have an estimated average concentration of 15 to 20 mg/L TSS. Clarifier overflow will be collected in a Clearwell Tank and pumped through a series of multi-media pressure filters to further reduce suspended solids. The clarifier underflow will be dewatered using a plate and frame filter press. Disposal of treatment residuals is discussed below in sub-section labeled "Treatment Residual Component Disposal" .
- **Multi-Media Filters:** A series of multi-media pressure filters will remove the remaining suspended solids from the clarifier overflow. The media filters will contain two media: fine sand and anthracite. The filters will be designed with a relatively low filtration rate (less than 5 gpm/ft^2) to ensure removal of TSS below 1 mg/L on an average basis. Solids that accumulate in the media filters will be periodically backwashed with filtered effluent or final RO product water. The backwash water will be routed back to the CWP or to the clarifier. Filter effluent with low TSS will be further treated in the water treatment plant using an RO system.

- **RO System:** Low Total Suspended Solids (TSS) water that has been clarified and filtered will be treated with a double pass RO system to reduce concentrations of dissolved constituents. RO systems apply water under pressure to semi-permeable membranes. Clean water permeates through the membrane, whereas dissolved constituents are retained by the membrane in a reject stream or brine. Two skid- mounted RO systems, each with a maximum raw water treatment capacity of 250 gpm (946 Lpm), will be used in parallel, and each will be operated in a two pass configuration. Permeate from the first pass will be treated with a second pass, and RO reject from the second pass will be recycled to the first pass. Brine from the first pass will be disposed. Each RO system will have a cartridge filter to remove additional suspended solids from the feed water and membranes specifically selected to eliminate the dissolved parameters of concern that are expected in the groundwater. The system selected for this application has an estimated overall recovery of almost 81.7% (RO system modeling results are provided in Appendix V). At the design RO feed flow of approximately 500 gpm (1,893 Lpm), the RO system will produce a final permeate flow of about 408 gpm (1,546 Lpm) and a reject flow of approximately 92 gpm (346 Lpm). The RO system will operate at maximum feed pressures of about 138 psig at a feed water temperature of 25°C (77°F) and 201 psig at a feed water temperature of 10°C (50°F). The feed pumps for the RO system will utilize variable frequency drives controlled by a programmable logic controller (PLC) to adjust feed pressure and maintain constant permeate flow rate under variable influent (temperature and TDS) conditions. The reject stream will be managed as described below, using a Vibratory Shear Enhanced Processing (VSEP) RO system designed by New Logic Research in Emeryville, California (*www.vsep.com)*. To mitigate potential fouling of the RO membranes, hydrochloric acid (HCl) and antiscalant will be added to the RO feed water after the granular media filter. A Clean-In-Place (CIP) system will also be available to clean RO membranes should they become fouled over time.
- **Product Storage Tank:** Treated water will be stored in a permeate storage tank before discharge or reuse. The treated water will be nearly pure water, containing less than 10 mg/L TDS, and will meet all of the EMAECs (Table 3-40).
- **Polishing Phase:** Since RO treatment systems produce treated water that is depleted in minerals, this water can be very aggressive and corrosive to components in downstream distribution systems and could cause leaching of minerals and metals (for example in the vicinity of UIGs). A measure of the "aggressiveness" water is the Langelier Saturation Index (LSI), which is a function of the pH, temperature, calcium and alkalinity (Hernandez, 2005). Negative values indicate the water is corrosive while values greater than or equal to zero are non-aggressive. To stabilize the treated effluent and prevent corrosion and leaching issues, post treatment is often necessary to return some calcium hardness and bicarbonate alkalinity to the water. For this application, the best approach is to pass the treated effluent through a bed of calcium carbonate (also known as calcite) prior to discharge. This will add both calcium and alkalinity (as carbonate) to the water which provides a dual benefit of raising the LSI to above zero while adding buffering capacity to the water. Adding buffering capacity will result in less pH changes in the treated effluent. For this application at the Project, approximately 100 mg/L of calcium carbonate is required to raise the LSI to slightly above zero and eliminate the corrosive nature of the water.

This treatment train will produce four streams: 1) filter backwash, 2) dewatered solids from the filter press, 3) permeate from the RO system, and 4) RO reject. The filter backwash will be routed back to the CWP or the clarifier. Dewatered solids will be stored on-site for ultimate disposal in the tailings facility after construction is complete. The RO permeate will meet discharge requirements and can be discharged to underground infiltration galleries or reused. The concentrated RO reject will require further management. At a feed rate of 250 gpm, each skid-mounted RO system will produce reject at an average flow rate of about 46 gpm (173 Lpm), or approximately 48.1 million gallons (182 million L) of RO reject during the initial two-year Mine Construction Phase. (RO reject volume is 18.3% of the estimated 263 million gallons (996 million liters) to be treated during the construction phase.) Mechanical evaporation, ambient evaporation, and on-site storage of the entire reject volume using temporary tanks were considered but rejected due to potential ineffectiveness, uncertain reliability, and / or prohibitive costs. On-site storage of concentrated brine in the CWP (brine cell) and / or off-site hauling to a disposal well is feasible if the volume of brine can be reduced to low enough levels.

To reduce the volume of RO brine that must be managed during the Construction Phase (as well as the Closure Phase), a VSEP system will be used. VSEP is an RO system that incorporates vibrational shear forces to prevent membrane fouling and maintain high recoveries, thereby effectively treating RO reject streams and reducing the volume of brine that must be managed. The VSEP system allows for rejection of suspended and dissolved solids in a single system. Numerous VSEP systems have been installed worldwide and are being used effectively for reducing the volume of RO reject and for water treatment in mining applications, including treatment of leachate, filter press effluent, and tailings wastewater. The proposed VSEP system will consist of four modules with a total treatment capacity of 43 to 60 gpm (163 to 227 L) at feed water temperatures ranging from 5 – 25°C (41 – 77°F) and an estimated recovery of approximately 85%. VSEP permeate will meet EMAECs, when combined with permeate, and the reject flow rate will be reduced from a maximum of approximately 46 gpm (173 Lpm) to a maximum of about 7 gpm (26 Lpm). The concentrated reject from the VSEP system (with a TDS concentration of about 53,000 mg/L; Appendix V) will be routed back to the CWP brine cell for storage until the Operational Phase. Alternatively, if the dissolved salt concentration in the CWP becomes too high, the VSEP concentrate brine will be hauled off for disposal in a permitted injection well. The nearest injection well is located in Utah.

Water management during the Construction Phase will rely on the availability of two components of the overall mine development: the underground infiltration galleries for discharge of treated water, and the CWP brine cell for storage of brine produced by the VSEP system. The underground infiltration galleries and the CWP (both cells) will be constructed early in the overall mine development process such that these facilities are available before dewatering and water treatment begins. Permeate will be discharged in the infiltration galleries, and the brine produced by the VSEP system will be stored in the CWP brine cell. Any flows from underground or from precipitation that exceed the RO system capacity of 250 gpm (946 Lpm) will be stored using the available capacity of the CWP and PWP.

Although not specifically identified as parameters of concern, oil and grease (O&G) may be present in groundwater pumped from the underground mine, or may be present in WRS run-off. BMPs for O&G management will be implemented at the Project during the Construction, Operation, and Closure Phases to minimize the potential of O&G entering the treatment system. Mine construction and operations personnel will be trained to prevent and respond to O&G spills and leaks, and spill response equipment will be strategically placed. The primary approach will be prevention of leaks and spills during blasting operations (fuel oil) and from heavy equipment (fuels, lubricating oils, and hydraulic oil). If spills or leaks do occur, the initial response will be capture and O&G containment of O&G to prevent contact with underground water. If O&G does come into contact with underground water, absorbent booms will be used to isolate and remove O&G from water in the underground sumps. O&G that reports to the surface with pumped water will be removed using absorbent booms or socks deployed in the CWP, clarifier, or other pre-treatment water systems. The clarifier will have a skimmer that will be used primarily for removal of surface scum, but which can also be used for skimming O&G from the water surface in the clarifier. Absorbent booms can also be temporarily affixed to the clarifier skimmer to improve O&G removal. Any residual O&G that remains in the clarifier overflow will be effectively removed in the media filter before entering the RO system.

Nitrogen species from blasting operations (nitrate, nitrite, and ammonium) may be present in mine water that reports to the surface. To minimize or eliminate these parameters in water that must be treated, Tintina will develop and implement an Explosives Management Plan which will emphasize BMPs for use of ANFO explosives compositions. Additionally, the use of explosives emulsions will be considered to eliminate use of ANFO and minimize concentrations of nitrogen species in water to be treated. The nitrogen species from blasting operations that are likely to be present in groundwater that reports to the surface will be effectively removed by the RO system. At an influent water temperature of 25°C (77°F), the RO system is projected to meet the treated effluent requirement for total Nitrogen (Appendix V). These estimates for the highest expected feed water temperature represent the lowest anticipated removals, as solute rejection by the RO system will increase at lower water temperatures.

Treatment Residual Component Disposal**:** During the surface construction and initial underground decline phase, the clarifier underflow from the WTP will be dewatered using a plate and frame filter press. The filter backwash will be directed to a storage tank and metered back into the clarifier for re-treatment. The resultant clarifier sludge (largely filtered TSS) will be:

- Hauled to the WRS pad and mixed with waste rock;
- Placed underground in fresh muck piles that will be ultimately hauled to the WRS pad;
- Placed temporarily in underground sumps and / or dead-end headings. Flocculants will be added, to settle/decant the solids which will later either be hauled to the WRS pad, or ultimately to the CTF; or
- Alternatively this material could be hauled off-site for disposal.

The concentrated reject from the VSEP system will be routed back to the CWP brine cell (2.5 year maximum capacity with additional 1 in 200 year storm water storage capacity and 3.3 feet (1 m) freeboard) for storage. During the Operational Phase RO brine will either be transferred to the PWP for storage and mixed with fresh water and used in the milling process, or transferred to the mill thickener for incorporation into the cemented tailings paste fill. Alternatively, if the volume requiring storage in the brine pond becomes too large, the VSEP concentrate brine will be hauled off for disposal in a permitted injection well as previously discussed. The nearest injection well is located in Utah.

Due to the temporary nature of this treatment system, some of these components will be temporary (two year) rental units. However, the two 250 gpm (946 Lpm) skid-mounted RO systems and the VSEP system will be purchased and repurposed for operational water treatment during later phases of this Project.

3.7.3.6 Water Treatment for the Operational Phase

The water treatment processes proposed for the Operational Phase (Figure 3.46) are similar to those for the Construction Phase. A mixture of groundwater, contact water run-off, and PWP water will be treated during the Operational Phase, and the parameters of concern will include TSS, dissolved metals, and nitrogen species. A clarifier will be used to reduce TSS concentrations, and an RO system will remove dissolved contaminants. O&G will be removed before the RO system. A more permanent WTP will be constructed to treat the higher anticipated flows. The operational phase WTP will be operated at an anticipated maximum influent flow rate of 588 gpm (2,226 Lpm), but will be designed to handle influent flows up to 750 gpm (2,839 Lpm). The nominal WTP input flow rate is approximately 500 gpm (1,893 L/min.) with actual flow through the RO component at 408 gpm (1,545 L/min.). Rental units (such as the clarifier, filter press, and pressure filters) used during the Construction Phase will be replaced with permanent water treatment processes with higher capacity. Additionally, multiple on-site disposal options (into the PWP or the thickener) for RO reject will be available, eliminating the need for volume reduction with the VSEP system during this phase. The VSEP system will be maintained as a back-up in case it is needed during the Operational Phase. Otherwise it will be used later in the Closure Phase.

Rather than using the CWP, influent will be collected in an influent tank that will provide storage and equalization. Water from the PWP will be combined with underground water in the influent process water storage tank. To prevent excessive accumulation of solids in the influent tank, the tank will have an agitator. Part of the influent groundwater will be routed directly to the clarifier inlet to reduce TSS loading to the influent tank. Water from the influent storage tank will be pumped to the WTP. After coagulation, flocculation, clarification, and pressure filtration, part of the flow (about 89 gpm) will be diverted to the Mill for use as gland water and other ancillary processes.

For treatment of the remaining 500 gpm (1,893 Lpm), the WTP will include two 250 gpm (946 Lpm) RO skids using a two-pass system, providing an RO treatment capacity of 500 gpm. Acid and anti-scalant will be added to the RO system feed, and the RO system will be operated at an anticipated steady state flow rate of 500 gpm (1,893 Lpm), which corresponds to the rated combined capacity of both skids and the optimal flow rate through the RO system. Additionally, the 250 gpm RO skid from the Construction Phase will be retained on site and will be available to provide standby treatment capacity. The storage capacity of the PWP and the influent storage tank will be used to dampen fluctuations in flows and to provide a near steady state, consistent influent flow rate to the RO system. The RO system is designed to accommodate a wide range of feed chemistry. Upstream pre-treatment is designed with flexibility to produce acceptable feed (flow rate and concentrations) for the RO system, and the RO system is designed to be self-compensating to maintain consistent flow rates over a wide range of influent temperatures and concentrations. As during the Construction Phase, the feed pumps for the RO system will utilize variable frequency drives controlled by a programmable logic controller (PLC) to adjust feed pressure and maintain a constant permeate flow rate under variable influent (temperature and TDS) conditions.

At the anticipated RO system recovery of 81.7%, 92 gpm (346 Lpm) of RO reject and 408 gpm (1,548 Lpm) of permeate will be produced (RO system modeling results are provided in Appendix V). Treated effluent will meet discharge standards for all parameters of concern, and will be discharged at the underground infiltration gallery system or reused at the site (Table 3-41).

Table 3-41. Operational Phase Parameters of Concern

PARAMETER	Units	Influent	Treated Effluent[(a)]	EMAEC[(b)]
pH	s.u.	6.6	8.1	6.5-8.5
Antimony (dissolved)	mg/L	0.023	<0.001	0.0009
Arsenic (dissolved)	mg/L	0.009	<0.001	0.001
Copper (dissolved)	mg/L	0.376	<0.001	0.006
Lead (dissolved)	mg/L	0.009	<0.001	0.001
Nickel (dissolved)	mg/L	0.024	<0.0005	0.016
Nitrate + Nitrite as Nitrogen	mg/L	36.2[(c)]	0.22	7.5
Strontium (dissolved)	mg/L	9.650	0.010	0.62
Ammonia as Nitrogen	mg/L	4.81	0.10	
Total Nitrogen	mg/L	41.01	0.32	0.61
Thallium (dissolved)	mg/L	0.0097	<0.0002	0.0003
Total Suspended Solids	mg/L	129[(d)]	< 1	20

Notes:

(a) Treated effluent concentrations are estimates based on modeling of water treatment process performance under expected operating conditions. Results shown are for a water temperature of 25°C (77°F); effluent concentrations will be lower for lower water temperatures. RO system modeling results are provided in Appendix V.

(b) Estimated Maximum Allowable Effluent Concentrations (EMAECs) are water quality goals that need to be met to be below the MPDES discharge limits (Hydrometrics, 2016a).

(c) Calculated based on the material balance model for combined sources of water entering the water treatment plant (Appendix V).

(d) Typical values based on experience and mass balance calculations.

As during the Construction Phase, the WTP will produce filter backwash, dewatered solids from the filter press, permeate from the RO system, and RO reject. The filter backwash will be directed to a new storage tank and metered back into the clarifier for retreatment. Dewatered solids will be stored on-site for ultimate disposal in the CTF. Approximately 900 pounds of dry solids per day will be removed by the clarifier and dewatered in the filter press. Assuming the filter press produces dewatered WTP solids at 40% solids, approximately 1 m^3/day (35 ft^3/day) of dewatered sludge will be sent to the tailings paste plant for ultimate placement underground or in the CTF.

The RO permeate will meet MPDES discharge requirements and can be discharged through the underground infiltration galleries or reused. After the mine facilities are in place, there will be multiple options for disposal of RO reject. The initial and preferred brine disposal option during the mining operations is pumping of brine to the PWP, while a secondary brine disposal option will be pumping of brine to the mill thickener. For both options dissolved salts removed from the system will ultimately be incorporated into the cemented tailings paste for permanent disposal of the salts. Because of operational flexibility, the brine could be split between the PWP and the Mill thickener; the fraction sent to each location could be modified as needed if RO recovery is lower than anticipated, (producing a higher volume of RO reject brine) or if the thickener is not operating due to maintenance or unscheduled shutdowns.

3.7.3.7 Water Treatment for the Closure Phase

Three sources of water will need to be treated in closure:

1) A very minor amount (if any) water from the sump of the closed CTF facility (see Section 7.3.3.3) that will be pumped to the PWP or directly to the WTP,

2) Water from the PWP to allow decommissioning of the pond and site restoration (see Section 3.3.3.5), and

3) Water from underground flooding of the Ynl B and *USZ* zones with contemporaneous pumping and treatment in preparation of underground mine closure (see Section 7.3.3.5).

The water treatment processes during the closure phase will be similar to those for previous phases, and will use the same treatment equipment to treat water at flow rates up to 502 gpm (1,900 Lpm), which is the capacity of the RO system (500 gpm; 1,893 Lpm) plus water removed with suspended solids in the clarifier (2 gpm; 7.5 Lpm) (see Figure 3.47). Parameters of concern will include pH, TSS, dissolved metals (antimony, arsenic, copper, lead, nickel, strontium, selenium, and thallium), and nitrogen species (nitrate, nitrite, and ammonium). Water from these sources will be treated in the clarifier to reduce TSS concentrations, and the RO system will remove dissolved contaminants. These processes will produce filter backwash, dewatered solids from the filter press, permeate from the RO system, and RO reject. Filter backwash will be routed to the PWP.

Dewatered solids will be disposed on-site if facilities are available, or off-site in a landfill. RO permeate will meet discharge water quality requirements and can be discharged in the underground infiltration gallery system or reused (e.g., dust suppression, WTP reagent mixing, fire suppression and fire protection water storage, and other minor uses).

Initially, the RO reject from treatment of each of these three sources will be directed back to the PWP in closure, because in closure the tailings thickener will be decommissioned and unavailable for brine disposal. Discharge of RO permeate will continue to the UIG system. However, continued return of RO reject to the PWP over time, although it will reduce the PWP volume, would significantly increase the dissolved salt concentration in the PWP. Prior to the brine reaching high concentrations in the PWP, the VSEP system will be recommissioned for reducing the PWP volume further. VSEP permeate will meet MAECs and will be discharged to the UIG system. The concentrated VSEP reject will be temporarily stored in the brine cell of the CWP in closure prior to being hauled off-site for disposal at a permitted disposal facility as previously discussed in Section 3.7.3.5. Once the PWP is empty the facility will be closed (see Section 7.3.3.4).

Water from the underground mine and water collected from the sump of the CTF (if any) would continue to be treated using the WTP with temporary brine storage in the CWP brine cell, prior to shipping the brine off-site for disposal.

3.7.4 Treated Water Disposition

Tintina proposes to dispose of treated water through two upland underground infiltration galleries (UIGs) and one alluvial UIG. With the exception of the PWS well, Tintina's only source of water for use in mining will be from groundwater inflow into the newly opened mine workings. This water will be pumped to surface in order to dewater the mine. On average, approximately 60% of the water produced from underground will not be put to any beneficial use, and will be treated to meet non-degradation standards and discharged back to groundwater. The other approximately 40% of the water produced will be used in the mining process. The upland UIGs are anticipated to be the primary outfalls and only use the alluvial UIGs if necessary. Tintina proposes to permit the upland and alluvial UIGs through the DEQ Water Protection Bureau (WPB) under a Montana Pollutant Discharge Elimination System (MPDES) permit. Tintina will provide The Hard Rock Mining Bureau with a copy of the permit application and future correspondence with the WPB regarding the MPDES permit.

3.7.4.1 Upland Underground Infiltration Galleries

Treated water will be returned to the local shallow bedrock hosted groundwater system through two upland UIGs. In addition, contact water from the mining operations (precipitation and surface water run-on to the various facilities) and groundwater collected in the CTF foundation drain pond will need to be treated and disposed of in the upland UIGs. Figure 3.44 provides a schematic of critical portions of the water flow path at the project site during operations.

Tintina plans to use two large areas of upland underground infiltration galleries (Figure 1.3) constructed to dispose of water below the frost level. This will return treated underground water to the shallow fractured bedrock system. Water will be treated to levels meeting non-degradation standards (see Section 3.7.3.3) for discharge to local groundwater and ultimately to alluvial gravels beneath Sheep Creek. Tintina has conducted shallow and deep percolation testing to identify areas suitable for these types of disposal scenarios as is described in the soil section (Section 2.5.3.4) above. Therefore, Tintina has developed the capability of discharging to an underground system that has considerable excess capacity for handling the anticipated mine water.

UIGs are used to minimize issues related to freezing surface conditions by disposing of water below the frost level. This allows year-round water disposal. Tintina's designed galleries return treated water to the shallow fractured uppermost part of the lower Newland Formation (*Ynl*) and Tertiary granodiorite (*Tgd*) bedrock system in the same general area as from where it was extracted.

The upland UIGs will be constructed with supply lines running down the axis of topographic ridges (Figure 1.3) (see Sections 2.5.3.4 and 3.7.4). The central area lies along a ridge approximately 985 feet (300 m) south of the portal pad. The depth to the groundwater table in this area is approximately 27 feet (9 m) based on MW-8 that lies within this infiltration galley footprint. The eastern area lies about 5,250 feet (1,600 m) east of the CTF. The potentiometric surface map (Figure 4.7) indicates that groundwater beneath the eastern UIG is approximately 40 feet (12 m) below the ground surface. Discharges to the underground infiltration gallery will be introduced from 4 to 6 feet (1.2 to 1.8 m) below the surface in highly fractured bedrock with high average infiltration rates of about 9 to 10 feet/day (2.7 to 3.0 m/day).

Water will be pumped directly from the WTP at a monitored quality that meets non-degradation standards for groundwater and surface water (see Section 3.7.3.3). It will be discharged through approximately 17,600 linear feet (5,360 m) of perforated HDPE pipe laid out in a grid-like pattern in the two disposal areas (Figure 1.3). Perforated pipes will be buried below the frost line in deep highly fractured near surface bedrock. The flow of water in individual arms of perforated pipe within the grid will be controlled by valves and Tintina is evaluating options for the installation of pressure compensating emitters to insure an even distribution of water along the entire line length. The valves will allow water to be switched to different areas (arms of the infiltration galley drain field) to avoid saturation of near surface soils or the formation of downgradient seeps and springs. It also allows control of periods of rest between infiltration cycles. Saturated depths will be monitored by piezometers shown on Figure 6.1 within the infiltration galley drain fields, and downgradient groundwater monitoring wells will measure downgradient water quality.

Based on the data presented in Table 2-27 the two proposed underground infiltration systems will have the combined capacity to infiltrate a total of about 2,640 gpm (9,990 Lpm). The maximum annual average volume of water received by the WTP operationally is 1,171,000 m^3 or 588 gpm (including 995,000 m^3 from mine dewatering, 110,000 m^3 from Surface Water Transfer, 26,000 m^3 from the mill catchment area, 40,000 m^3 from the CTF foundation drain, and 29,000 m^3 of recycled water) as shown on Figure 3.44. The water will initially go through a clarification and filtration process, after which approximately 177,200

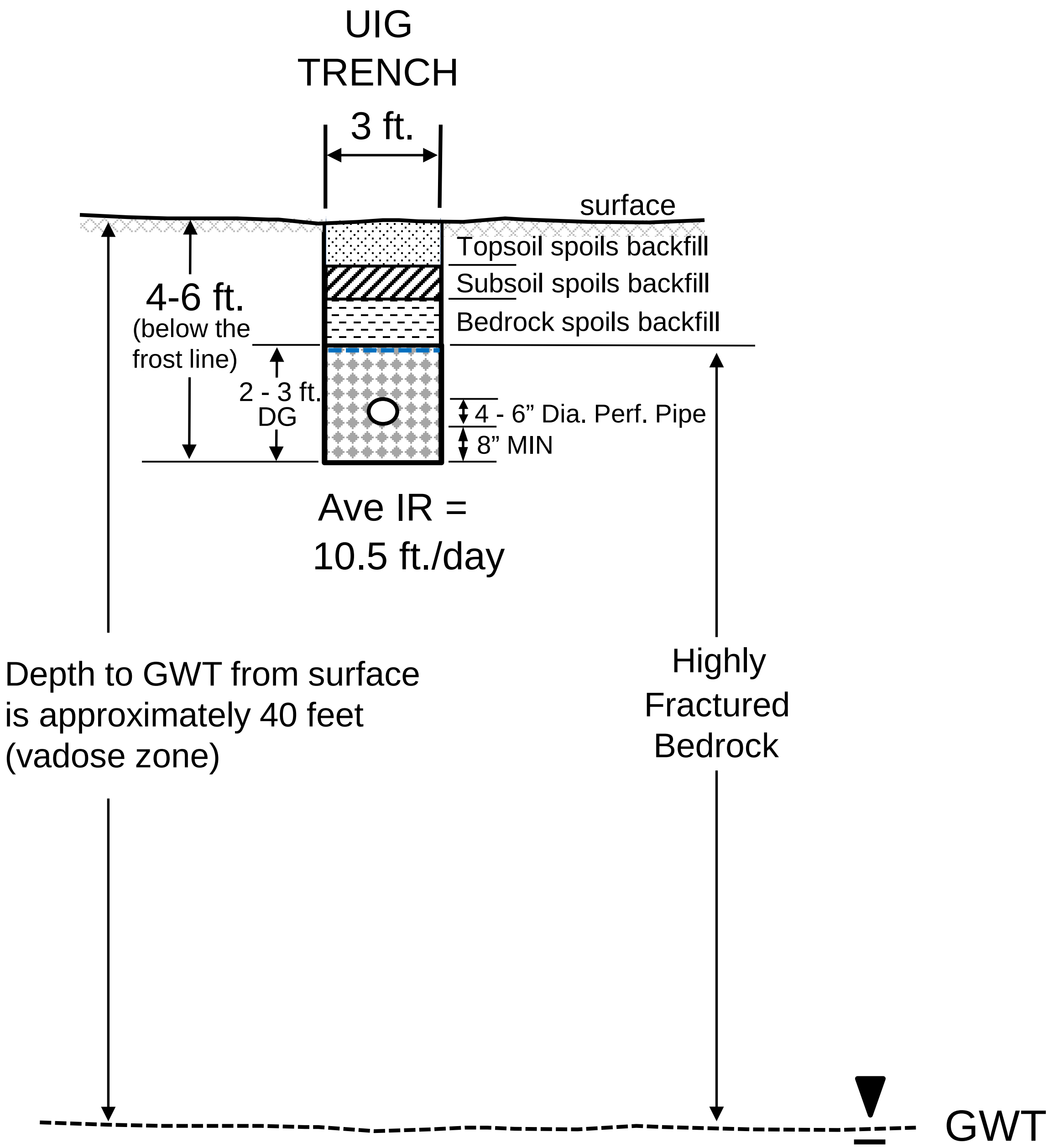
m^3 is sent to the mill. About 12% of this volume (about 91 gpm; 344 Lpm) is brine, which will be diverted to the PWP for use as make-up water and will not be discharged to the infiltration galleries. Therefore, the average annual rate of application to the combined infiltration galleries should be about 398 gpm (1,507 Lpm). This indicates that the combined infiltration galleries have the ability to receive about 6.6 times the amount of water discharged. Or alternatively, the discharge to the UIGs may be switched to various arms and drain field areas in order to avoid saturation of shallow bedrock and soils such that they would create seeps, springs or discharges to surface water.

The capacity of the Upland UIG system is also dependent on the ability of the surface of the groundwater aquifer to dissipate any mounding that might result from the discharge of treated water via the infiltration galleries, through an unsaturated zone, and to the groundwater table. Excessive mounding runs the risk of a discharge at the surface as a seep or spring. An analytical analysis was conducted to evaluate the projected mound and it's dissipation over a one year period of cyclical discharge for a single arm in both the central and eastern UIGs (Hydrometrics 2017a). The analytical analysis was conducted using a series of large diameter injection wells in AQTESOLV (v4.50) to simulate the average discharge rate (0.13 gpm per linear foot of perforated UIG) for a 400 foot long arm of the UIG; assuming a total of 3,000 feet of upland UIG was actively discharging 398 gpm. The simulated discharge consisted of cycling through 10 seven-day discharge periods, followed by a five-week recovery period (no discharge). The analytical analysis shows that groundwater mounding directly beneath an active UIG segment in the central and eastern UIGs is estimated to be upwards of approximately 16 feet and 9 feet, respectively after one year of discharge. Mounding between two arms was evaluated assuming the mound from both perforated arms will contribute resulting in a mound of 8 feet and 5 feet for the central and eastern UIG segments, respectively. The unsaturated zone in the central and eastern UIGs is approximately 40 feet; therefore, this analysis indicates there is sufficient capacity in the groundwater system to sustain average discharge to the eastern and central UIGs without causing seeps. This mounding analysis was conducted assuming 100% of the treated water will be discharge to the Upland UIGs; if water is discharged to the alluvial UIG, the mounding in the central and eastern UIGs would be much less than simulated. Hydrometrics (2017b) conducted the detailed summary of the Upland UIG mounding analysis that is included in Appendix B-2.

The local and regional potentiometric surface maps (Figure 2.8 and Figure 4.6 respectively) indicate a primary flow direction to the east-north-east in the central and eastern areas, away from the decline collar. The decline would descend northward from the portal at a slope of about minus 15% and would not intercept the regional groundwater table until reaching about 1,700 feet (518 m) in length at an elevation approximately 220 feet (67 m) below the overlying ground surface and about 170 feet (52 m) lower in elevation than the portal. Therefore, there is little chance for water from the infiltration gallery to reenter the active mine workings. The infiltrated treated water will mix with the regional groundwater and improve its overall water quality.

Construction of the UIGs will require a tracked excavator, loaders, and trucks with trailers to move men and materials to the excavation sites with details of the UIG construction shown in Figure 3.48. The tracked excavator will dig a 3-foot (0.9 m) wide trench approximately 4 to 6 feet deep (1.2 to 1.8 m) (below the frost line). Discharge water will be distributed from the WTP at or below groundwater and surface water non-degradation standards using a 6-inch (15.2 cm) HDPE pipe that will be perforated in areas where subsurface irrigation is desired (dashed magenta lines in the center of Figure 1.3). The pipe will not be perforated in areas that serve only to transmit water (the solid magenta lines on Figure 1.3 and Map Sheet 1). The bottom 2 to 3 feet (61 to 91 cm) of the trench in the perforated segments to be used for infiltration will be filled with washed granodiorite gravel. The pipe will be welded together and perforated in the appropriate sections before laying it in the trench. The perforated sections of the pipe will have a minimum of 3 inches (7.6 cm) of gravel placed over the top of the pipe. The lower portion of the trench will be protected from fine soil infiltration using a filter fabric or plastic screen sections developed for that purpose. The trench will be backfilled with excavated material, soil placed and revegetated (see Figure 3.48).

Surface disturbances required for UIG access and construction will consist of pioneered roads of approximately 20 feet (6.1 m) in width. Trenches will be excavated in the roadway. Total trench lengths will be approximately 29,800 feet (9,083 m), making the total disturbance area for the subsurface drain system approximately 13.7acres (5.5ha). Trenches will be backfilled, roads scarified, topsoil / subsoil replaced and the area revegetated upon completion of construction of the system. The underground infiltration galleries are not expected to require significant maintenance. Any maintenance and monitoring of system performance will occur during routine inspections conducted by an inspector on an ATV along two-track trails.



------- Filter fabric or plastic screen placed over the top of the drainage gravel backfill in the UIG trench

Abbreviations:
DG = drainage gravel with specifications as per Drawing C0003 in Appendix K
GWT = static groundwater table data based on information from MW-14 and MW-15;
Dia. = diameter; Perf. = perforated;
UIG = Underground infiltration gallery; Pipe = HDPE or PVC pipe; MIN = minimum; ft. = feet;
IR = infiltration rate based on ASTM D 3385-88 (see Appendix E1)

Note: The 4 – 6 inch diameter perforated UIG pipes will be buried in place in closure

Date: February 3, 2017 (from Geomin Resources Inc.)

Figure 3.48
Eastern UIG Schematic Section
Black Butte Copper MOP
Meagher County, Montana

TINTINA RESOURCES

Twenty-four new piezometers and seven new monitoring wells will be installed within the various cells and down-gradient of the underground infiltration galleries (Figure 6.1). Infiltration areas will be rotated based upon piezometer results. Monitoring of these piezometers will eliminate the risk of developing shallow bedrock saturation zones and surface seeps and springs downgradient, and the risk of impacting flow rates in downgradient streams. Baseline conditions will be measured before initial use of the system. The frequency of measurements will be adjusted pending the results of the initial monitoring.

Tintina will construct the UIGs no closer than 400 feet (122 m) to any wetland or surface water. The locations of the UIG lines shown on Figure 1.3 are conceptual. Prior to their installation, Tintina will use data from monitoring wells and piezometers near the wetlands and infiltration galley sites to finalize the drain field design. Tintina will notify DEQ prior to beginning installation of the underground infiltration gallery system so that DEQ staff can be on-site to observe installation and construction.

3.7.4.2 Underground Infiltration to Sheep Creek Alluvium

In addition to upland UIG disposal of treated water to the shallow bedrock system (described in Section 3.7.4.1 above), Tintina is proposing groundwater infiltration of treated water into the Sheep Creek shallow alluvial aquifer system. Tintina plans to infiltrate this treated water to an infiltration gallery located in non-wetland areas beneath the floodplain of Sheep Creek southwest of Strawberry Butte (Figure 1.3). The lithologic log and aquifer testing conducted on well MW-4A (completed in the Sheep Creek alluvial system and described below) demonstrates the alluvial system is suitable for this type of disposal. Although the upland UIGs are intended to be the primary areas of infiltration, Tintina is proposing to infiltrate to Sheep Creek alluvium on a routine and regular basis..

The shallow groundwater alluvial infiltration gallery located adjacent to Sheep Creek will be used to dispose of water below the frost level allowing for year-round water disposal. The infiltration gallery will be constructed with a supply line running from the water treatment plant, east down a portion of the main mine access road, then turning northwest to cross under the county road and up the private drive southwest of Strawberry Butte to the gallery’s location (Figure 1.3). The depth to the groundwater table in the infiltration gallery area is approximately 3 feet (1 meter) based on monitoring well MW-4A that lies proximal to the infiltration gallery. The gallery proper will be located outside of all wetland areas and its length will be oriented perpendicular to the groundwater flow direction.

The upper portion of the infiltration gallery (3-10 feet) (1 to 3 m) will be within sandy clayey gravel and the lower portion will be constructed in sandy gravel. The NRCS soil web survey indicates the soil from 3-10 feet (1 to 4.6 m) has a weighted average saturated hydraulic conductivity ranging from 4.5 to 26 ft./day and a saturated infiltration rate of 0.58 ft./day. The hydraulic conductivity of the sand and gravel in the lower portion of the gallery has been estimated at 200 ft./day (Hydrometrics, 2016a, Appendix B of this report). Discharges to the infiltration gallery will be introduced from 3 feet to 15 feet (1 to 4.6 m) below ground surface to assure the lower portion of the gallery is completed in the more permeable lower sand and gravel aquifer. Based on the NRCS infiltration rate, the infiltration gallery would be 6 feet (2 m) wide, and 40 feet (12 m) long, and extend from 3 to 15 feet (1 to 4.6 m) below the ground surface. The bottom 12 feet (3.7 m) of the gallery will be backfilled with 1- to 2-inch (25 to 50 mm) washed rock. A geotextile fabric barrier will separate the rock backfill from the subsoil fill material. Two feet (60 cm) of subsoil will be topped with one foot (30 cm) of topsoil. A three foot (1 m) diameter plastic (HDPE) corrugated culvert (on end) with saw cuts in the bottom 10 feet (3 m) will be located in the center of the gallery. When installed, the culvert will be backfilled with washed rock. The supply pipeline will enter the culvert five feet (1.5 m) below ground surface.

Water will be pumped directly from the WTP at a monitored quality that meets applicable non-degradation standards. A source specific mixing zone (3,500 feet, 1,066 m in length) may be required for Total Nitrogen during the summer months to meet the seasonal nutrient standard for total nitrogen in surface water. The groundwater flux through the alluvial aquifer is estimated at 200 gpm (909 Lpm) (Hydrometrics, 2016a, Appendix M of this report), which will mix with the treated water discharged through the infiltration gallery. A series of downgradient groundwater monitoring wells and piezometers will measure downgradient mixed water quality to ensure permit compliance (Figure 6.1).

The local and regional potentiometric surface maps (Hydrometrics, 2016a) (Figure 2.8 and Figure 4.6 respectively) indicate groundwater flows parallel to Sheep Creek near this infiltration gallery and then towards Sheep Creek as the alluvial system pinches out as Sheep Creek enters a small canyon north as it flows north. It is assumed that 100% of the mixed effluent will report to Sheep Creek in the northern portion of the valley. As with the other UIGs construction of this infiltration gallery will require a tracked excavator, loaders, and trucks with trailers to move men and materials to the excavation sites. The tracked excavator will dig a 3-foot (0.9 m) wide trench approximately 4 to 6 feet deep (1.2 to 1.8 m) (below the frost line). The main pipeline will be buried beneath the main access road for 2,265 feet (690 m). At that point the pipeline will follow the contour to the north-west 1,500 feet, (457 m) to the main county road. The pipeline will pass under the county road and follow the private drive 675 feet (205 m) to the gallery's position. No mapped wetlands will be disturbed by the pipeline or infiltration gallery construction. The pipeline itself will be constructed using a 6-inch (15.2 cm) HDPE pipe, welded together in appropriate sections before laying it in the trench. The pipeline will be bedded and laid on grade to eliminate sags with appropriate sized bedding material and backfilled/compacted. The trench will be backfilled with excavated material, soil placed and revegetated.

Surface disturbances required for the pipeline and infiltration gallery construction will consist of pioneered roads of approximately 15 feet (4.6 m) in width. Both ends of the buried pipeline will be under either proposed or existing roads, such that the only an additional amount of surface disturbance associated with pipeline trenches will be about 1,500 lineal feet (459 m) or about 0.7 acres (0.3 ha). Total trench/pipeline lengths will be approximately 4,440 feet (1,353 m). Trenches will be backfilled, roads scarified, topsoil / subsoil replaced and the area revegetated upon completion of construction of the system. As with the other UIGs, this underground infiltration gallery is not expected to require significant maintenance. Any maintenance and monitoring of system performance will occur during routine inspections conducted by an inspector on an ATV along two-track trails or inspection of the center well at the infiltration gallery.

The location of the infiltration gallery is shown on Figure 1.3 is conceptual. Prior to its installation, Tintina will use data from monitoring wells, test pits, and piezometers near the infiltration galley site to finalize the infiltration gallery siting and design. Once the groundwater discharge permit is issued, Tintina will notify DEQ prior to beginning installation of the infiltration gallery so that DEQ staff can be on-site to observe installation and construction.

3.7.5 Storm Water

3.7.5.1 <u>Design Events</u>

The 24-hour design storm events for the Project (at El. 5,698 feet (1737 m)) are presented on Table 3-42.

Table 3-42. Storm Event Summary

Return Period (years)	24-Hour Storm Event (mm)	24-Hour Storm Event (in.)
2	35	1.37
5	49	1.92
10	58	2.28
15	64	2.52
20	67	2.64
25	70	2.76
50	79	3.11
100	88	3.47
200	96	3.78
500	108	4.25

The probable maximum precipitation (PMP) for the Project area is defined as the greatest depth of precipitation for a given duration that is physically possible. The PMP event for the Project is estimated to be 22 inches (560 mm). This is equivalent to the average annual precipitation (21.7 inches) (550 mm) at the Project site.

The probable maximum flood (PMF) is defined as the largest flood that could conceivably occur at a particular location. The PMF is usually estimated from probable maximum precipitation (Appendix A-1) (Knight Piésold, 2015a and 2015b), and where applicable, snow melt, coupled with the worst flood producing catchment conditions. The PMF for the Project area is therefore calculated by adding together the PMP (22 inches or 560 mm) and the 1 in 100 year snow accumulation (11.4 inches or 290 mm) which results in a PMF of 33.46 inches (850 mm) or 1.5 times the total annual precipitation in the Project area.

The Project facilities including the CWP, PWP, and CTF were designed to store the PMF volume in addition to their normal operations volume as required by FEMA, ICOLD, and DEQ based on the high potential hazard facility classification (see Section 3.5.3). The NCWR spillway will be a low risk facility which is designed to safely pass a peak instantaneous discharge associated with the 1 in 200 year 24-hour storm event. The spillway is included to prevent overtopping of the embankment and safely route the design storm event through the NCWR, and discharge it to the wetlands downstream. The NCWR facility was conservatively modeled as full to the invert elevation of the spillway at the start of the storm.

3.7.5.2 Surface Water Diversion Ditches

The primary objective of the diversion ditches is to maximize the collection of non-contact run-off from the catchments upstream of the WRS, CWP, CTF, PWP, and NCWR and convey it around these facilities for downstream discharge (Map Sheet 6). The diversion ditches reduce the amount of run-off contributing to the mine facilities by diverting their respective upstream catchments. This reduces the capacity required in the facilities to meet storm water PMP and PMF storage requirements, and reduces overall consumptive water use. Diversion of non-contact water also reduces flow impacts downstream of the Project.

All sections of the diversion ditch system for the CTF and PWP are designed to carry the predicted peak flow generated during a PMF event (Figure 3.49). The diversion channels for the WRS, CWP, and NCWR are designed to carry predicted peak flow for a 1 in 200 year storm event. HydroCAD was used to model the contributing areas in order to estimate the peak instantaneous discharge associated with the storm event that will report to the ditches.

The ditches will be constructed with a side slope of 2H:1V. Excavated fill material will be used as construction fill for other Project facilities as needed or placed on reclamation material stockpiles. It is currently assumed that the channels will be predominantly cut in rock and will need little erosion protection. The 2:1 side slopes to the diversion ditches will be able to maintain long-term stability. A 2H:1V grade is slightly less than a typical angle of repose for soil. Based on the average surface soil depth on site the majority of the diversion channel slopes are going to be excavated into weathered bedrock, and therefore should not have any issues with long term stability. Portions of the diversion channel will be constructed from fill, however they are going to be constructed using proper fill placement, compaction, and armoring with rip-rap to ensure long term stability. Where erosion protection is required (e.g. sections of deep overburden or filled downslopes) engineered soil stabilization (i.e., concrete filled or vegetated geocell products) or riprap will be used to prevent erosion of the channel bed during high flows. The base width of the various ditch sections ranges from 6.5 to 8.2 feet (2.0 m to 2.5 m), while the ditch depth ranges from 4 to 8.2 feet (1.2 m to 2.5 m). Entire channel widths are as wide as 40 feet (12 m). The ditches were designed to maintain a 0.3 m freeboard during the storm event. Steel pipe bridges will be constructed to allow tailings delivery and reclaim water pipelines to pass over the diversion channel.

An energy dissipater (Figure 3.50) is included to reduce the run-off velocities and energy at the outlet of the diversion ditch system. A spreading transition still basin will serve as an energy dissipater, and includes the following components:

- Spreading transition,
- Chute blocks at the entrance to the stilling basin,
- Basin blocks, and
- End sills.

Surface water diversion channel construction details are illustrated on Drawings C5001 to C5004 in Appendix K (Knight Piésold, 2017a) and Figure 3.49 and Figure 3.50.

Run-off drainage control on and around the mill and portal pads will include swales to route contact water to structures that remove it from the pads (Map Sheet 6). These structures would include rock lined drainage channels underlain with HDPE liner to prevent head cutting from the bottom fill line to the surface elevation of the pad (Map Sheet 6). Run-on drainage ditches would be cut / fill ditches much like Knight Piésold's diversion channels as shown in Figure 3.49, but smaller. Drainage control is sized for the 10-year / 24-hour event peak flow. Culverts will have inlet / outlet protection to prevent scour.

3.7.5.3 Storm Water Control and Management

Prior to any surface disturbing activities, Tintina is required to apply for a permit for authorization for storm water discharges associated with construction activities from the DEQ's Water Protection Bureau. The applicant must prepare a Storm Water Pollution Prevention Plan (SWPPP) which is designed to protect State waters from pollutants, which during construction are principally sediment. There are three major components to the Storm Water Pollution Prevention Plan:

- Assessing the characteristics of the site such as nearby surface waters, topography, and storm water run-off patterns;
- Identifying potential sources of pollutants such as sediment from disturbed areas, and stored wastes or fuels; and

- o Identifying BMPs which will be used to minimize or eliminate the potential for pollutants to reach surface waters through storm water run-off.

A snow plowing and removal plan will be included in the final storm-water pollution plan.

BMPs at construction sites typically develop various erosion and sediment control measures and implement a plan of regular maintenance and inspections to ensure that they operate correctly over time.

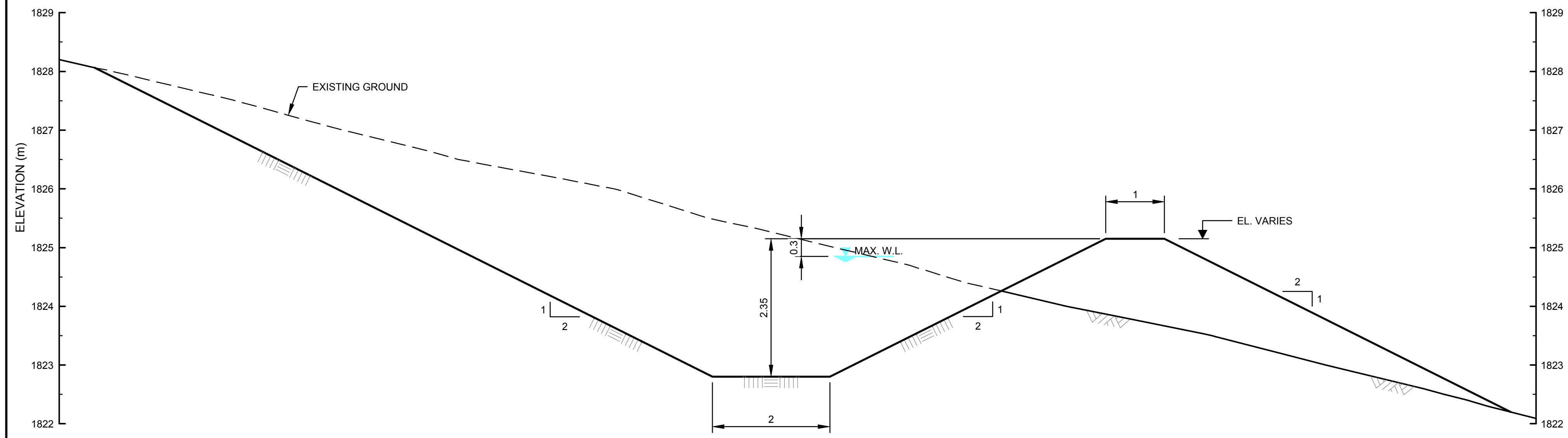
After Tintina has completed construction activities at the site and prior to going into production, it will be required to apply for a second permit for authorization for storm water discharges associated with industrial activity from the DEQ's Water Protection Bureau.

BMPs for construction activities are described below in Section 3.7.6. During Tintina's preparation of a SWPPP, a water control and a storm water management plan will be prepared and implemented at the site to prevent co-mingling of unaffected water with water affected by construction activities and later by mining and milling. This plan will also develop controls for run-off from the site and adjacent areas (Map Sheet 6). Storm water management is typically implemented by diverting storm water run-off around disturbed areas, or by collecting run-off for sediment removal prior to discharge. The majority of storm water run-off at the site will be controlled by diversion around disturbed soils. Diversion structures will consist of drainage ditches or swales, spreaders, sediment traps, rock berms, straw wattles, and slash windrows. Drainage structures will be sized to safely convey the 24-hour, 100-year storm event.

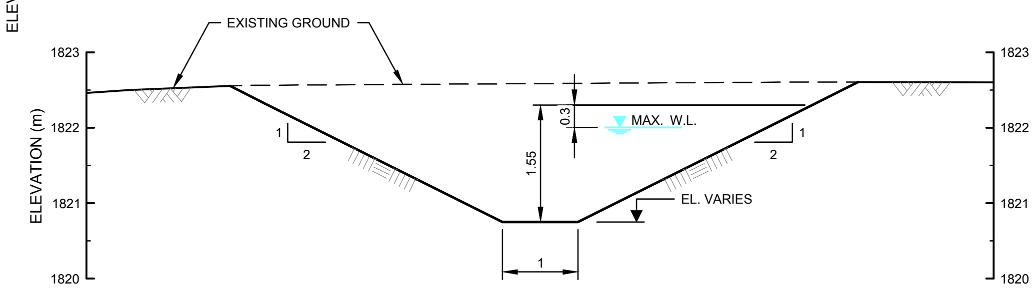
All storm water controls will be constructed prior to, or in conjunction with, soil removal and stockpiling. Storm water controls are passive systems that require regular inspection for eroded areas and build-up of sediment in the slash windrow or sediment traps. With proper maintenance and inspection, each storm water control will remain in place until completion of the construction phase, and where required throughout the operational stages of the Project. Many BMPs will remain in place through mine closure and until subsequent stabilization and revegetation of disturbed areas is complete.

A surface water diversion ditch around the upper sides and side slopes of disturbed areas will be used to divert clean storm water from the disturbed facility areas within the site. Energy dissipation features or spreaders (Figure 3.50) will be constructed where the surface water diversion outlets meet undisturbed ground. The spreaders will convert the flow concentrated in the diversion ditch to sheet flow and discharge it over an erosion blanketed lip to an undisturbed area at non-erosive velocities. The spreaders will be located such that the discharge water will not be collected by the down-slope berms or concentrated in down-slope channels. If site conditions determine that the spreaders are not appropriate for the site, down-slope drainage channels and energy dissipating outlets or infiltration basins will be specified. Sediment carried from diversions around facilities by storm water run-off will be periodically removed from the ditches and sump(s) collection drains or infiltration basins and stored for use in reclamation on the sub-soil or reclamation materials stockpiles as appropriate.

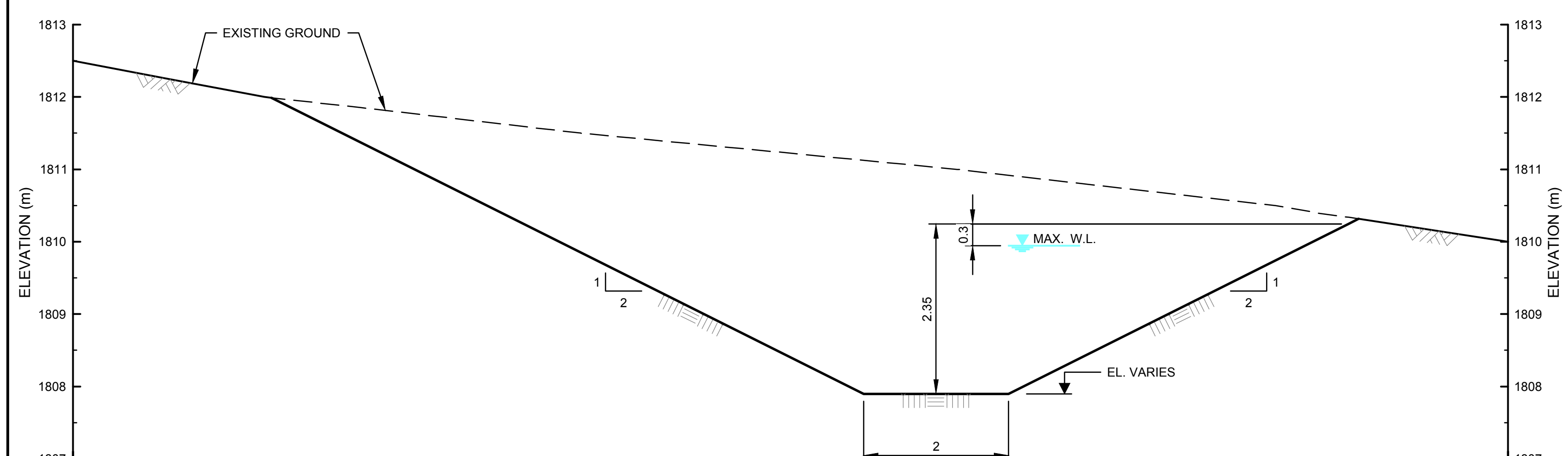
Water captured in the toe ditches surrounding the waste rock pads and seepage collection ponds will be diverted to the seepage ponds. Figure 1.3 and Sheet 6 shows the general location of surface water and run-off diversion ditches developed for the Project's construction areas, mine site and its supporting facilities. Typical cross-sections of diversion ditches are illustrated on Figure 3.49 from the CTF and PWP areas. A SWPPP will be developed for the Project site illustrating the final layout with respect to storm-water management. The SWPPP will be updated as needed to accurately reflect actual site BMPs conditions.



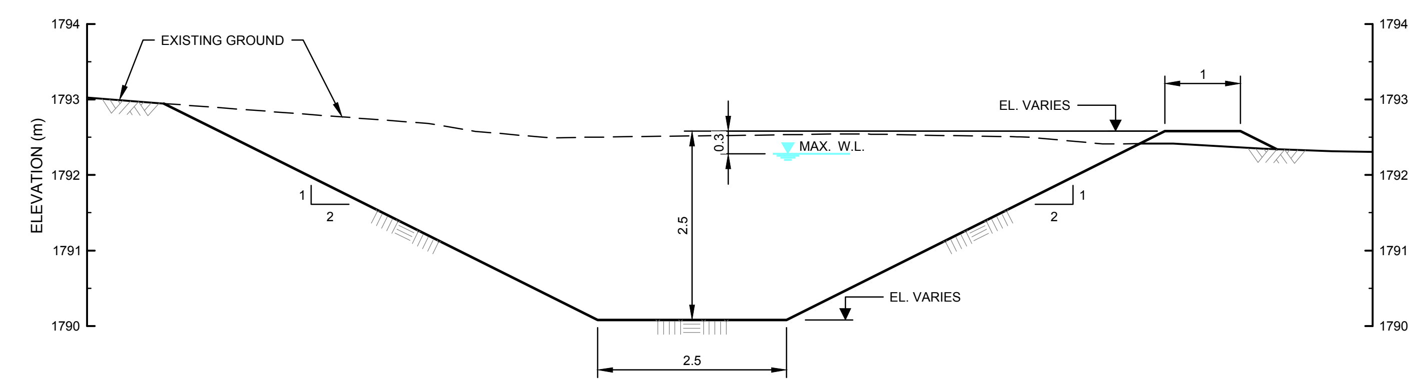
SECTION TYPE 1
(1 / C5001)
CTF DIVERSION CHANNEL (CUT AND FILL)
SCALE A



SECTION TYPE 3
(3 / C5002)
PWP DIVERSION CHANNEL
SCALE A



SECTION TYPE 2
(2 / C5001)
CTF DIVERSION CHANNEL (ALL CUT)
SCALE A



SECTION TYPE 4
(4 / C5002)
CTF AND PWP DIVERSION CHANNEL
SCALE A

SCALE A 1 0.5 0 1 2 3 4 5 m

TINTINA RESOURCES

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. MAXIMUM WATER LEVEL (MAX. W.L.) BASED ON ANTICIPATED WATER DEPTH DURING THE PROBABLE MAXIMUM FLOOD (PMF).

BLACK BUTTE COPPER PROJECT M

MEAGHER COUNTY, MT

FIGURE 3.49
TYPICAL CROSS-SECTIONS OF DIVERSION CHANNELS FOR PROCESS WATER POND AND CEMENTED TAILINGS FACILITY

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD		

REVISIONS

REVISED DATE: OCTOBER 15, 2015

REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C5003

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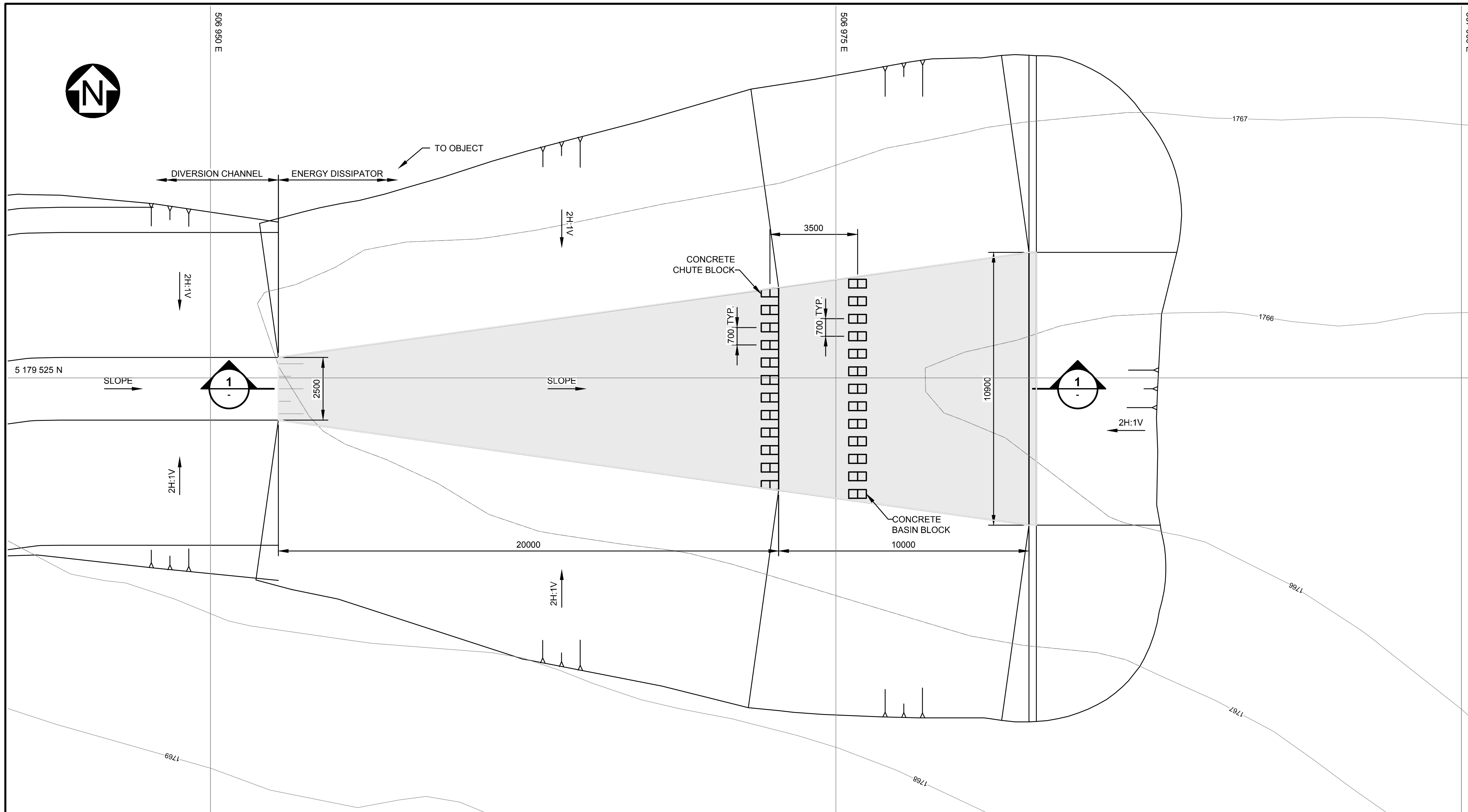
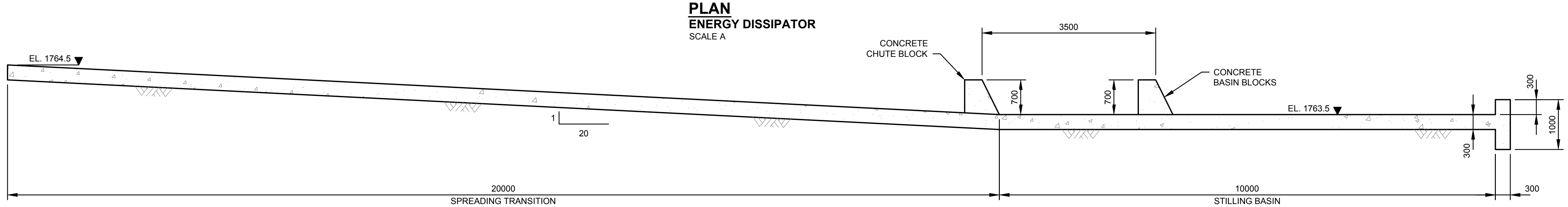


PLAN
ENERGY DISSIPATOR
SCALE A



1 SECTION
SCALE B

LEGEND:
CONCRETE

NOTES:
1. DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE B: 1000 500 0 1000 2000 3000 4000 5000 mm
SCALE A: 2 1 0 2 4 6 8 10 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.50
TYPICAL DIVERSION CHANNEL ENERGY DISSIPATION PLAN MAP

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	NSD		

REVISIONS

REVISED DATE: OCTOBER 15, 2015
REVISION: 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3
SOURCE FIGURE NUMBERS: C5004

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3.7.6 Erosion Control Methods and Best Management Practices (BMPs)

During the construction, operations, and closure phases, a number of erosion control techniques, methods or features will be used. The bulleted list that follows identifies and defines them.

- **Vegetation Management and Revegetation-** Natural vegetation is one of the best and most cost effective methods of reducing the potential for erosion and sedimentation by keeping soil secure and providing ground cover to reduce raindrop velocities.
- **Mulching-** This is the application of a uniform protective layer of straw, wood fiber, wood chips, or other acceptable material on the soil surface of a seeded area to allow for the immediate protection of the seed bed during revegetation. Mulching can be used in areas that require temporary or permanent covers.
- **Rolled Erosion Control Products-** Tintina will use products that consist of primarily organic materials composed of two layers of coarse mesh with a central layer of permeable fibres. These are used to cover un-vegetated cut or fill slopes when vegetation or mulching alone may be unsuccessful.
- **Slope Roughening-** Cut and fill slopes can be roughened with tracked machinery or other means to reduce run-off velocities, increase water infiltration rates, and helps facilitate future revegetation. It is simple, inexpensive, and provides immediate short-term erosion control for bare soil where vegetative cover is not yet established.
- **Recontouring-** This method can reduce the effect of erosion by shortening the length of the accumulation and movement of water as well as decreasing the angle of the erosional slope. Recontouring is easily planned and constructed on site.
- **Silt Fencing-** This is a perimeter control type BMP used to intercept sheet flow run-off in conjunction with other BMPs. Typical silt fencing comprises a geotextile fabric partially buried in the ground (on the disturbed side of the fence) and anchored to posts driven into the ground. It promotes sediment control by filtering water that passes through the fabric and increases short term retention time, allowing suspended sediments to settle. Silt fences will be placed parallel to slope contours in order to maximize ponding efficiency.
- **Temporary Sediment Traps and Sediment Basins-** A sediment trap / basin is a temporary structure used to detain run-off from small drainage areas (generally < 2 hectares) to allow sediment to settle out. A sediment trap / basin can be created by excavating a basin, utilizing an existing depression, or constructing a small dam on a slight slope downward from the work area.
- **Filter Bags-** Filter bags are generally constructed from a sturdy non-woven geotextile capable of filtering particles larger than 150 microns. Filter bags are typically installed at the discharge end of pumped diversions, via fabric flange fittings, and remove fine grained materials before discharging to the environment.
- **Flocculants-** Flocculation systems are installed in sediment control ponds and use chemical or natural additives (e.g., corn starch, chitosan, guar gum, etc.) to accelerate the natural settling process as sediment-laden water flows through the pond. These systems reduce the required pond retention time.
- **Collection Ditches-** A collection ditch intercepts contact water run-off from disturbed areas and diverts it to a stabilized area where it can be effectively managed. Coarse non-acid generating

rock and equipment to build ditches and dams will be easily obtained on site, and require little further maintenance, making them effective improvements.

- **Diversion Ditches-** Diversion ditches are constructed up-gradient of disturbed areas to intercept clean surface water run-off and discharge it through a stabilized outlet designed to handle the expected run-off velocities and flows from the ditch without scouring.
- **Culverts-** Culverts are used in tandem with collection or diversion ditches to pass water flow beneath disturbed areas, typically roadways, to prevent the erosion of these constructed structures.
- **Water Bars-** Water bars serve to reduce sheet flow and surface erosion of areas of exposed soil and/or roads by diverting run-off towards a stable vegetated area or collection ditch. Water bars may require regular maintenance when subjected to frequent traffic crossings.

3.7.6.1 Specific Construction BMPs

Erosion control BMPs will be implemented prior to and during construction at the Project. Erosion control BMPs reduce erosion by stabilizing exposed soil, or by reducing surface run-off flow velocities. There are generally two types of erosion control BMPs:

- Source control BMPs for protection of exposed surfaces, and
- Conveyance BMPs for control of run-off.

Examples of BMP's that will be implemented are included in "Water Quality BMPs for Montana Forests" (MSU Extension Service, 2001). The BMPs listed below will likely be used to minimize erosion, sedimentation, and to control surface and storm water run-off at the Project site.

1) Staged development to allow "green-up" or re-establishment of vegetation and minimize erosive areas.
2) Suspension of construction dirt work during periods of heaviest precipitation and run-off to minimize soil disturbance and erosion.
3) Restrict vehicular and equipment access to construction areas, or provide working surfaces / pads.
4) Minimize clearing of rights-of-way and stripping of building sites.
5) Physically mark clearing boundaries on the construction site.
6) Hydroseed or revegetate cut and fill slopes and disturbed natural slopes as early as possible.
7) Use mulches and other organic stabilizers to minimize erosion until vegetation is established on sensitive areas or soils.
8) Plan seeding and planting to allow establishment before end of growing season.
9) Isolate cleared areas and building sites with diversion channels, ditches, and swales to redirect run-off.
10) Retain natural drainage patterns wherever possible.
11) Install run-off diversions that are primarily located at surface facilities and separate contact storm water and non-contact storm water.

12) Line unavoidably steep interceptor or conveyance ditches with filter fabric, rock, polyethylene lining, or armoring to prevent channel erosion.

13) Construct stable, non-erodible ditches, and inlet and outlet structures.

14) Sediment / silt fencing or other similar methods such as straw bales, sediment traps, and berms will be used to control sediment from disturbed areas.

15) Provide bed load clean-outs at culverts and ditches.

16) Construct, operate, and maintain sediment control ponds.

17) Develop and follow a maintenance and inspection schedule as part of the development plan. Regular inspections will occur after major precipitation or other run-off events, and also on a routinely scheduled basis to ensure that BMPs are functioning properly

18) Stockpile the required erosion / sediment control materials including: filter cloth, rock, seeding, drain rock, culverts, staking, matting, polyethylene, used tires, etc.

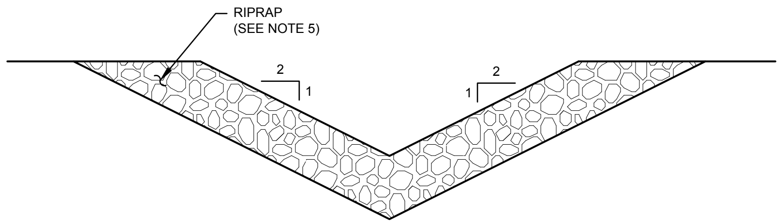
19) Plow snow off of the Project access roads as required. Good drainage will be established along all access roads and travel surfaces before each winter. Particular attention will be paid during the spring snowmelt / run-off season to ensure that water is controlled along access roads and in disturbed area of the site. This will minimize erosion and the transport of sediment.

Tintina commits to marking by flagging and / or staking all disturbance boundary limits for construction of surface facilities to prevent inadvertent disturbances of land surfaces that should not be impacted during project implementation. In addition, silt fencing could be installed around most disturbance area boundaries during the earliest phase of construction to eliminate sediment transport off of disturbed sites and would serve as an additional marker of disturbance area boundaries.

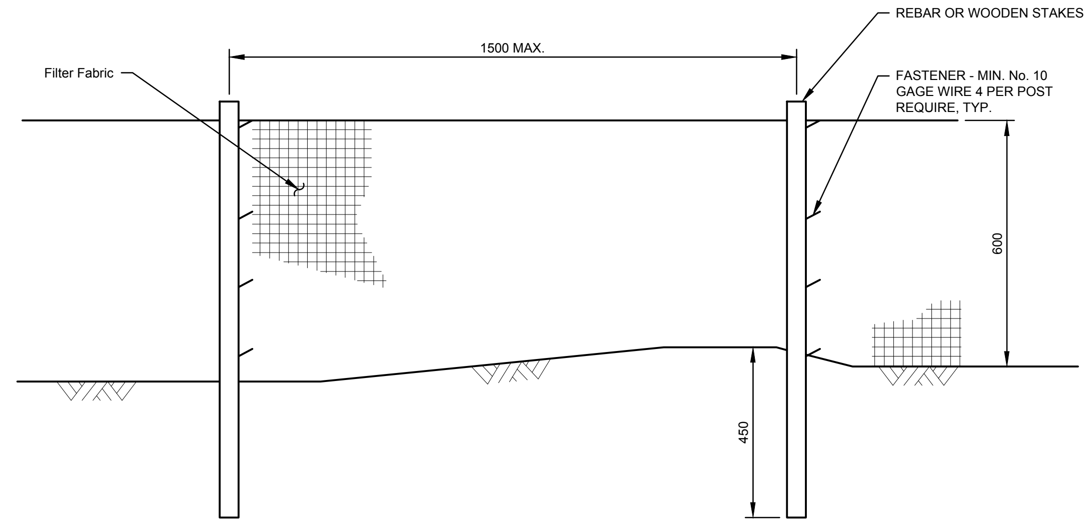
Topsoil and subsoil will be removed from the sites and stockpiled. Small shrubs and herbaceous vegetation will be mowed or chip and salvaged with topsoil. Non- commercial trees, slash tall shrubs and small stumps will be chipped and salvaged with topsoil. Larger stumps will be stored at the toe of soil and reclamation stockpiles to aid in erosion control and ultimately for distribution as part of reclamation.

Iinterceptor or major diversion ditches will be installed uphill from the WRS, portal pad, mill facility, PWP, and CTF (Figure 1.3 and Map Sheet 6) to intercept non-contact water drainage, and convey it to existing drainage outlets. Figure 3.49 shows cross-sections of typical diversion structures around major facilities such as the PWP and CTF that are designed to carry the PMF event as defined in Section 3.5.3.

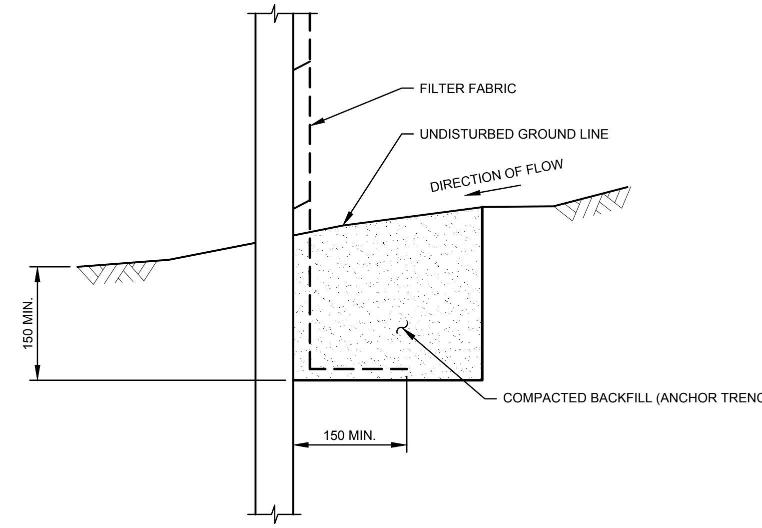
Figure 3.51 and Figure 3.52 illustrate a variety of typical erosional control BMPs that will be implemented at the Project site.



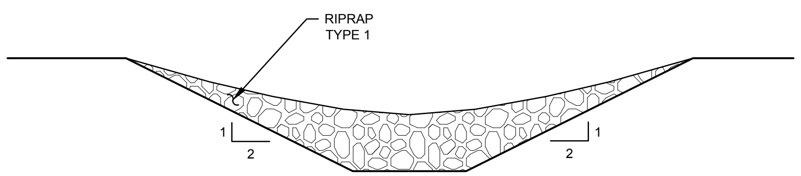
CD DD **COLLECTION AND DIVERSION DITCH**
NTS



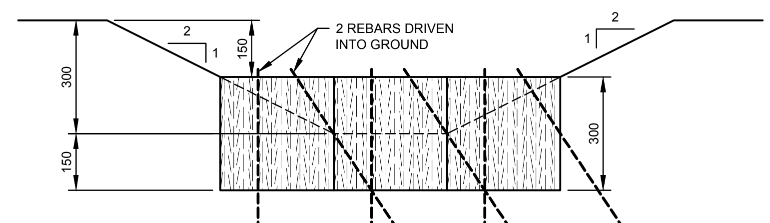
SF **SILT FENCING PROFILE**
SCALE A



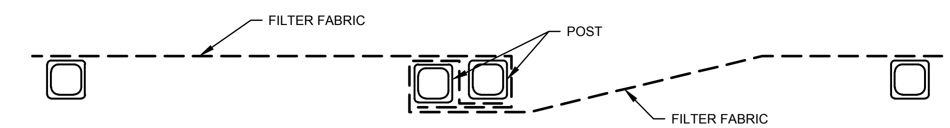
SF **SILT FENCING CROSSING SECTION**
SCALE B



RD **ROCK DAM CROSSING SECTION**
SCALE A



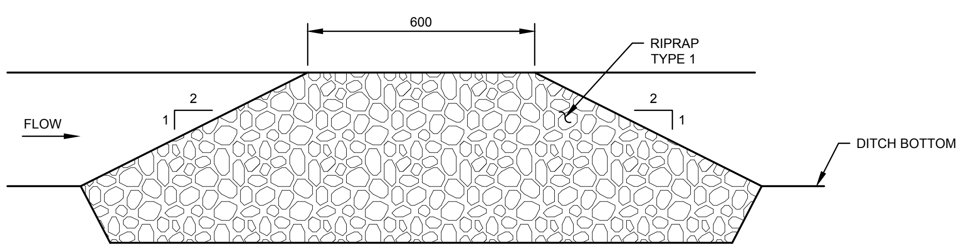
ST **STRAW BALE CROSSING SECTION**
SCALE A



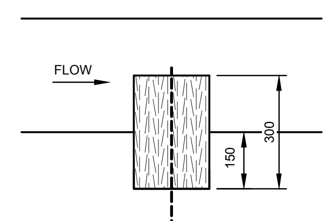
SF **ATTACHING TWO SILT FENCES**
SCALE B

NOTES:

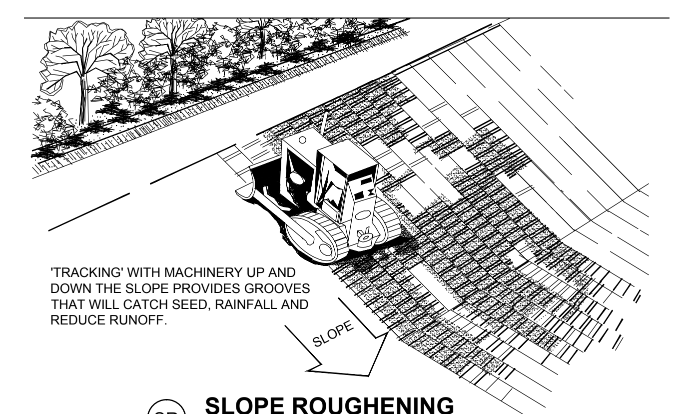
1. ALL SEDIMENT AND EROSION CONTROL MEASURES MUST BE CONSTRUCTED, STABILIZED AND FUNCTIONAL BEFORE SITE DISTURBANCE BEGINS.
2. SITE GRADING SURFACE WATER RUNOFF TO BE DIRECTED TO THE SEDIMENT TRAPS AT ALL TIMES DURING SITE DISTURBANCE ACTIVITIES UNTIL FINAL STABILIZATION IS ACHIEVED.
3. THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES SHALL BE MADE IMMEDIATELY.
4. AN AREA IS CONSIDERED TO HAVE ACHIEVED FINAL STABILIZATION WHEN IT HAS A MINIMUM UNIFORM 70% VEGETATIVE COVER OR OTHER PERMANENT NON-VEGETATIVE COVER TO RESIST ACCELERATED SURFACE EROSION.
5. ONLY REQUIRED WHEN ERODIBLE SOILS HAVE BEEN EXPOSED.



RD **ROCK DAM PROFILE**
SCALE A



ST **STRAW BALE PROFILE**
SCALE A



SR **SLOPE ROUGHENING**
NTS

SCALE B 100 50 0 100 200 300 400 500 m
SCALE A 200 100 0 200 400 600 800 1000 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.51
TYPICAL BMPS
SHEET 1 OF 2

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	PP		

REVISIONS

REVISED DATE: OCTOBER 15, 2015 — REVISION 0

DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C5005

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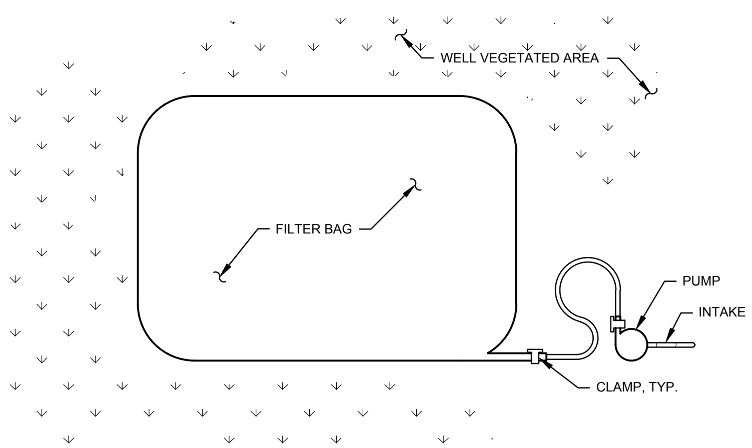
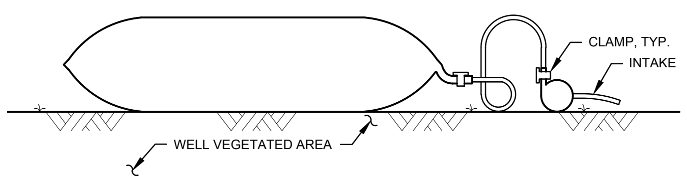
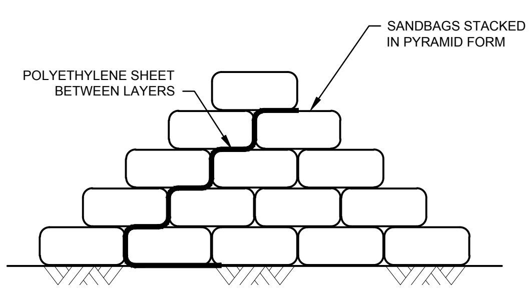


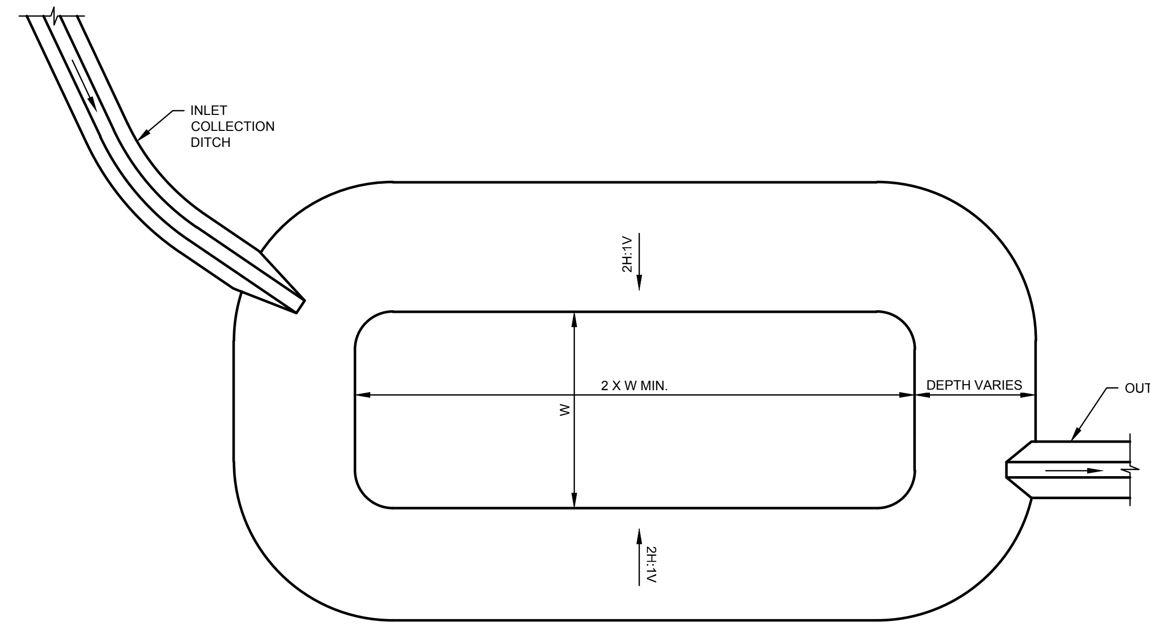
(FB) **FILTER BAG PLAN**
SCALE A



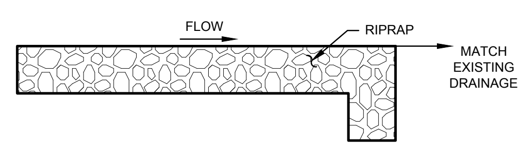
(FB) **FILTER BAG ELEVATION**
SCALE A



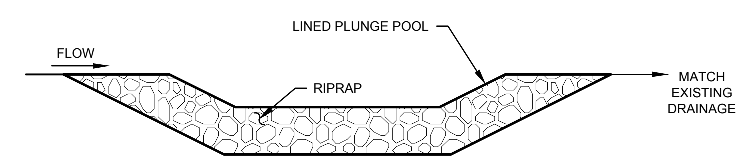
(DS) **TEMPORARY STREAM DIVERSION STRUCTURE**
NTS



(SB) **SEDIMENT BASIN PLAN**
SCALE B



TYPE 1
SMALL DRAINAGES



TYPE 2
LARGER DRAINAGES

(ED) **ROCK ENERGY DISSIPATOR**
NTS

SEDIMENT BASIN GENERAL NOTES:

1. SEDIMENT BASINS DETAIN STORMWATER RUNOFF FROM A DISTURBED AREA FOR AN EXTENDED TIME, ALLOWING SEDIMENT TO SETTLE.
2. SEDIMENT BASINS MAY REMAIN IN PLACE DURING OPERATIONS, AS INDICATED IN THE PLANS OR AS DIRECTED BY THE ENGINEER, OR SITE EMT.
3. SEDIMENT BASINS MAY HAVE PUMP OR OUTLET CHANNEL TO COLLECTION DITCH.
4. RELEASES FROM SEDIMENT BASINS REQUIRE FURTHER WATER MANAGEMENT/BMPS (EX. PUMPBACK, DISCHARGE TO COLLECTION DITCHES, FILTER BAGS, AND VEGETATED BUFFER STRIPS.)
5. SEDIMENT BASINS TO BE FIELD FIT TO OPTIMIZE CUT AND FILL QUANTITIES TO ACHIEVE MINIMUM SPECIFIED DIMENSIONS.

SEDIMENT FILTER BAG GENERAL NOTES:

1. NON-WOVEN GEOTEXTILE FILTER BAG WHICH RETAINS ALL SEDIMENT PARTICLES LARGER THAN 150 MICRONS.
2. PLACE FILTER BAGS ON STABLE OR WELL VEGETATED AREAS WHICH ARE FLATTER THAN 5% AND WILL NOT ERODE WHEN SUBJECTED TO BAG DISCHARGE
3. CLAMP PUMP DISCHARGE HOSE SECURELY INTO FILTER BAGS.
4. THE PUMPING RATE SHALL BE NO GREATER THAN 750 gpm OR ½ THE MAXIMUM SPECIFIED BY THE MANUFACTURER, WHICHEVER IS LESS. PUMP INTAKES SHOULD BE FLOATING AND SCREENED.
5. WHEN SEDIMENTS FILL ½ THE VOLUME OF A FILTER BAG, IMMEDIATELY REMOVE THAT BAG FROM SERVICE. PROPERLY DISPOSE OF SPENT BAGS WITH THEIR SEDIMENTS. SPARE BAGS SHALL BE KEPT AVAILABLE FOR REPLACEMENT OF THOSE THAT HAVE FILLED.
6. THE DISCHARGE FROM THE FILTER BAG SHOULD NOT PASS THROUGH A DISTURBED AREA OR CAUSE AN EROSION PROBLEM DOWN SLOPE.
7. VEGETATED BUFFER STRIP WILL BE LEFT DOWNSTREAM OF THE FILTER BAG.
8. FILTER BAGS SHALL BE INSPECTED DAILY. IF ANY PROBLEM IS DETECTED PUMPING SHALL CEASE AND NOT RESUME UNTIL THE PROBLEM IS CORRECTED.

SCALE B: 5 2.5 0 5 10 15 20 25 m

SCALE A: 2 1 0 2 4 6 8 10 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MT

FIGURE 3.52
TYPICAL BMPS
SHEET 2 OF 2

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15OCT'15	ISSUED FOR MOP APPLICATION	MH	PP		

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DRAWING BY KNIGHT PIESOLD: VA101-460/3

SOURCE FIGURE NUMBERS: C5006

3.8 Other Operational Management Components

3.8.1 Employees, Contractors and Housing

3.8.1.1 Total Project Employment with Subcontractors

During operations, work will follow a schedule of two 12-hour shifts per day, seven days per week, and 365 days per year. The personnel required to support and conduct the complete operation includes a total of 243 hourly employees and salaried Tintina staff, and 24 contract employees from a mining subcontractor. Out of the total Tintina work force of 243 normally only 104 people will be on-site during day shifts, 41 during night shifts, and the remaining 98 on days off.

During the initial 3 years of surface support and mine construction the total number of subcontractor employees will range between 59 and 144. Due to shift work and days off, the number of actual subcontractors on-site will average approximately 74 on day shift. Construction will follow a 7 day a week, 12-hour per day schedule with a skeleton workforce on nightshift.

3.8.1.2 Positive Effects of the Project on Local Communities

Positive effects of the proposed Project development include:

- Reduction of unemployment in the region;
- Job opportunities for younger people, and encouragement to retain younger people in the adjacent communities;
- Increased tax base for local, State, and Federal government;
- Economic stimulus for existing local businesses;
- Long-term, meaningful employment for residents in mining operations and related positions (i.e., environmental monitoring, service, and supply sectors);
- Economic development and contract opportunities for existing and new businesses; and
- Community infrastructure improvements.

3.8.1.3 Accommodations for Employees and Subcontractors

Tintina will require 243 employees for the operation over the 15 years and will focus on hiring from local communities within 110 miles (177 km) of the operation. Tintina currently estimates it will have the opportunity to hire at least 30% of their employees within this distance of the operation. The remainder will come from further away and will relocate to the area or commute to the mine. The mine will offer a 7 day on, 7 day off schedule which will allow some employees the opportunity to commute. Table 3-43 lists the names of towns, their, populations, and the distance from White Sulphur Springs. In order to enhance employment opportunities, Tintina is committed to providing training positions for various jobs throughout the operations.

Tintina has inventoried as many as 35 vacant apartments and houses for sale in the White Sulphur Springs community (August 2013). Table 3-44 also lists available motel room and recreational vehicle spots within a distance of about 75 miles (121 km) of the Project. Note that this table does not include many motel room and recreational vehicle (RV) sites available in the communities of Livingston, Bozeman, Helena, and Great Falls.

Tintina does not intend to provide housing for its permanent employees or construction camp lodging for the temporary construction work force. Tintina will work with the local community to help develop suitable housing options for all of its permanent / subcontractor employees needing assistance.

Table 3-43. Towns and Their Populations within 111 Miles of White Sulphur Springs

Town	Distance from White Sulphur Springs (miles)	Population*
White Sulphur Springs	0	943
Neihart	40	51
Great Falls	111	59,152
Helena	76	29,943
Townsend	42	1,942
Three Forks	77	1,903
Whitehall	99	1,079
Belgrade	87	7,798
Bozeman	80	41,660
Livingston	71	7,245
Harlowton	57	974
Belt	79	597
	Total	**153,269**

*Data from 2013 US census.

Table 3-44. Temporary Construction Housing Availability

Units Available		Motel Facility	Location	Distance From Project Site (miles)
32		All Seasons Motel	White Sulphur Springs	18
32		Spa Motel	White Sulphur Springs	18
12		Tenderfoot	White Sulphur Springs	18
8		Gordons Highland	White Sulphur Springs	18
36		Mustang Motel	Townsend	61
15		Bob’s Bar / Motel	Neihart	22
19		Countryside	Harlowton	74
18		Corral Motel	Harlowton	74
99 total rooms within 50 miles; 172 total rooms within 74 miles*				
Hook-ups	**Condition**	**Recreational Vehicle Facility**	**Location**	
16	Frost Free	Conestoga	White Sulphur Springs	18
31	Warm Weather	Conestoga	White Sulphur Springs	18
13	Frost Free	Springs	White Sulphur Springs	18
56	Few Frost Free	Lake KOA	Townsend	68
6	Frost Free	Tahoe Acres	Livingston	61
20	Few Frost Free	Chief Joseph Park	Harlowton	74
60 RV spaces available within 18 miles; 142 RV spaces within 74 miles				

*Does not include motel rooms nor all RV sites available in Livingston, MT (71 miles)

Numerous other motel and RV sites are also available in Livingston, MT (71 miles), Bozeman, MT (80 miles), and Great Falls, MT (110 miles).

3.8.2 Projected Construction and Operational Traffic

Projected average daily construction (over a 3 year period) and operational (over a 15 year period) traffic numbers are 62.6 and 100.6 per day, respectively (Table 3-45). Highway transportation study numbers indicate that some 850 vehicles per day travel US 89 and US 12 (both south and east of White Sulphur Springs), and as many as 1,480 vehicles per day pass through White Sulphur Springs proper (Table 2-37, Section 2.12.2).

Table 3-45. Project Traffic Estimates for Construction (a.) and Operations (b.)

(a.) Traffic Estimates - Construction Phase	
Materials Incoming	**Average Trucks per Day**
Construction Material	3.6
Diesel / Propane	0.5
Equipment / Mining Supplies	1
Misc.; WTP, Sewage, etc.	1
Total	**6.1**
Worker Transportation	**Daily Average**
Bus	2
Personal Cars	33
Suppliers / Visitors / Management	20
Total	**55**
Materials Outgoing	Daily Average
Wastes (trash, recycle, oil wastes, sewage)	1.5
Total	**1.5**
Grand Total Daily Construction	**62.6**

(b.) Traffic Estimates - Operations Phase	
Materials Incoming	**Average Trucks per Day**
Mill Materials, Cement, Binder	6.3
Fuel, Propane	0.3
Site & Mining Supplies	1
Misc., WTP, Sewage	1
Concentrate	18
Total	**26.6**
Worker Transportation	**Daily Average**
Cars	70
Misc., Suppliers	3
Total	**73**
Materials Outgoing	Daily Average
Wastes (trash, recycle, oil wastes, sewage)	1
Total	**1**
Grand Total Daily Operations	**100.6**

3.8.3 Waters of the US (WOTUS)

Baseline wetland delineation and functional assessment (Figure 2.10) mapping and reports were completed during 2014 and 2015 by Westech Environmental Services, Inc. (WESTECH). Summary results are presented in Section 2.3.6 and detailed technical reports in Appendices C-1 and C-2 of this report. Based on WESTECH's delineation, Tintina initiated a formal request for jurisdictional determinations from the U.S. Army Corps of Engineers (USACE) to identify Waters of the United States (WOTUS). Field investigations over the course of two days (July 27 and August 18, 2015) included personnel from the USACE, US EPA, WESTECH, and Tintina. Tintina received an Approved Jurisdictional Determination Form for the Lease Boundary area from USACE in May 2016 (attached as Appendix C-3). A total of 327.4 acres (132.5 ha) of wetlands and 16.3 miles (21.9 km) of stream were determined by USACE to be jurisdictional within the (7,768 acres (3,144 ha) Study / Lease Boundary Area. A total of 1.32 acres (0.53 ha) of wetlands and 588 lineal feet (179 m) of streams were deemed non-jurisdictional. Only 0.85 acres (0.34 ha) of wetlands and 696 lineal feet (212 m) of streams would be impacted by project construction. Tintina has consulted with the USACE to avoid temporary impacts to wetlands and streams and will continue to work with USACE to evaluate and develop mitigation strategies for the permanent impacts to jurisdictional wetlands and streams. Tintina will provide copies of the permit application and subsequent follow-up paperwork associated with the filing of an individual permit under Section 404 of the Clean Water Act (if required) to DEQ as they become available.

Proposed facility locations, as presented in this mine operating permit application (Figure 1.3), were overlaid with mapped wetlands and streams to identify areas of potential impacts to WOTUS by mine facilities construction. Tintina examined a variety of alternatives in order to identify the least environmentally damaging practicable alternative relative to wetland and stream impacts. Original mine facility designs might have directly impacted as much as 11.68 acres (4.70 ha) of wetlands. However, careful planning has led to a proposal that would directly impact 0.85 acres (0.34 ha) of wetlands (Table 3-46). These include: 0.12 acres (0.03 ha) along the main access road, 0.71 acres (0.30 ha) beneath the proposed CTF, and 0.01 acres in a culvert crossing on a service road near the CTF.

In addition to wetlands, the USACE also regulates the placement of dredged or fill materials into streams. Table 3-47 identifies stream segments that would be impacted by proposed facility construction. These include 696 linear feet (212 m) at two intermittent streams channels beneath the proposed CTF. Impacts to Brush Creek and Little Sheep Creek at the main access road crossing would be avoided by half-culverts that span the stream channel. Tintina proposes to install the buried potable water pipeline beneath Coon Creek and the UIG pipelines at two locations under Brush Creek (one just east of the foundation drain pond, the other between the central and eastern UIGs) using a directional utility installation drill to avoid impacts to these creek stream channels and associated wetlands.

Tintina's individual application for a Section 404 permit considers both direct and potential indirect impacts to wetlands and streams. The groundwater modeling results indicate there is potential for indirect impacts to wetlands from mine dewatering. However, it should be noted that the groundwater model does not include infiltration of mitigation water to offset the consumptive use of the project. This addition of water from the NCWR is projected to reduce the amount of drawdown in the alluvial system where indirect impacts have a higher potential to occur including those below the CTF. A wetland monitoring program and a mitigation plan have been developed to evaluate and mitigate indirect impacts to wetlands (Section 6.3.6). A 404 permit is required to be approved before construction of facilities.

Finally, the USACE has initiated government-to-government consultation with Native American tribes to determine if any Traditional Cultural Properties (TCP) are associated with the USACE permit area.

Numerous site visits among the USACE, tribal representatives, and Tintina were completed in March and April 2017. As of June 2017, tribal consultation by the USACE has essentially been completed. As a result of the consultation process and site visits, Tintina voluntarily moved the access road crossing location on Brush Creek and the nearby buried alluvial conveyance pipeline to avoid a cultural site near Brush Creek. This revised crossing location slightly decreased the amount of fill within wetlands at Brush Creek from 0.07 acres to 0.06 acres.

Table 3-46. Estimated Wetland Disturbance Acreage by Project facility

Site	Wetland Class	Project Facility	Disturbance Footprint (acres)
W-LST1-02	PSS6B	Access Road	0.03
W-LST1-03	PSS1B	Access Road	0.03
W-LS-05	PEM1E	Access Road	0.06
		Access Road Total	**0.12**
W-LST1-13	PEM1B	Cement Tailings Facility (CTF)	0.27
W-LST1-12	PEM1B	Cement Tailings Facility (CTF)	0.16
W-LST1-09	PEM1B	Cement Tailings Facility (CTF)	0.29
		Cement Tailings Facility (CTF) Total	**0.72**
W-LST1-16	PEM1A	Service Road	0.01
		Service Road Total	**0.01**
		Grand Total	**0.85**

Note 1: PEM wetland class is an herbaceous wetland, PSS wetland class is a shrub wetland.
Note 2: Wetlands at the NCWR (0.95 acres) would not be dredged or filled with soil, but flooded with surface irrigation water. Other impacts to wetlands, such as construction of a construction service road and spillway from the CTF are temporary.

Table 3-47. Estimated Linear Feet of Stream Disturbance by Project Facility

Stream Segment ID	Stream Class	Name	Project Facility	Disturbance Length (feet)
S-LST1-07	R4SB5		Cement Tailings Facility (CTF)	339
S-LST1-06	R4SB5		Cement Tailings Facility (CTF)	357
			Cement Tailings Facility (CTF) Total	**696**
			Grand Total	**696**

Note 1: R3 stream class is a perennial stream. R4 stream class is an intermittent stream.
Note 2: Temporary impacts to streams at the utility line or UIG crossings would be avoided by boring under the streams and associated wetlands.

3.8.4 Air Quality and Dust Control

Air quality monitoring plans are designed to ensure that fugitive dust generated from cut and fills, tailings surfaces, and other construction, storage, and disposal areas do not become a public nuisance, or detriment to flora or fauna. In addition, air quality rules require reasonable precautions to be taken to prevent emission of airborne particulate matter. Tintina will be required to obtain a Montana Air Quality Permit under the Montana Clean Air Act that specifies requirements for applicable State and Federal air quality standards. The permits issued will specify dust control, monitoring, and reporting requirements in detail. The air quality permit application requires that the applicant demonstrate compliance with all applicable State and Federal regulations and ambient air quality standards.

Tintina will apply for a new air quality permit pending discussion with the DEQ's Resource Management Bureau. Tintina anticipates submission of an Air Quality Permit application during the summer of 2016.

The Air Quality Permit needs to be approved prior to commencement of the construction and operational phases of the Project. Tintina will provide copies of the relevant paperwork to DEQ associated with the Air Quality Permit as these become available.

A list of equipment and specifications for all other stationary emissions sources will be compiled for submittal for review and final determination of permitting needs for the Air Quality permit once specific pieces of equipment have been selected for the mining operation. Detailed information will be provided for the two diesel generators (545 and 320 kW) proposed for the construction and pre-production mining phase, the air compressor used temporarily during initial underground construction (prior to line-power being connected), and the two main back-up 1MW generators used operationally as along with the other four small emergency generators used for hoists for emergency underground mine evacuation operationally, as well as propane heat sources for mine air during winter months. In addition, there will be about eight small trailer-mounted mobile generators use to support various construction projects during facility construction. The conditions of the Air Quality Permit will specify monitoring and reporting requirements in detail, and may specifically require air quality monitoring for particulates.

The ambient air monitoring station just west of the core shed (Figure 1.2) will remain operational to accurately characterize and update the period of record for the local meteorology, and to collect additional baseline data during mine permitting.,

The Administrative Rules of Montana (ARM) 17.24.115(h) requires that a reclamation plan ensure that precautions are taken to ensure that airborne fugitive dust generated from cuts, tailings, or disposal areas do not become a public nuisance or detriment to flora or fauna. Further, air quality rules under ARM 17.8.308 requires that reasonable precautions are taken to prevent emissions of airborne particulate matter.

Tintina will implement additional dust control measures by watering along access and CTF roads and / or the use of chemicals on high traffic areas near private ranch buildings. This will reduce the impacts of fugitive dust to ensure that it is not further exacerbated by wind. Temporary waste rock and life-of-mine copper-enriched rock storage areas will also be watered as necessary to minimize dust while loading or unloading material. Monitoring by site personnel during each shift will ensure watering is done to the level required to minimize the effects of dust at the site. Water for dust control measures is shown as a component of “Other Fresh Water Requirements” on the water balance figure (Figure 3.44) and is budgeted for about a 5 gpm flow rate (11,000 m^3 per year). Construction related disturbances that may generate dust and are not needed operationally will be recontoured, soil placed, and revegetated as quickly as possible following construction. This will include road cut-and-fill slopes, facility berms (WRS stockpile, and mill facility), embankments and berms of the CTF, CWP, PWP, WRS and NCWR, buried pipelines, water diversion ditches, and soil / subsoil stockpiles. Dust control from the CTF is not expected to be problematic because the material will be moist (20%) and will be stabilized with cement additions to provide a non-flowable mass. Dust control features for the interior and exterior environments for the mill site and primary crusher are detailed in the mill facility section (Section 3.3.2).

Other components of the dust control plan Include:

- Minimizing exposed soil areas to the extent possible by prompt revegetation of reclaimed areas,
- Establishing temporary vegetation on inactive soil and sub-soil stockpiles that will be in place for one year or more,
- Use of chemical dust control products to stabilize access and trucking road surfaces,
- Application of water to access roads and active haul roads during dry periods,

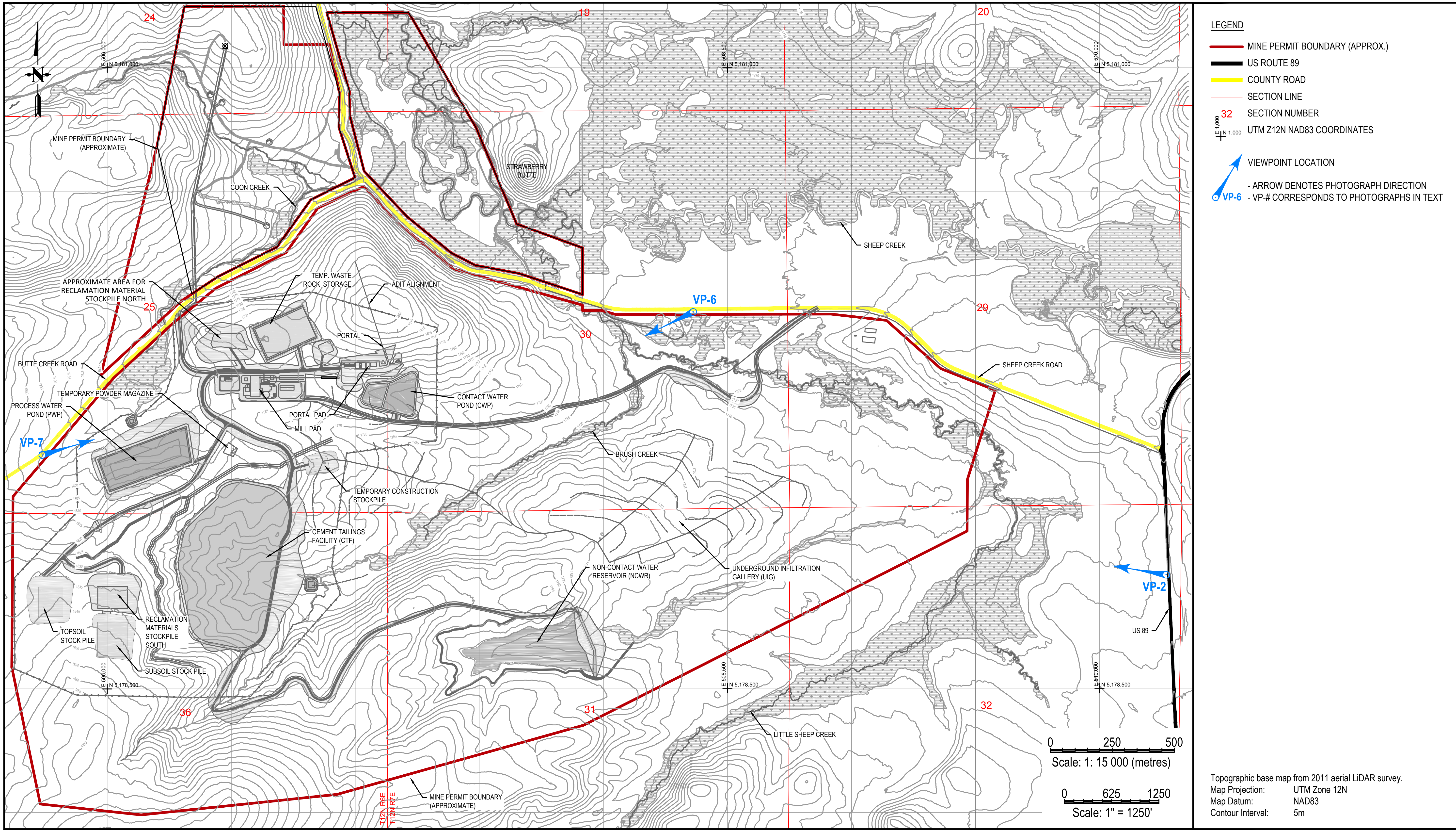
- Enclosure of screens, crushers, and copper-enriched rock and waste transfer points,
- Covering of conveyor belts, and
- Use of fabric filter dust collectors at crushing, screening, transfer, and loading points.

3.8.5 Visual Resource Assessment

Plan maps of the surrounding area and proposed facility locations were used to determine viewing angles of the Project in order to generate visual resource projections. This information was then used to determine where the public would have the least obscured view of proposed facilities. Section map worksheets were then prepared to determine sight lines from the viewpoints to the proposed facilities. Land and structure elevations and the relationship to the viewpoint elevations were used as measurements for the simulations. The projection of the sight lines revealed if and how much of the proposed facilities were visible from the viewpoints, and was used to aid in selection of the final viewpoints. A wireframe of the proposed facilities was constructed on the landscape using the information from the worksheets. Once the visibility of the subject was determined, color, shading, and texture were then added to the wireframe.

Three viewpoints (VP) from which the public was likely to view the Project site were selected for visual resources assessment of the Project site (Figure 3.53). Viewpoint 2 (Figure 3.54) is located on US 89 about 0.5 miles (800 m) south of the junction with the Sheep Creep county road looking west-northwest (see Figure 1.3). VP-6 (Figure 3.55) is located on the Sheep Creek county road about 0.5 miles (800 m) west of the core sheds looking southwest. VP-7 (Figure 3.56) is located on the Butte Creek Road about 300 feet (100 m) northeast and downhill of the divide between Sheep and Butte Creek looking northeast. In the figures, the existing condition is shown in the upper photograph and the year 3 view (shortly after construction) is simulated in the lower photograph.

As a means of providing a site-wide oblique aerial photographic view, Figure 3.57 illustrates a graphic representation of the Project site looking to the northwest.



Prepared by Tetra Tech Inc. (Revised July 2017)

FIGURE 3.53

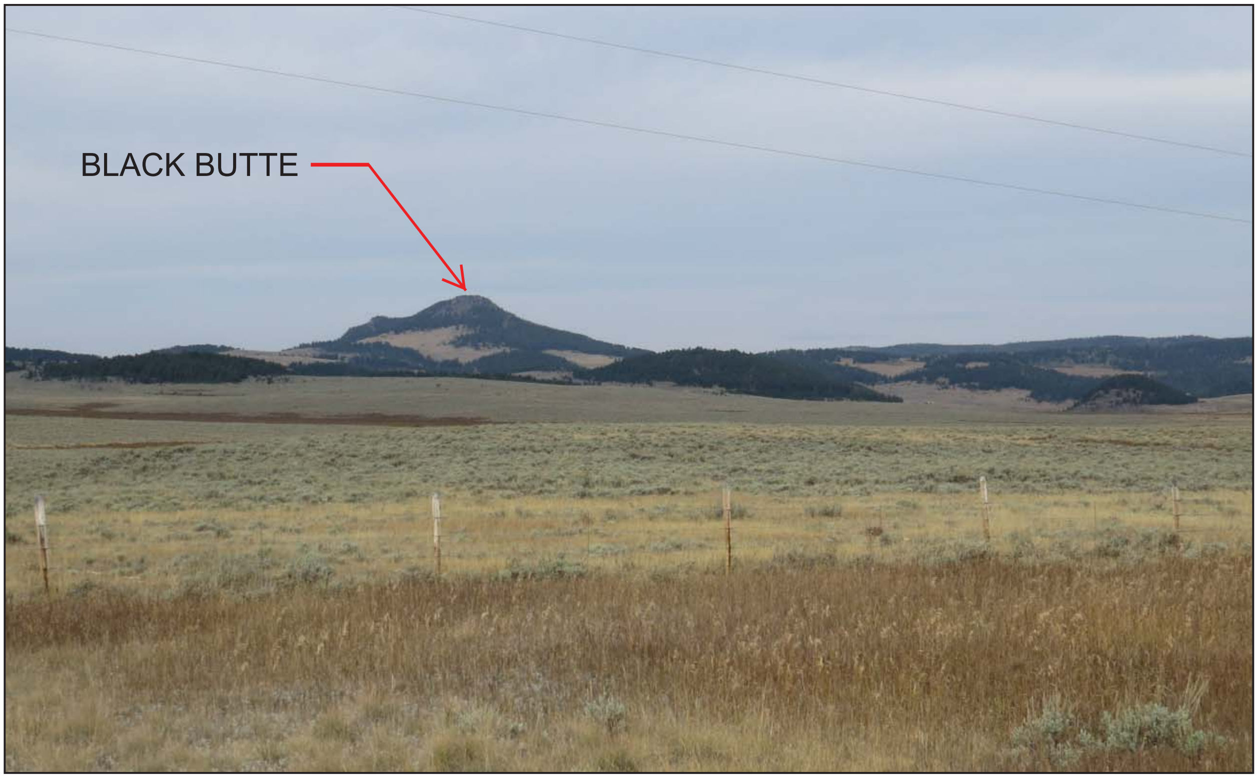
Plan Map Showing Viewpoint Locations

Black Butte Copper Project

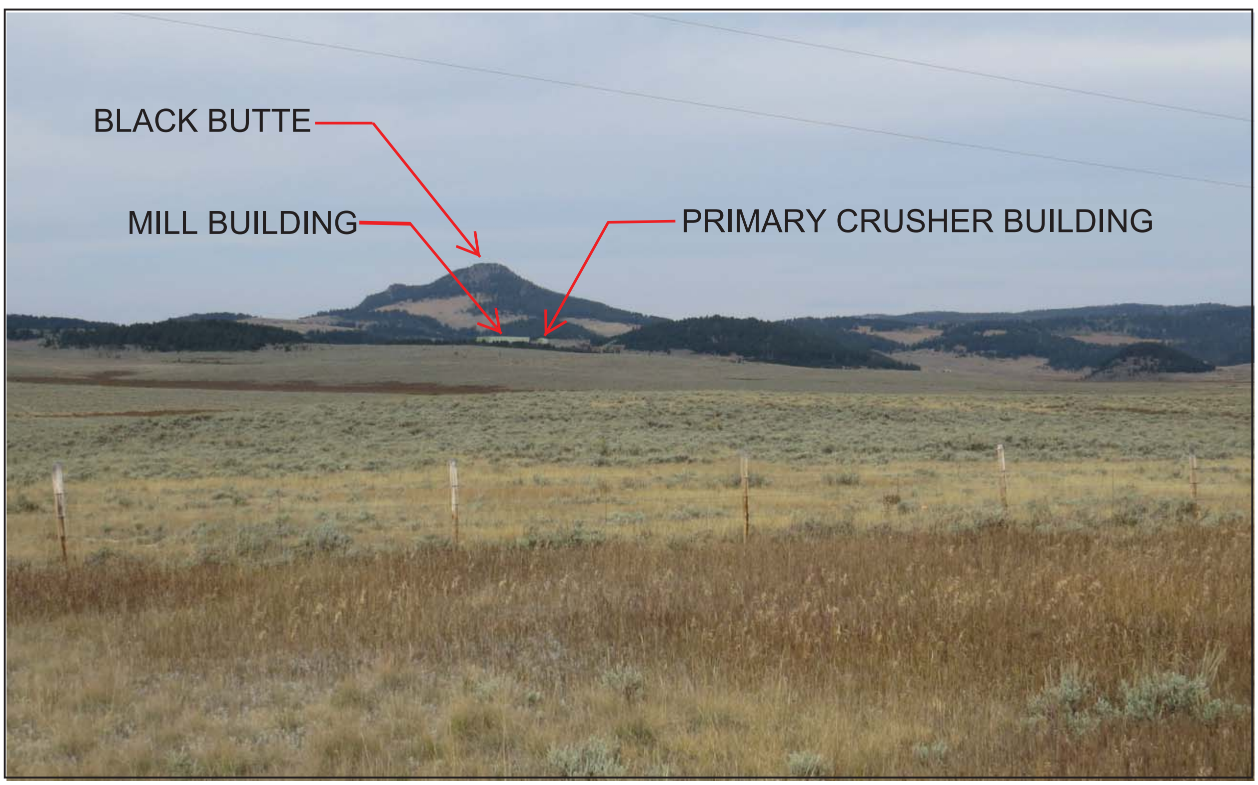
Mine Operating Permit Application

Meagher County, Montana

TINTINA RESOURCES



VP-2 LOOKING AT THE EXISTING LANDSCAPE



VP-2 LOOKING AT THE PROPOSED FACILITIES

Date: Revised July 25, 2016: Tetra Tech (2016)

TINTINA RESOURCES

Figure 3.54
Viewpoint VP-2 Looking West from US Highway 89
Black Butte Copper Project
Meagher County, Montana

VP-6 LOOKING AT THE EXISTING LANDSCAPE

VP-6 LOOKING AT THE PROPOSED FACILITIES

Date: July 7, 2017 (from Tetra Tech, 2017)

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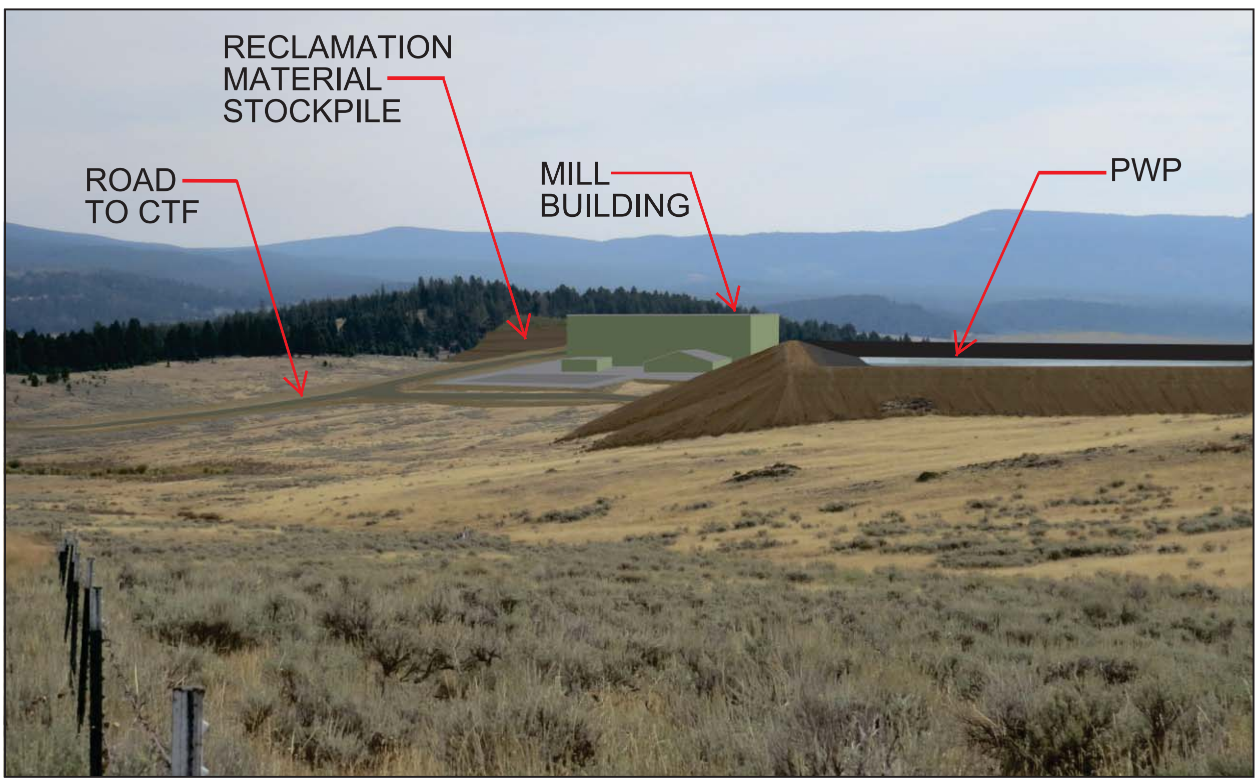
Figure 3.55
Viewpoint VP-6 Looking SW from Sheep Ck. County Road
Black Butte Copper Project
Meagher County, Montana

VP-7 LOOKING AT THE EXISTING LANDSCAPE

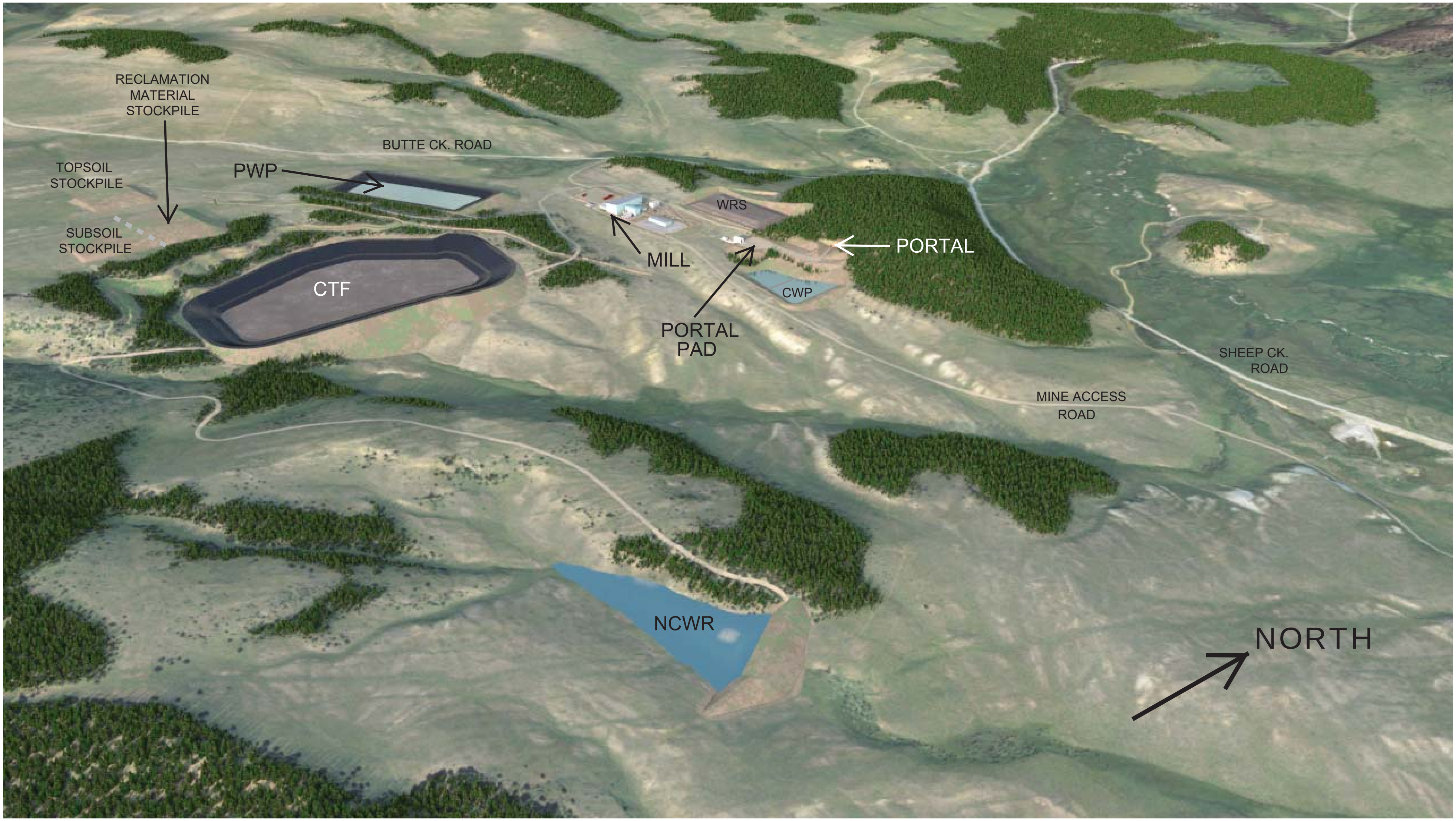


VP-7 LOOKING AT THE PROPOSED MINE FACILITIES

Date: Revised July 25, 2016; Tetra Tech (2016)

TINTINA RESOURCES

Figure 3.56
Viewpoint VP-7 Looking NE from Butte Ck. County Road
Black Butte Copper Project
Meagher County, Montana



SOURCE: Tetra Tech (2017)

NOTE: SEE FIGURE 1.3 FOR FACILITY SITE PLAN AND FACILITY ABBREVIATIONS

TINTINA RESOURCES

Figure 3.57
Oblique Aerial Simulation Looking Northwest
Black Butte Copper Project
Meagher County, Montana

3.8.6 Construction, Operational, Blasting and Traffic Noise Assessment

An Operational Noise Assessment was completed for the Project by Big Sky Acoustics. Methods of quantifying and describing noise levels are discussed in greater detail in Appendix J-1 (Big Sky Acoustics, 2017).

3.8.6.1 Measurement of Noise Levels

Noise levels are quantified using units of decibels (dB). Humans typically have reduced hearing sensitivity at low frequencies compared with their response at high frequencies. The "A- weighting" of noise levels, or A-weighted decibels (dBA), closely correlates to the frequency response of normal human hearing (250 to 4,000 hertz (Hz)). Noise levels typically decrease by approximately 6 dBA every time the distance between the source and receptor is doubled, depending on the characteristics of the source and the conditions over the path that the noise travels. The reduction in noise levels can be increased if a solid barrier or natural topography blocks the line of sight between the source and receptor.

For environmental noise studies, noise levels are typically described using A-weighted equivalent noise levels, L_{eq}, during a certain time period. The L_{eq} metric is useful because it uses a single number, similar to an average, to describe the constantly fluctuating instantaneous noise levels at a receptor location during a period of time, and accounts for all of the noises and quiet periods that occur during that time period. The L_{max} metric denotes the maximum instantaneous sound level recorded during a measurement period.

The ambient noise at a receptor location in a given environment is the all-encompassing sound associated with that environment, and is due to the combination of noise sources from many directions, near and far, including the noise source of interest. The 90th percentile-exceeded noise level, L_{90}, is a metric that indicates the single noise level that is exceeded during 90% of a measurement period although the actual instantaneous noise levels fluctuate continuously. The L_{90} noise level is typically considered the ambient noise level, and is often near the low end of the instantaneous noise levels during a measurement period.

The day-night average noise level, L_{dn}, is a single number descriptor that represents the constantly varying sound level during a continuous 24-hour period. The L_{dn} can be determined using 24 consecutive one–hour L_{eq} noise levels, or estimated using measured L_{eq} noise levels during shorter time periods. The L_{dn} includes a 10 decibel penalty that is added to noises that occur during the nighttime hours between 10:00 p.m. and 7:00 a.m., to account for people's higher sensitivity to noise at night when the background noise level is typically low.

C-weighting, or C-weighted decibels (dBC), gives equal emphasis to sounds of most frequencies. This dBC scale is generally used to describe low frequency noise, such as the "rumble" of large fans and the "boom" of blasting. Because A-weighting underestimates the human annoyance caused by these types of low frequency sounds, C-weighting is used to assess disturbance due to low frequency sounds. Large amplitude impulsive sounds, such as blasting, are commonly defined using the unweighted instantaneous peak noise level, L_{pk}, and reported as L_{pk} dBC.

It is important to note that the EPA has determined that a day-night average noise level (L_{dn}) of 55 dBA or less is sufficient to protect public health and welfare in residential areas. Instantaneous peak noise levels (L_{pk}), such as those produced by blasting, are considered an annoyance if they exceed 115 dBP.

Representative noise levels cannot be measured at the site until equipment and facilities are in place.

3.8.6.2 Noise Assumptions

Assumptions used for noise predictions are summarized in Table 3-48 and are based upon a conservative assumption that all equipment and operations will operate simultaneously during a given phase. Noise contours for the construction and production phases show the influence of the local topography on the propagation of noise relative to the four baseline monitoring sites (Figure 3.58 and Figure 3.59).

Table 3-48. Summary of Assumptions Used for Noise Predictions

Action / Phase	Assumptions
Construction	• Two pieces of diesel-powered earth-moving equipment operating at the Cemented Tailings Facility (CTF) for 20 hours per day. • Two pieces of diesel-powered earth-moving equipment operating at the Process Water Pond (PWP) for 20 hours per day. • Two pieces of diesel-powered earth-moving equipment operating at the portal pad for 20 hours per day. • Two pieces of diesel-powered earth-moving equipment operating at the mill, waste rock and copper-enriched rock stockpile pads for 20 hours per day. • Crusher and screen plant operating with two pieces diesel-powered earth-moving equipment at the Temporary Construction Stockpile for 20 hours per day. • Haul or water trucks moving material from the portal pad area to the CTF or PWP. 80 round trips per day for 20 hours per day at 25 mph. • Air compressor and diesel generators operating 24 hours per day.
Production	• Indoor mill operates 24 hours per day. • Outdoor crusher at west end of portal pad operates 20 hours per day. • Underground mine truck bringing material from portal to crusher. 82 round trips per day for 24 hours per day at 15 mph. • Front-end loader operating at crusher 20 hours per day. • Vent raises with ventilation fan at bottom of two 120 foot long, 16-foot diameter shafts. Fan is attenuated to meet 85 dBA at 3 feet (0.9 m).
Blasting	• Construction phase surface (intermittent 12 months, second half of first year, first half of second year) and decline blasting within 500 feet (153 m) of surface (30 days). • Operation underground blasting decline and orebody • Charge is 632 pounds (286.6 Kg) of explosive per round.

3.8.6.3 Construction Noise

Table 3-49 summarizes the predicted Construction Phase noise levels and a determination of the audibility of the Project noise at the four measurement locations shown on Figure 2.28**.** Figure 3.58 indicates the predicted L_{dn} noise level contours for the construction phase. As shown on the figure, the topography in the area affects how noise travels in the vicinity of the mine site. The predicted construction noise L_{dn} levels are less than the EPA guideline L_{dn} 55 dBA at each location.

As shown in Table 3-49, the audibility of construction noise levels are predicted to be L_{eq} 28 to 38 dBA at the noise measurement locations, which are typically considered “faint” noise levels, but audible, due to the low ambient L_{90} noise levels in the area. The predicted construction L_{eq} 28 to 38 dBA noise levels are much lower than the L_{eq} 70 dBA Federal Transit Administration nighttime construction noise guidelines. However, due to the low ambient L_{90} noise levels, the construction noise is predicted to be clearly audible at Location 1 (Bar Z Ranch), occasionally audible at Location 2 (Castle Mountain Ranch), Location 3 (Butte Creek Road gate), and Location 4 (Lodge at Sheep Creek) (Figure 2.28).

Table 3-49. Summary of Predicted Construction Noise Levels (dBA)

Noise Measurement Location	Ldn Noise Level		Audibility			
	Calculated Baseline Noise Level (Ldn)	Predicted Construction Noise Level (Ldn)	Average Measured Baseline Noise Level (L90)	Predicted Construction Noise Level (Leq)	Difference (Leq –L90)	Perception of Construction Noise at Locations
1	42	41	24	38	+14	Clearly audible
2	48	32	25	30	+5	Occasionally audible
3	33	33	21	29	+8	Occasionally audible
4	31	31	22	28	+6	Occasionally audible

Table 3-50 summarizes the predicted Operational Phase noise levels and a determination of the audibility of the Project noise at the four measurement locations shown on Figure 2.28. Figure 3.59 indicates the predicted L_{dn} noise level contours for the operation phase. As shown on the figure, the topography in the area affects how noise travels in the vicinity of the mine site. Please note the operation noise levels are primarily due to the crusher, which is the loudest noise source as identified in Table 3-48. The predicted operation noise L_{dn} levels are less than the EPA guideline L_{dn} 55 dBA at each location.

The operation noise levels are predicted to be L_{eq} 27 to 35 dBA, at the noise measurement locations, which are typically considered "faint" noise levels, but clearly to occasionally audible at the four measurement locations, due to the low ambient L_{90} noise levels in the area (Figure 2.28).

All surface vehicles will use discriminating backup alarms that comply with MSHA requirements where backup alarms are required. Noise levels will be maintained at less than 82 dBA at a distance of 3-feet from ventilation fans.

Table 3-50. Summary of Predicted Operational Noise Levels (dBA)

	L_{dn} Noise Level		Audibility			
	Calculated Baseline Noise Level (L_{dn})	Predicted Operation Noise Level (L_{dn})	Average Measured Baseline Noise Level (L_{90})	Predicted Operation Noise Level (L_{eq})	Difference ($L_{eq} – L_{90}$)	Perception of Operation Noise at Locations
1	42	40	24	35	+11	Clearly audible
2	48	34	25	30	+5	Occasionally audible
3	33	36	21	31	+10	Clearly audible
4	31	32	22	27	+5	Occasionally audible

3.8.6.4 Blasting Noise

Table 3-51 summarizes the predicted noise levels at the noise level measurement locations shown on Figure 2.28 when the Construction Phase blasting occurs at or near the surface. Knight Piésold estimates that the majority of surface blasting in the CTF (and PWP) excavation footprints (many other facilities may not require any blasting) will be within the latter half of year one and the first half of year two of surface facility excavation. However, surface blasting could occur at any time during the two-year construction period as rock conditions warrant. Blasting noise will be mitigated by the use of blasting mattes during surface excavation. Blasting will be audible for several miles around the Project site. As the Project progresses underground during the Operation Phase, blasting noise will decrease. The blast noise is predicted to be less than the Montana DEQ 105 L_{pk} dBC threshold at each location.

Table 3-51. Summary of Predicted Blasting Noise Levels (dBP)

Baseline Monitoring Location	Predicted Blast Noise Level (L_{pk})
1	87
2	87
3	75
4	85

3.8.6.5 Traffic Noise

Traffic noise is evaluated using one-hour equivalent noise levels, L_{eq}(h) (MDT 2011), and therefore, road traffic noise is evaluated separately from the L_{dn}. During the Construction Phase, approximately six trucks per day will be used to transport material, supplies and water to/from the site, and approximately 45 employee vehicles per day are expected to travel roundtrip (Tintina 2015). From US 89, Construction Phase traffic will travel on Sheep Creek, Butte Creek, and the construction access road located on the west side of the site (Figure 2.28). To estimate a volume of traffic during one hour, it was conservatively assumed all 45 employee vehicles would travel the roads in the same hour near a shift change, but the truck volume would be distributed throughout an 8-hour shift, resulting in approximately 1 truck per hour.

During the Operation Phase, approximately 27 trucks (i.e., delivery, fuel and haul trucks) and 73 employee vehicles per day are predicted to travel roundtrip (Tintina 2015). From US 89, Operation Phase traffic will travel on the Sheep Creek operational access road located east of the site (Figure 2.28). Again, it was assumed all 73 employee vehicles would travel the road in the same 1- hour period, and the trucks were distributed throughout an 8-hour shift, which results in approximately 4 trucks per hour.

The predicted traffic noise levels at Locations 1, 3 and 4 near the mine site (Figure 2.28) are presented in Table 3-52. The traffic noise levels shown in the table include the effect of the natural topography in the area. Since Location 2 is adjacent to US 89, it was evaluated separately (Table 3-53). As shown, the predicted traffic noise levels with the addition of the mine-related traffic do not exceed MDT's L_{eq}(h) 66 dBA criterion, and do not exceed MDT's +13 dBA significant increase criterion at the receptors.

Table 3-52. Traffic Noise Levels near Mine Site

Noise Measurement	Measured Daytime L_{eq}	Construction Phase		Operation Phase	
		Predicted L_{eq}(h)	Difference vs.	Predicted L_{eq}(h)	Difference vs.
1	38[1]	39	+1	22	-16
3	33	4	-29	7	-26
4	28	25	-3	26	-2

Note: [1]Represents the average measured daytime L_{eq}(h) obtained during the 24-hour measurement).

The estimated traffic noise levels at various distances from US 89 are shown in Table 3-53. The predicted traffic noise levels shown assume a direct line of sight exists between the road and a listener. Where the line of sight between the road and a listener is blocked by terrain, the traffic noise levels will be less than those shown in Table 3-53**.**

Traffic data for US 89 were obtained from MDT (MDT 2014). The MDT traffic data is provided in terms of average annual daily traffic (AADT). Based on data for MDT Count Site 30-2-1, located at the 90-degree curve in US 89 east of the Project (Figure 2.28), the AADT in the year 2014 was 390, which includes 43 commercial (heavy) trucks. Since TNM bases its calculations on traffic volumes during a 1-hour period, BSA assumed that the 1-hour traffic volume was approximately 10% of the AADT.

As shown, the traffic noise levels due to the addition of mine-related traffic to the US 89 traffic volume is not predicted to exceed MDT's L_{eq}(h) 66 dBA criterion, and do not exceed MDT's +13 dBA significant increase criterion (Table 3-53).

Table 3-53. Predicted US 89 Traffic Noise Levels

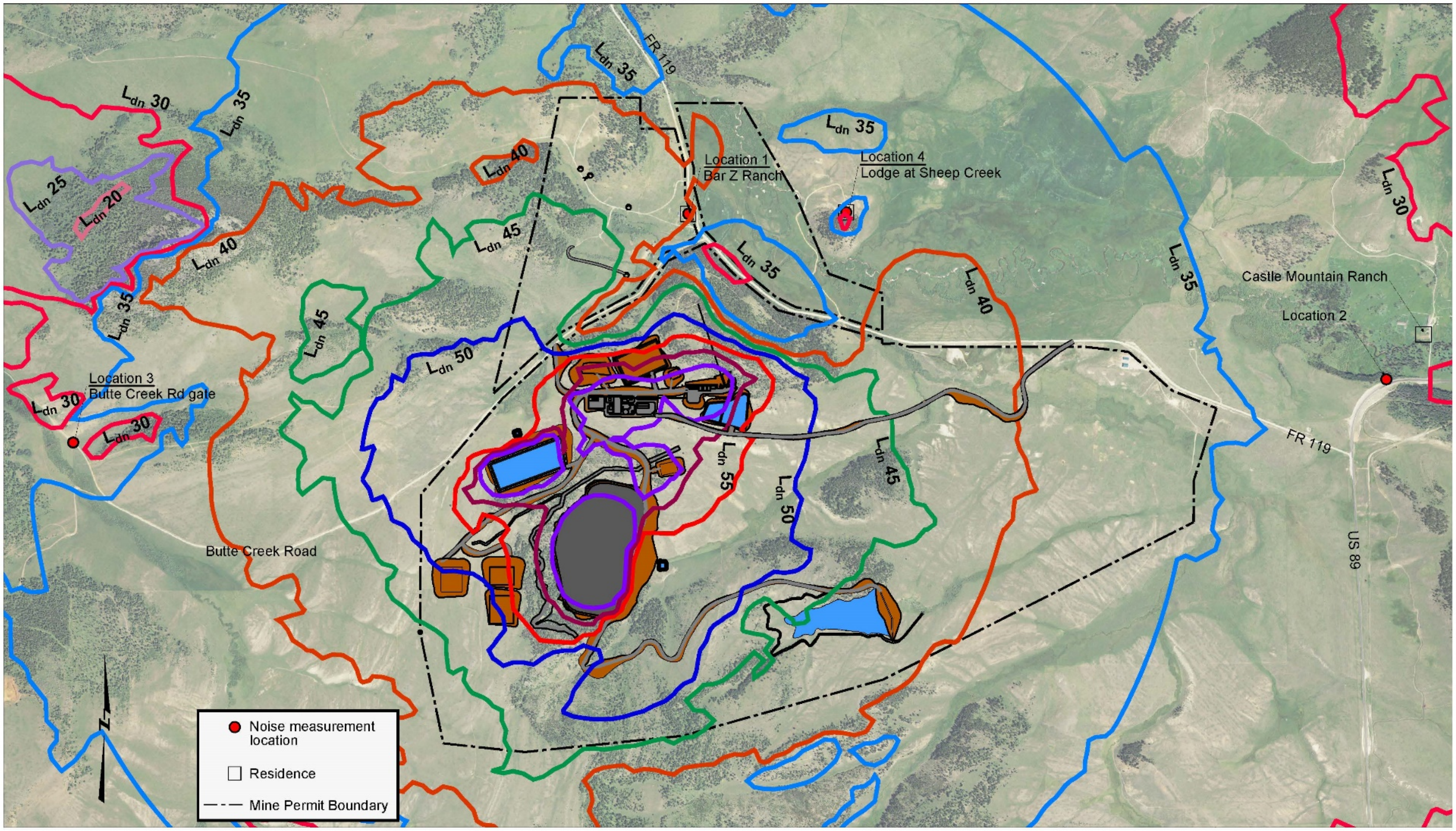
Distance from Centerline of Road	Existing US 89 Traffic Noise Level L_{eq}(h) (dBA)	Construction Phase		Operation Phase	
		Existing US 89 + Construction Traffic Noise Level L_{eq}(h) (dBA)	Difference vs. Existing US 89 Traffic	Existing US 89 + Operation Traffic Noise Level L_{eq}(h) (dBA)	Difference vs. Existing US 89 Traffic
100 ft.	56	59	+3	61	+5
200 ft.	49	52	+3	54	+5
300 ft.	45	47	+2	49	+4
400 ft.	41	44	+3	45	+4
500 ft.	39	41	+2	43	+4
750 ft. (Location 2 Residence)	34	37	+3	38	+4
1,000 ft.	32	34	+2	36	+4
5,000 ft.	22	25	+3	26	+4
10,000 ft.	18	21	+3	22	+4

3.8.6.6 Potential Noise Mitigation

Reasonable noise mitigation measures could be implemented to reduce the project noise levels at nearby residences during the Construction and Operational phases. Noise control measures will also reduce the noise exposure of workers in the vicinity of the equipment. Although noise mitigation measures could provide a clearly noticeable reduction in noise, the construction and operation noise sources will still be audible at nearby residences (Table 3-49 and Table 3-50), even if noise mitigation measures are implemented.

The construction and operation noise could be reduced by implementing the noise mitigation measures described below in order to minimize human annoyance and disruption of wildlife.

- On all diesel-powered construction equipment, replace standard back-up alarms with approved broadband alarms that limit the alarm noise to 5 to 10 dBA above the background noise. Broadband alarms replace the traditional “beep-beep-beep” alarms with a “shhh-shhh-shhh.”
- Install high-grade mufflers on all diesel-powered equipment.
- Reduce the noise of the underground haul trucks by enclosing the engine.
- Restrict the surface and outdoor construction and operation activities to daytime hours (7:00 am to 7:00pm).
- Combine noisy operations to occur for short durations during the same time periods.
- Turn idling equipment off.



Prepared by: Big Sky Acoustics, LLC (2016)

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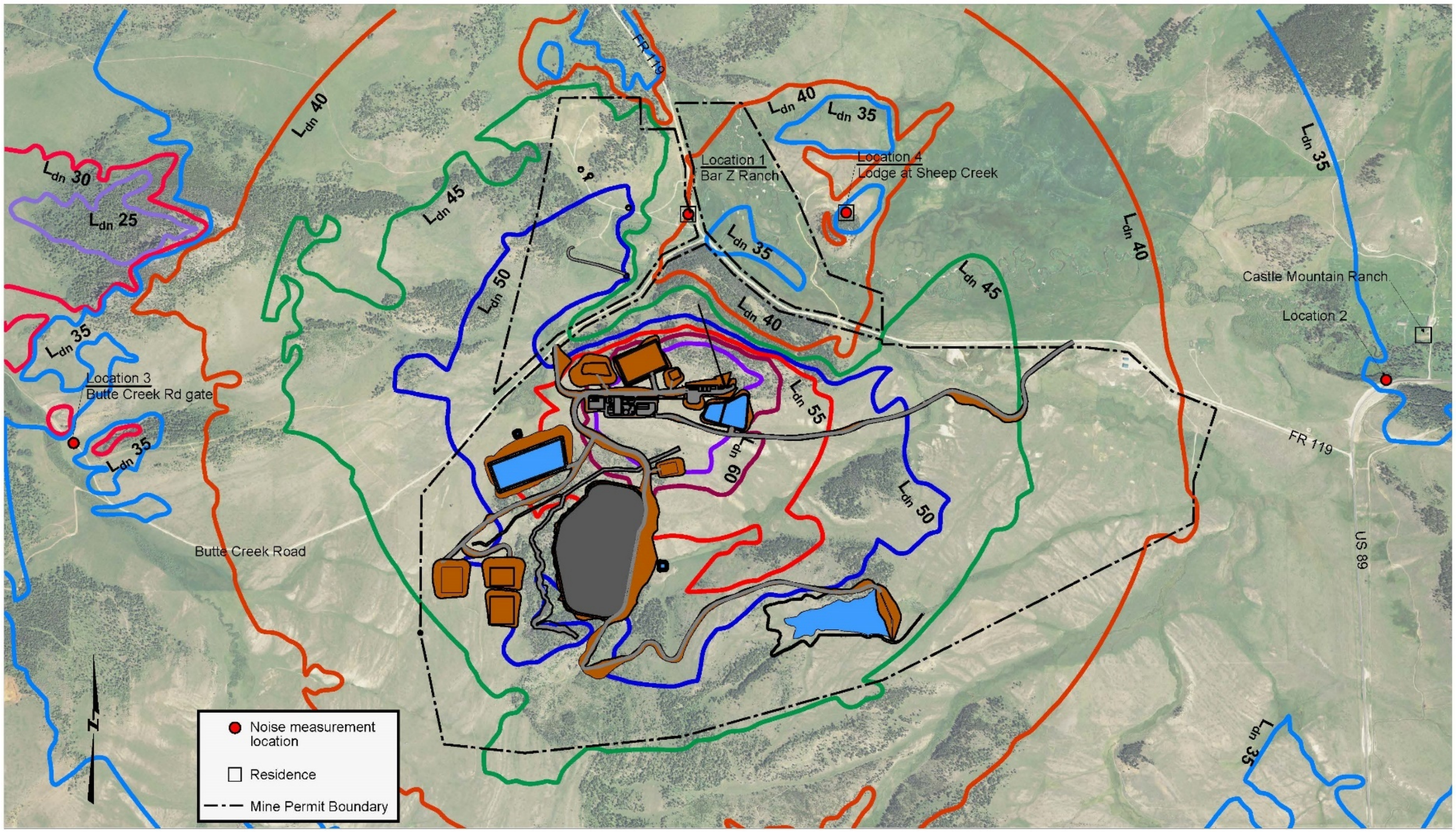
Figure 3.58
Noise Contours (dBA): Construction Phase
Mine Operating Permit Application
Meagher County, Montana



Prepared by: Big Sky Acoustics, LLC (2017)

TINTINA RESOURCES

Figure 3.59
Noise Contours (dBA): Operational Phase
Mine Operating Permit Application
Meagher County, Montana

3.8.7 Fire Protection

Fire protection is a typical component of both construction and mining operations. Fire hazards at the Project are very low for most of the year, and moderate in the late summer through the fall. The principle potential zones of fire include:

- Brush fires in the shrub-covered terrain surrounding the Project site
- Fire at the mill processing facility, and
- Douglas-fir forested ridgetops in the vicinity of the Project area.

All mobile equipment will have installed fire extinguishers for Class A, B, and C fires. During the summer forest fire season, Department of Natural Resources and Conservation (DNRC) guidelines will be followed. Tintina will require employees, contractors, and subcontractors to comply with all applicable Federal and State fire laws and regulations, and insure that they take all reasonable measures to prevent and suppress fires in the area of operations. Fire and ambulance equipment are described in the mill facility section (Section 3.3.3). The mill facility, shop, and administrative areas will be protected to National Fire Protection Agency requirements with sprinkler systems and will be MSHA-compliant.

In the event of a brush fire, fire protection will be with water from the fire storage tank and the water and fire trucks, augmented by the White Sulphur Springs and Meagher County fire services. Support for fires involving forest lands could include the U.S. Forest Service. Tintina will cooperate with Meagher County and other stakeholders on fire reduction mitigation activities.

Appendix P (Tintina Resources, 2017) is an Emergency Response Plan developed for the Project. The Plan provides information concerning an emergency call list, a site evacuation plan, medical emergencies plan, spill (see Section 3.8.10), flood and fire responses plans. The State Fire marshal, White Sulphur Springs Fire Chief and the Meagher County Fire Warden have been provided copies of the Emergency Response Plan including Spill and Fire Plans.

3.8.8 Solid Waste Disposal

The predominant solid wastes from the Project will be tailings and waste rock, and the facilities for storage, and the handling of these materials are discussed in Sections 3.6.8 and 3.6.5 respectively. Other waste generated at the site will include general wastes (paper, bottles, cans, and food), maintenance shop wastes, and sewage wastes. All solid waste will be disposed of in accordance with rules and regulations of the Solid Waste Management Section in the Waste Management and Water Protection and Underground Tank Management Bureau of the DEQ. No landfill will be constructed on site. Containers for various types of refuse will be provided at appropriate locations at the site. For refuse that contains food or other items that could be an attractant to wildlife, appropriate containers will be properly located to minimize wildlife access and will be emptied frequently.

General waste will be collected daily in plastic bags and placed in dumpsters at various locations at the site for collection by a contract service. This service will pick-up wastes on a weekly basis and transport them to a licensed county solid waste facility.

Maintenance shop waste consisting of rags, paper, metal, cardboard, and wood boxes (in which spare parts are received) will be sorted and disposed of in a specific dumpsters identified for this purpose. Once a week (or more often if required), a contract service will pick up this waste and dispose of it in various types of facilities including a metal recycling facility, a wood waste disposal facility, and / or a licensed county solid waste facility. Recycling will be implemented wherever appropriate and applicable.

3.8.9 Sewage Treatment

Domestic wastewater (from sinks, toilets, and showers) at the mine site will be treated and disposed using a conventional septic system. The septic system will consist of a septic tank to settle solids and a subsurface drain field to dispose of settled wastewater. The system will require periodic maintenance that includes cleaning the septic tank effluent filter and pumping out the septic tank to remove accumulated solids. Septic tank pumping frequency is assumed to occur annually but may not be required more than every 3 to 5 years. Solids will be pumped from the septic tank by DEQ licensed septic haulers and disposed at an approved facility according to applicable regulations.

The volume of wastewater generated at the site was determined based on the predicted workforce size and wastewater flow values taken from the Montana DEQ Circular DEQ-4 (Montana DEQ, 2013b). For aboveground workers, wastewater values for Industrial Buildings were used. For underground miners, wastewater values for Dormitory / Bunkhouses were used as these workers are likely to generate more wastewater due to their use of onsite shower facilities. The resulting average daily wastewater flow from the site is 3,800 gallons (14,385 liters) per day (Table 3-54).

Table 3-54. Estimated Waste Water Flow

Typical Wastewater Flows (DEQ 4)	Range of Wastewater Flow (gpd)		Wastewater Flow Typical (gpd) /employee	Number of Employees	Total Flow (gpd)
Industrial Building (Aboveground Workers)	10	16	13	76	**988**
Dormitory, Bunkhouse (Underground Workers)	20	50	40	69	**2,760**
				Total	**3,748**

Based on the expected rate of effluent flow from the septic tank and online soil infiltration data (which are consistent with data collected during siting studies for mine dewatering underground infiltration galleries systems), approximately 4,750 square feet (440 m^2) of drain field will be required. The Project intends to construct a drain field measuring approximately 100 foot by 100 foot (930 m^2) in order to provide about 50% excess capacity.

3.8.10 Hazardous Materials Disposal

All hazardous materials (fuels, lubricating oil, hydraulic fluid, antifreeze, chemicals, milling reagents, and hydrocarbon wastes) will be stored in US Department of Transportation (DOT) approved containers with secondary containment, labeled by specific fluid type. A licensed commercial hazardous waste disposal contract service, that specializes in handling and recycling or other licensed means of disposal of these types of waste will pick up these fluids and transport them to a recycling facility. A Spill Prevention, Control and Countermeasures (SPCC) plan for the Project will be prepared as required for the final operating permit and a copy will be kept onsite and maintained in accordance with applicable EPA requirements prior to initiation of construction at the project site, and made available during regulatory inspections by agencies with regulatory authority. These plans will address the potential for accidental spills of fuel or other hazardous materials such as hydraulic fluid, grease, or coolant and provide details of typical spill response actions. The SPCC plan will describe and contain examples of internal and agency forms for inspections and spill reporting. The SPCC plan will also describe in detail which agencies needs to be contacted to report various types of spills. Appendix P (Tintina Resources, 2016) is a preliminary Emergency Response Plan developed for the Project. The local and State Fire Marshal's offices were both presented with Tintina's Appendix P (Rev #1) Emergency Response Plan. However, the State Fire Marshal's Office will review the final SPCC Plan during an onsite inspection following installation and prior to use of above ground storage tanks and pipelines.

3.8.11 Site Security

A four-strand barbed-wire fence will surround the core Project facility area as shown on Figure 1.3. The purpose of this fence is to keep cattle out of the active mine areas while allowing property owners maximum use of their land for cattle grazing. The fence will be placed on either side of the main access and construction access roads to lane them off for worker, vehicle and cattle safety (Figure 1.3). The main access road to the Project will have a lockable gate at the Sheep Creek county road. This gate will remain open during all active periods of operation. The main access road will have another gate and a guardhouse on the southeast end of the mill facility pad (Figure 3.9). The guardhouse will be located along the barbed-wire perimeter fence described above. This gate will be either monitored or manned 24-hours per day during operations to control entry onto the site. Because the operating schedule is anticipated to be 7 days per week, 365 days per year, mine staff will provide security, in the event of a longer term closure the company may elect to hire a watchman.

The guardhouse area will also have a small parking area and a truck scale for weighing trucks carrying materials onto and off the site. In the vicinity of the mine, signs will be posted between the public access roads and adjacent private property to discourage trespassing.

The contractor access road will have a lockable gate at the Butte Creek county road, this gate will be open and monitored during active construction periods or alternatively during less active periods locked and opened as necessary.

All lined ponds including the CWP, PWP, CTF and the CTF and PWP foundation drain ponds will have eight-foot (2.4 m) high wildlife fences constructed around them. The NCWP will have a barbed wire fence surrounding the reservoir to prevent cattle from damaging the shoreline and diversion ditches. Six-foot high chain-link fences will also surround the four ventilation raise collar areas and the PWS well location (Figure 1.3). The temporary powder magazine will be protected as required by MSHA regulations until it is relocated underground during the first year of development mining.

3.8.12 Lighting

All operational and construction exterior lighting will be shielded to reduce visual impacts from viewpoints in the Sheep Creek valley to the extent that it can be safely accomplished.

3.8.13 Cultural Resource Protection

Cultural resources were surveyed in areas likely to be within the area of influence of surface disturbances. Although several lithic scatter sites have been identified as occurring in proposed construction areas (Section 2.9), Tintina has agreed to mitigate these sites by excavation and / or study where necessary as determined by State Historic Preservation Office (SHPO). DEQ has recommended an archaeologist be present during construction in the vicinity of any of the prehistoric sites identified. Any future discoveries in the Project area will be professionally recorded and evaluated and any sites found to be eligible for the National Register of Historic Places will be protected or mitigated in accordance with State SHPO requirements. SHPO response letters are included at the end of Appendix I.

4 MODELING STUDIES

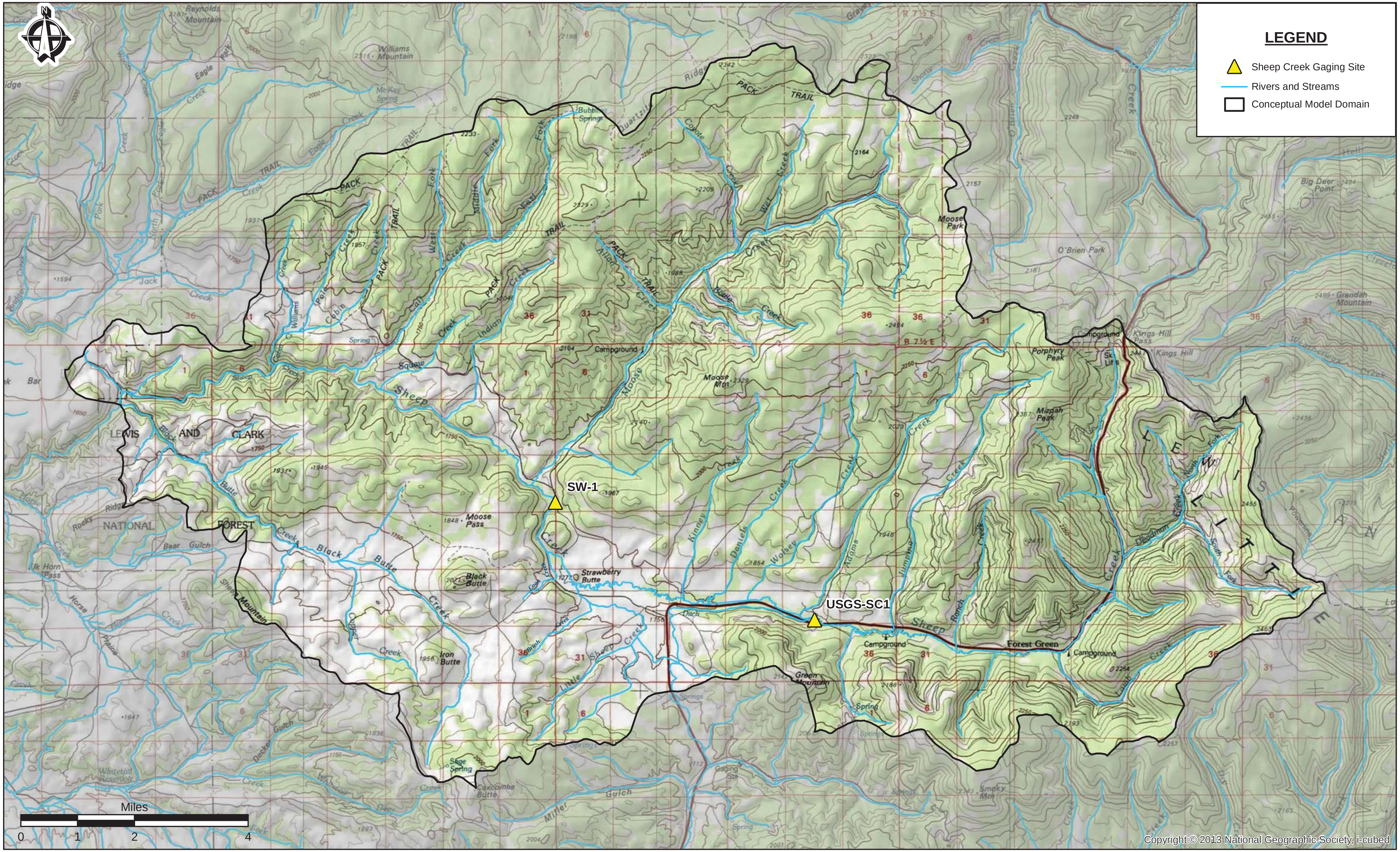
4.1 Hydrologic Conceptual Model

4.1.1 Regional Setting

Sheep Creek originates in the Little Belt Mountains at an elevation of approximately 7,400 feet (2,256 m). It discharges to the Smith River approximately 36.6 river miles (59 km) to the west at an elevation of 4,380 feet (1,335 m). This hydrologic conceptual model focuses upon the upper two thirds of the Sheep Creek watershed, which extends from the headwaters of Sheep Creek downstream to the confluence of Black Butte Creek. The conceptual model area is shown in Figure 4.1 and Figure 4.2 is a geologic map of the area. Figures 4.3 and 4.4 show geologic cross-sections that include estimations for the top of the groundwater table. The conceptual model area includes a number of small unnamed tributaries in addition to larger tributary streams which support perennial flow over most of their reach. Little Sheep Creek and Black Butte Creek are two of the larger named tributaries to Sheep Creek in the immediate Project area that support perennial flow over most of their length. Black Butte Creek lies immediately west of the Project area and joins Sheep Creek approximately 7 miles (11.3 km) downstream of the Project site.

4.1.2 Hydro-Stratigraphic Units

The regional and local geologic setting of the Project, including stratigraphic units, is presented in Section 1.4. A hydro-stratigraphic unit (HSU) is a body of rock or structure that acts as a reasonably distinct hydrogeologic system. For the purposes of this model, the major hydro-stratigraphic units (HSUs) generally coincide with parts of the principal geologic units in the area, but also include structural fault zones. The principal HSUs are described below and shown in Figure 4.5 and are also shown in the schematic cross-sections (Figure 4.3 and Figure 4.4) and in the block flow diagram Figure 4.8. Hydraulic properties of the major units within the Project area are listed in Table 4-1, and are based on the results of aquifer testing described in the Baseline Water Resources Monitoring and Hydrologic Investigations Report (Hydrometrics, 2016a). Hydrologic characteristics of units outside of the Project area have been estimated based upon literature values for similar formations.

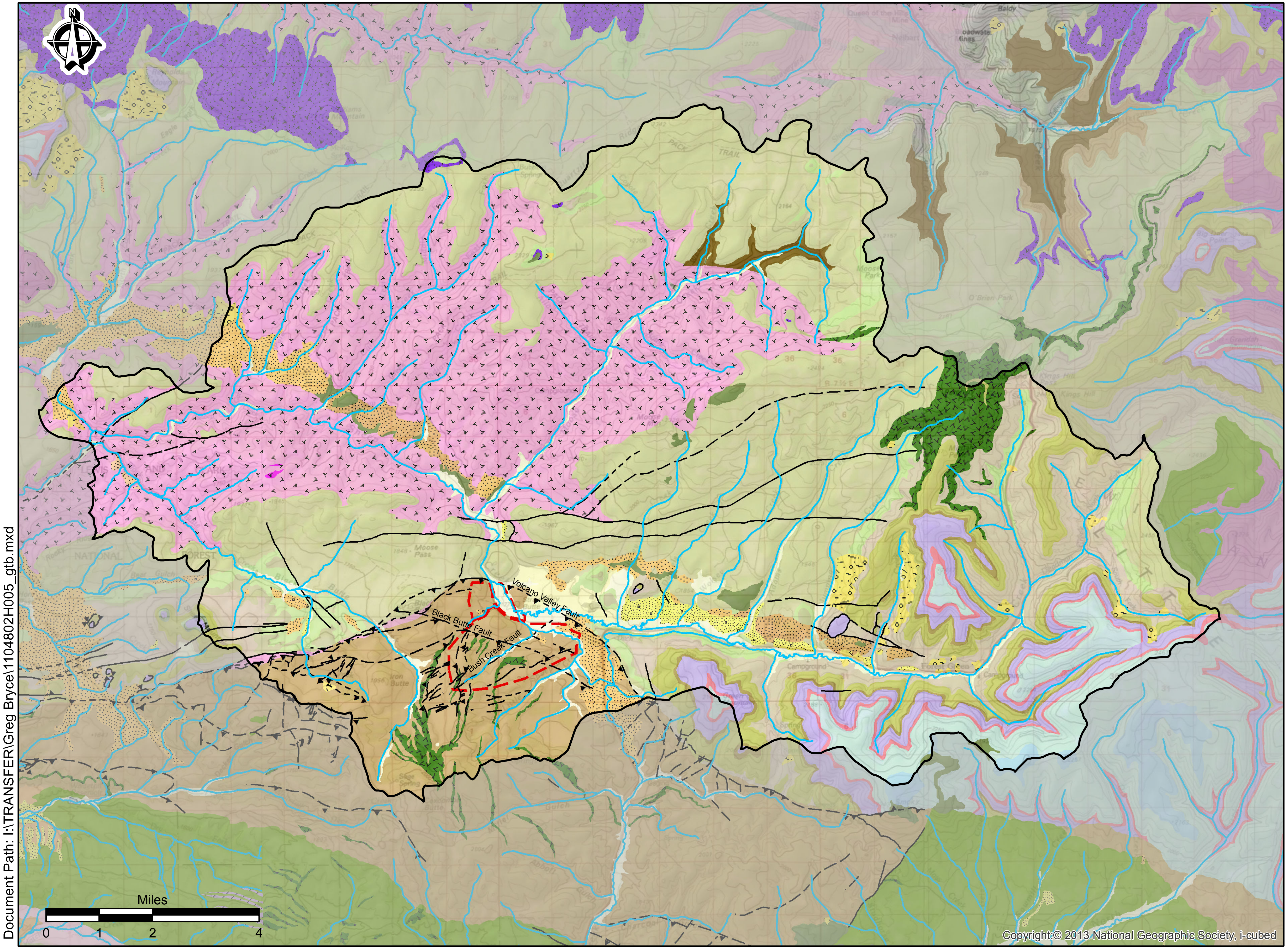


Document Path: K:\project\11048\GIS\Model Figures\Fig2-1_ConcModelArea.mxd

Date: November 9, 2015 Source: Hydrometrics (2015)

TINTINA RESOURCES

Figure 4.1
Conceptual Hydrologic Model Area
Black Butte Copper Project
Meagher County, Montana



Date: June 2016; Source: Hydrometrics (2016)

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LEGEND

Quaternary
- Qt Terrace gravel (Holocene and Pleistocene)
- Qp Pediment gravel (Holocene? and Pleistocene)
- QTg Older gravel (Pleistocene and Pliocene)
- Qoa Old alluvium (Holocene or Pleistocene)
- Ql Landslide deposit (Holocene and Pleistocene)
- Qc Colluvium (Holocene)
- Qac Alluvium and colluvium, undivided (Holocene)
- Qa Alluvium (Holocene)

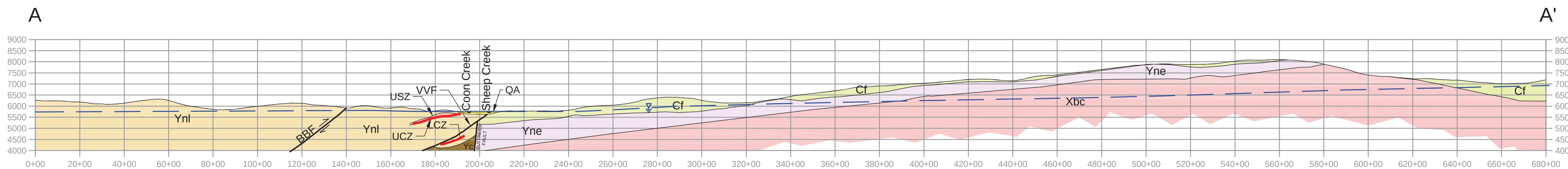
Tertiary
- Ts: MIOGs Sedimentary rocks, undivided (Miocene and Oligocene)
- Ts: OGs Sedimentary rocks older than basalt flow (Oligocene and Eocene?)
- EOqm Quartz monzonite (Eocene)
- Ti: Eobhqm Biotite hornblende quartz monzonite (Eocene)
- Eobgd Biotite hornblende dacite (Eocene)
- Oib Basalt (Oligocene)

Paleozoic
- Mm Mission Canyon Limestone (Upper and Lower Mississippian)
- Ml Lodgepole Limestone (Lower Mississippian)
- MDt Three Forks Formation (Lower Mississippian and Upper Devonian)
- Dj Jefferson Formation (Upper Devonian)
- DCm Maywood Formation (Upper and Middle Devonian) and locally Upper Cambrian beds
- Cpi Pilgrim Formation (Upper Cambrian)
- Cp Park Shale (Upper and Middle Cambrian)
- Cm Meagher Limestone (Middle Cambrian)
- Cw Wolsey Formation (Middle Cambrian)
- Cf Flathead Sandstone (Middle Cambrian)

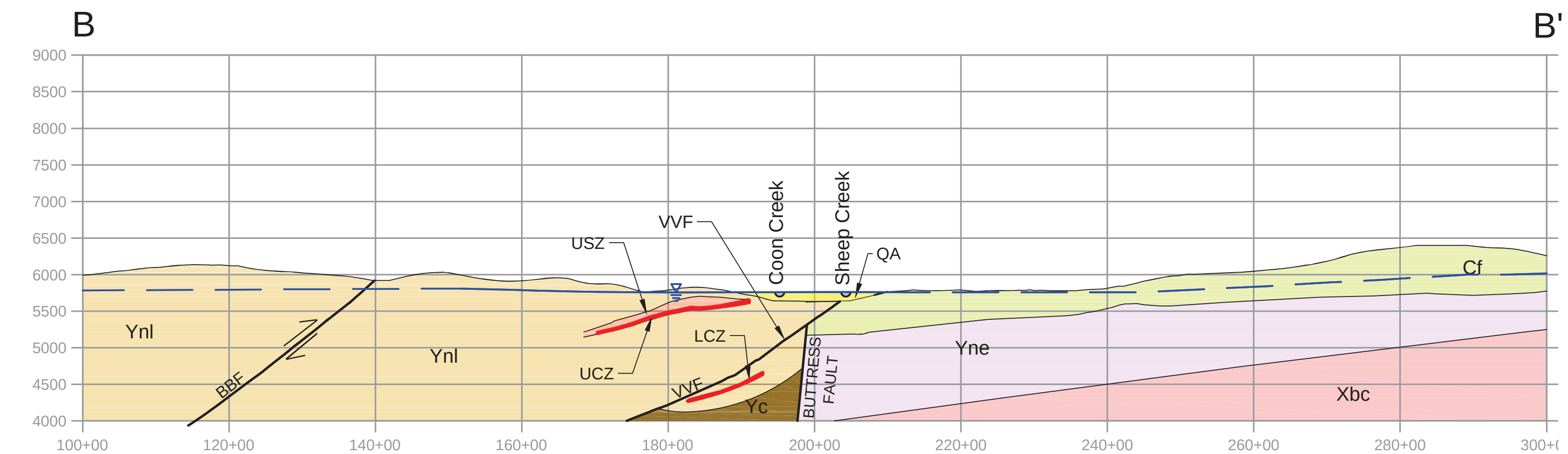
Belt Supergroup
- Yg Greyson Formation (Mesoproterozoic)
- Ynu / Ynl: Yn Newland Formation (Mesoproterozoic)
- Yc Chamberlain Formation (Mesoproterozoic)
- Xbc:
  - Xag Augen gneiss (Paleoproterozoic)
  - Xgg Granite gneiss (Paleoproterozoic)
  - Xbg Biotite gneiss (Paleoproterozoic)
  - Xgda Gneissic granodiorite and amphibolite, undivided (Paleoproterozoic)
  - Xd Diorite (Paleoproterozoic)
  - Xa Amphibolite (Paleoproterozoic)
  - Xpd Pinto Diorite (Paleoproterozoic)
  - Wd Metadiorite (Neoarchean)
- Mine Permit Boundary
- Fault_defined
- Fault_approximate
- Fault_inferred
- Thrust_defined
- Thrust_approximate
- Thrust_inferred

Souce: Geologic data from White Sulphur Springs Quadrangle (Reynolds and Brandt, 2006) and Canyon Ferry Dam Quadrangle (Reynolds and Brand,2005)

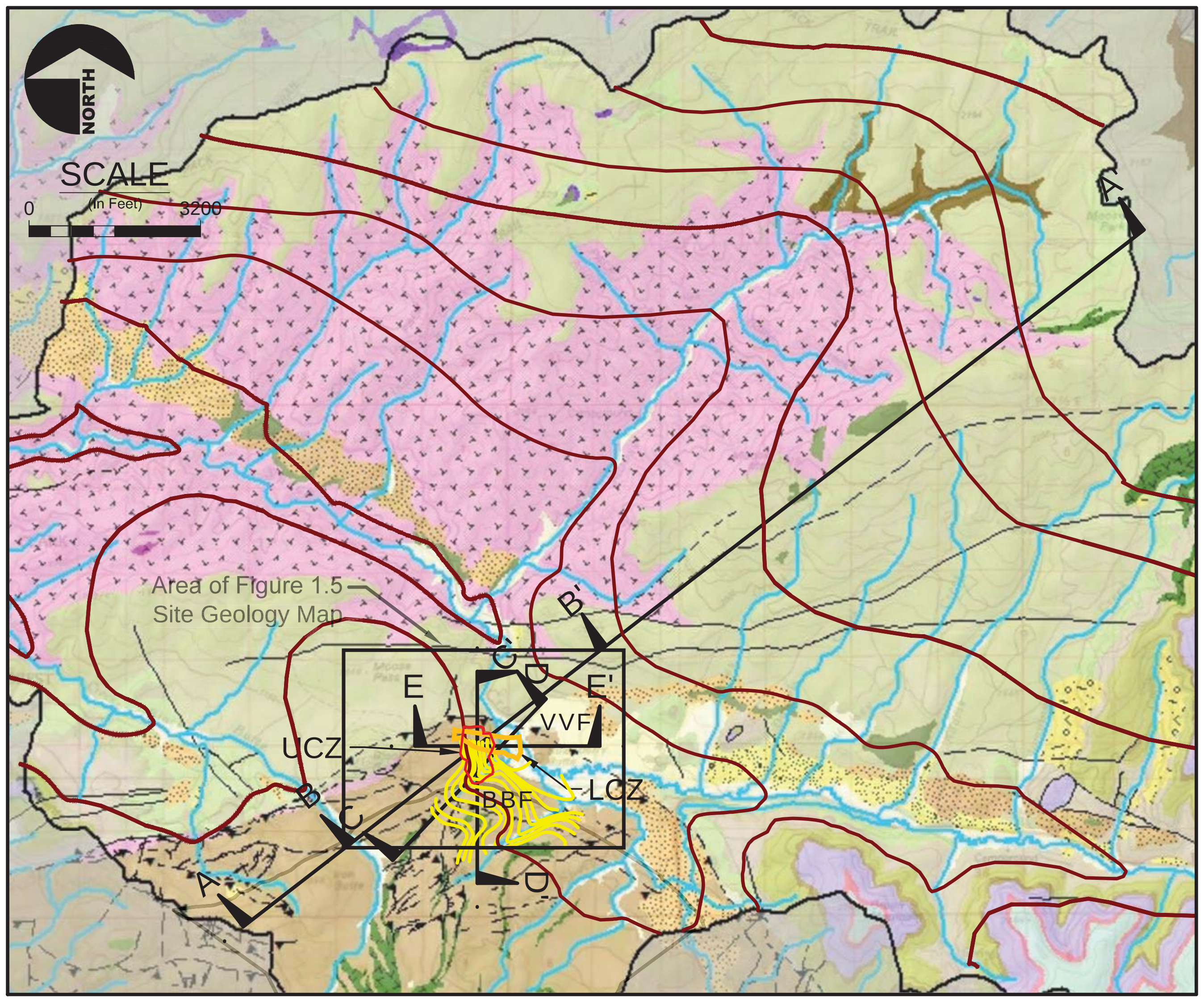
Figure 4.2
Geologic Map of Conceptual Model
Black Butte Copper Project
Meagher County, Montana



CROSS SECTION A - A'



CROSS SECTION B - B'



CROSS SECTION LOCATION MAP

LEGEND

Conceptual Hydrologic Model Domain

A A' Cross Section Line

Potentiometric Surface on the cross sections

Potentiometric Surface Contour lines on the plan map dark red contour lines are 250 ft. invtervals (see Figure 4.6 in MOP Application) whereas the yellow lines are 20 ft. contour lines (see Figure 2.8 in the MOP Application)

GEOLOGY LEGEND

Qa	Quaternary Alluvium
Cf	Flathead Sandstone
Ynl	Lower Newland Fm
USZ	Upper Sulfide Zone
UCZ	Upper Copper Zone
LCZ	Lower Copper Zone
Yc	Chamberlain Fm
Yne	Neihart Fm
Xbc	Crystalline Basement Rocks
VVF	Volcano Valley Fault
BBF	Black Butte Fault

Fm = Formation

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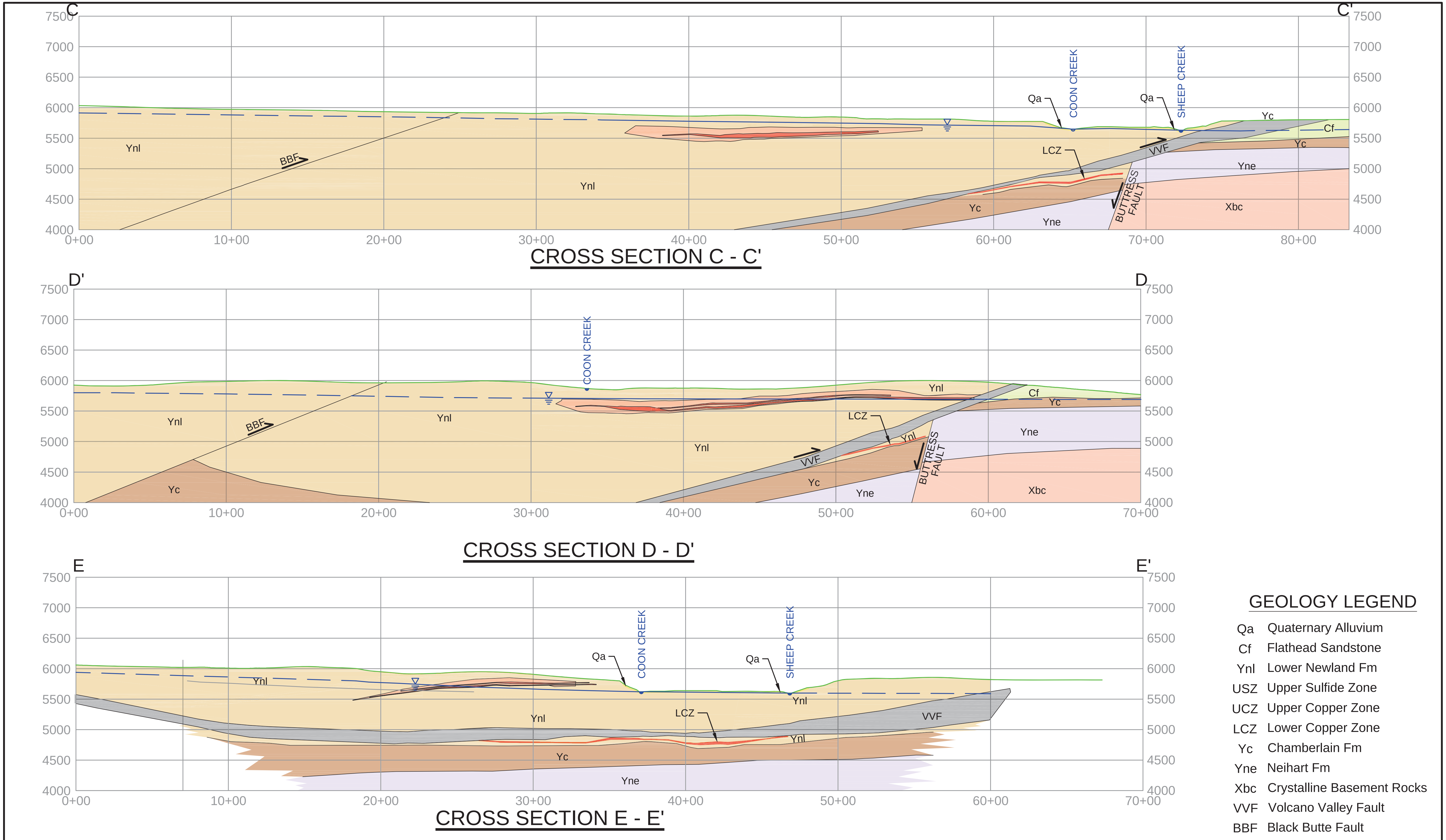
See Figure 4.4 for additional schematic cross-sections

Figure 4.3
Schematic Cross-sections (1 of 2)
Black Butte Copper Project Meagher County, Montana



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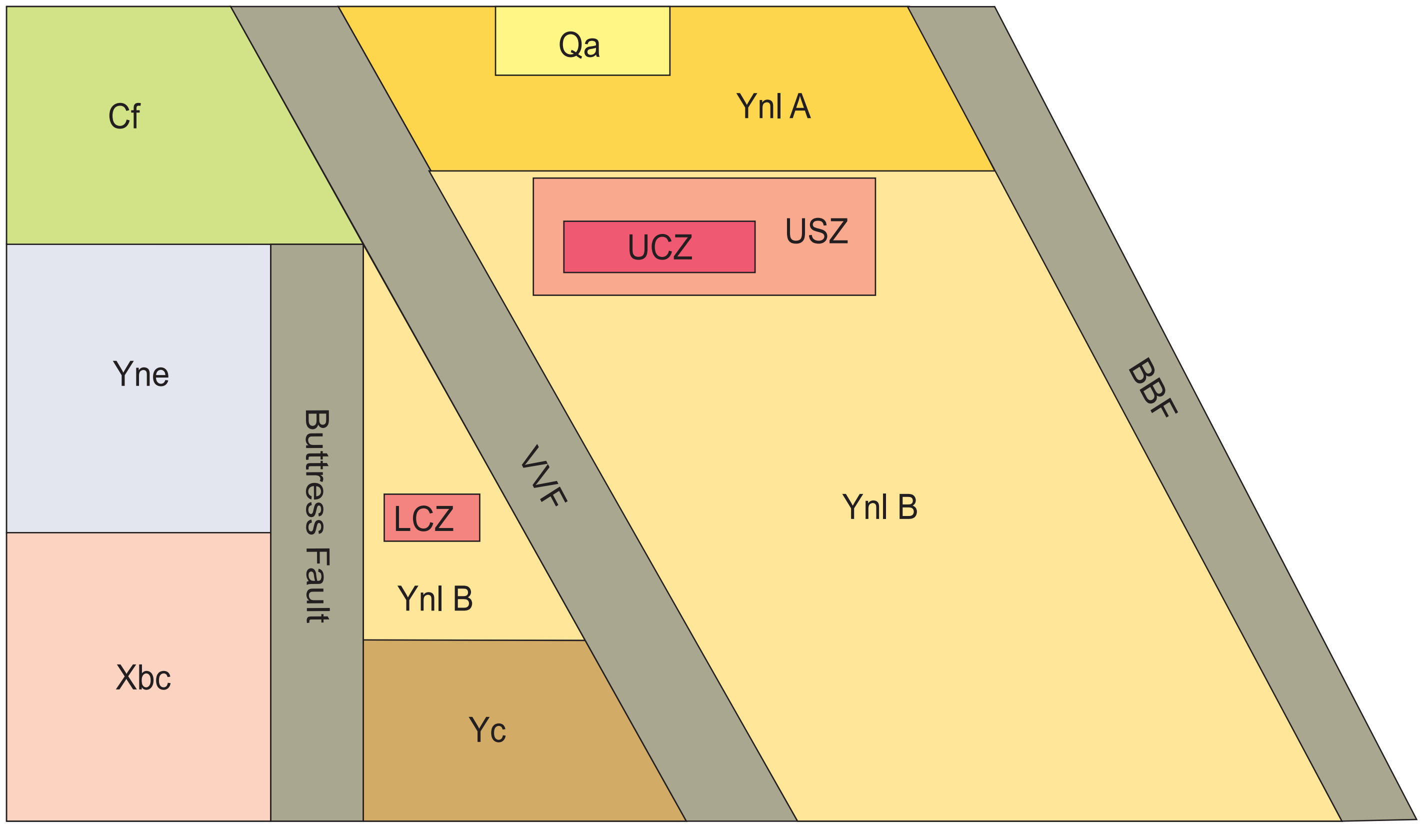
TINTINA RESOURCES

See Figure 4.3 for additional cross-sections.
See Figure 4.3 for cross-section lines on plan map.

Figure 4.4
Schematic Cross-sections (2 of 2)
Black Butte Copper Project
Meagher County, Montana



LEGEND

Qa	Quaternary Alluvial Deposits
Cf	Flathead Sandstone
Ynl A	Lower Newland Fm. (shale: shallow)
Ynl B	Lower Newland Fm. (shale: deep)
USZ	Upper Sulfide Zone
UCZ	Upper Copper Zone
LCZ	Lower Copper Zone
Yc	Chamberlain Fm. (shale)
Yne	Neihart Fm. (quartzite)
Xbc	Metamorphic Crystalline Basement rock
VVF	Volcano Valley Fault
BBF	Black Butte Fault

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Figure 4.5
Hydro-Stratigraphic Units
Black Butte Copper Project
Meagher County, Montana

Table 4-1. Hydraulic Properties of Hydro-Stratigraphic Units

Unit	Description	Thickness (ft.)	Hydraulic Conductivity* (ft./day)	Storage Coefficient	Source of Hydraulic Properties
Geologically-Based Hydro-Stratigraphic Units					
Sheep Creek Alluvium (AL)	coarse-grained sand and gravel alluvium	17	200	0.2 to 0.35	slug test; literature
Flathead Sandstone (*Cf*)	sandstone bedrock	100	10^{-5} to 1.5	NA	literature
Lower Newland Formation shallow (*Ynl A*)	calcareous and non-calcareous shale and siltstone bedrock	30-50	1 to 2.3 GM 1.5	1×10^{-4} to 8×10^{-6}	pumping test
Upper Sulfide Zone [*USZ*]	highly mineralized zone	30-150	0.01 to 0.7 GM 0.08	6×10^{-5} to 9×10^{-5}	pumping test
Upper Copper Zone [*UCZ*]	copper zone within USZ				
Lower Copper Zone [*LCZ*]	copper mineralized zone	30-50	1.9×10^{-4}	NA	pumping test
Lower Newland Formation deep (*Ynl B*)	dolomitic and non-dolomitic shale and siltstone bedrock	150 in FW; to 2,000	0.001 to 0.007	NA	pumping test
Chamberlain Formation Shale (*Yc*)	siliceous, locally arenaceous shale	500	0.001 to 0.007	NA	assumed
Neihart Formation Quartzite (*Yne*)	recrystallized sandstone	800	low; N.A.	NA	assumed
Crystalline Bedrock (*Xbc*)	metamorphic crystalline rock	to depth	10^{-3} to 10^{-1}	NA	literature
Structurally Defined Hydro-Stratigraphic Units					
Volcano Valley Fault	fault; clay gouge core; variable associated fracturing	150	7.1×10^{-4} to 1.5×10^{-5} avg. 2.8×10^{-5}	NA	permeameter testing
Black Butte Fault		10 - 14			assumed
Buttress Fault		5			
Brush Creek Fault		44			

GM=geometric mean value; used when properties ranged several orders of magnitude FW=footwall
N.A.=not available; avg. = arithmetic average value; used when properties were within the same order of magnitude;
* hydraulic conductivity values determined from the aquifer testing described in the Hydrometric's 2016 Baseline Water Resources Report (2017a) in Appendix B.

4.1.2.1 HSUs Established Based in Geologic Units

Quaternary Deposits: This HSU corresponds to the alluvial sand and gravel deposits of the Sheep Creek Alluvium that lie along the axes of the major drainages.

Newland Formation: The rocks hosting this HSU are calcareous and non-calcareous shale and siltstone with discrete weathered intervals. For the purpose of this model, the Newland Formation is divided into shallow (*Ynl A*) and deep (*Ynl B*) hydro-stratigraphic units. The highly mineralized Upper Sulfide Zone (*USZ*) separates *Ynl A* and *Ynl B*. The deeper bedrock (*Ynl B*) typically produces lower yields than wells completed in the shallower bedrock unit (*Ynl A*). These hydro-stratigraphic units are designated for use specifically in the Johnny Lee deposit area, and should not be extended beyond that area.

Upper Sulfide Zone (*USZ*): This HSU divides the shallow and deep *Ynl A* from *Ynl B* and is a thick zone of mineralization that includes the upper copper zone (*UCZ*). The *USZ* is a lower permeability unit within *Ynl A* and *Ynl B*.

Flathead Sandstone: The rocks hosting this HSU are composed of well cemented, fine- to medium-grained sand. It was encountered in exploration boreholes adjacent to the Volcano Valley Fault (*VVF*). There are no test wells within the Flathead sandstone in the Project area to establish site-specific hydraulic parameters for this unit. Hydraulic conductivity is assumed to exhibit a general decrease with depth due to decreased weathering and greater overburden pressures (Snow, 1968).

Chamberlain Formation Shale: This HSU underlies the *Ynl B* and has only been encountered in exploration boreholes on the north side of the *VVF*. There are no test wells that penetrate the Chamberlain Formation shale to determine hydrologic characteristics of this unit. For the purposes of this model it is assumed to have properties similar to the shale of the lower Newland Formation (*Ynl B*).

Neihart Formation Quartzite: The rocks hosting this HSU are composed of recrystallized sandstone of the Neihart Quartzite that underlies the Chamberlain Formation shale on the north side of the *VVF*. Quartzite's have low permeability and typically form confining units except where they are fractured. No quantitative hydrologic data exist in this area. However, core hole data indicate this unit generally exhibits low permeability characteristics except in localized zones of fracturing associated with the Buttress Fault. While the Neihart Formation quartzite is considered to be a low permeability HSU in the model. It has the potential to produce high yields if highly fractured intervals are directly encountered in association with permeable fault zones (see the discussion of the Structural HSUs). It should be noted that the mine workings under the current mine plan do not intercept the Neihart Formation quartzite.

Crystalline Bedrock: This HSU forms the core of the Little Belt Mountains and is present north of the *VVF*. Because crystalline rocks have negligible primary porosity, groundwater is only present within joints and fractures. The permeability of the joints and fractures typically decreases rapidly with depth due to the combined effect of the weight of the overlying rock and the tendency of weathering to penetrate only a short distance into the bedrock. The model incorporates this general relationship between permeability and depth (Snow, 1968) and assumes that the permeability of crystalline basement rocks decreases by three orders of magnitude in its upper 300 feet (91.4 m).

Tertiary Intrusive Rocks: This HSU is partly hosted by igneous granodiorite intruded into the lower Newland Formation in the area south of the *BBF*. There are no test wells completed in the intrusive rocks. However, granodiorite is a low permeability crystalline rock that for the purpose of this model is assumed to have hydrologic characteristics similar to the crystalline bedrock.

4.1.2.2 Structurally Defined HSUs

The Johnny Lee deposit is bounded by four fault zones that have the potential to significantly influence groundwater flow through this area. These include the Volcano Valley Fault, Black Butte Fault, Buttress Fault, and Brush Creek Fault. The influence of these faults over groundwater flow is a function of the permeability characteristics within the faults. In general, fault zones are considered to have two structural zones: a core where most of the movement takes place and a surrounding damage zone where brittle fracturing may extend out into the surrounding rock. The fault core can have very low permeability due to clay-rich fault gouge that restricts groundwater flow across the fault plane. Damage zones contain fractures that can enhance the permeability of the rock immediately bounding the fault core and thus enhance flow parallel to the fault plane. The permeability of these features can be altered by later mineralization or alterations that fill the fractures and reduce permeability within the damage zone. The permeability characteristics of a given fault depend upon the presence and thickness of a gouge zone, the degree of supplementary fracturing in the damage zone, and the presence of cementation (and alteration minerals) that fills fractures.

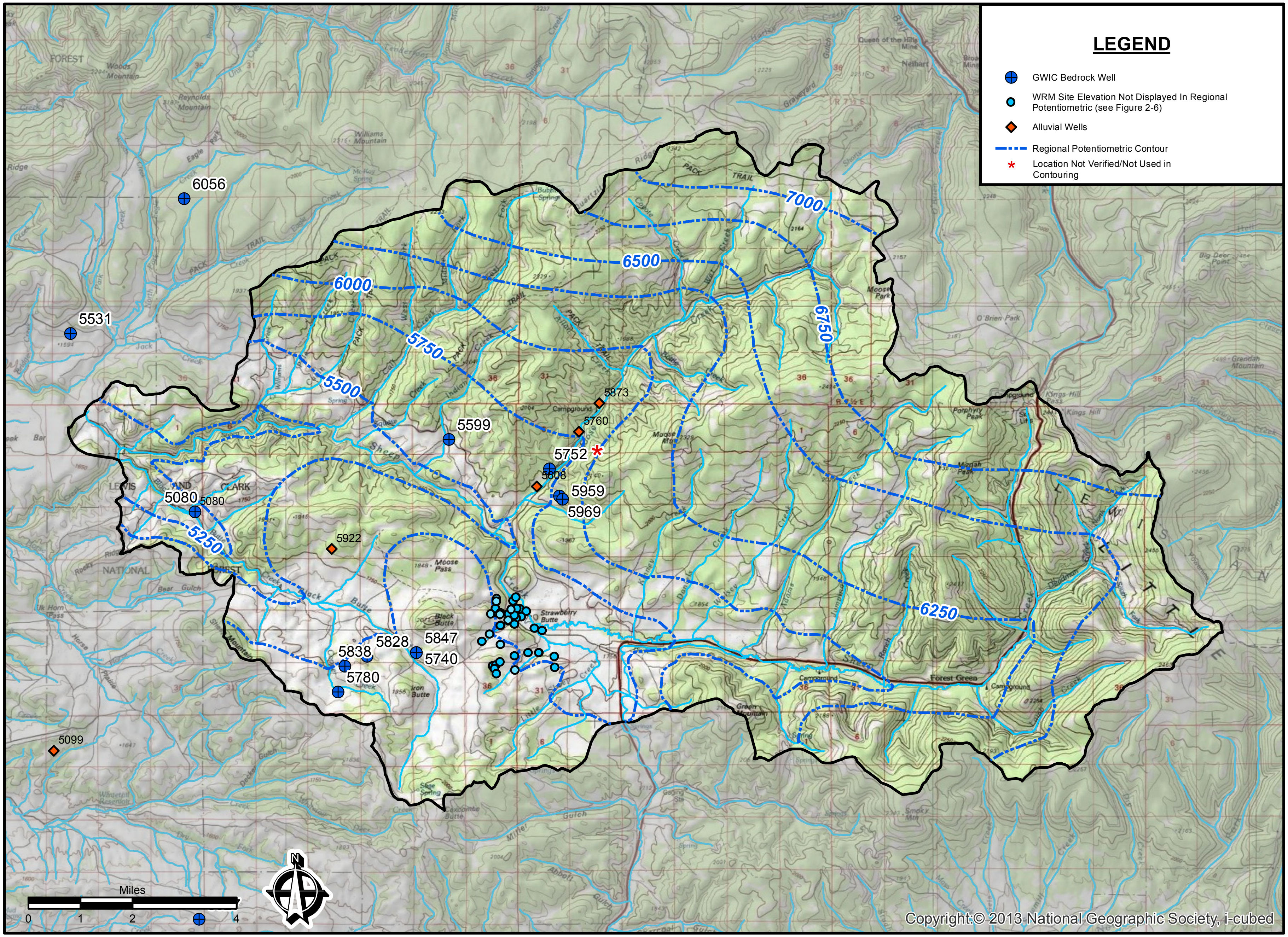
Exploration boreholes show fault gouge present within the cores of each of the faults. Therefore, these fault zones are considered separate hydro-stratigraphic units for the purposes of this model. The presence and extent of fault gouge versus open fracture / damage zones was evaluated for each of the fault units. It should be noted that below the Buttress Fault, test well PW-6 did encounter a fractured interval in the Neihart Formation quartzite approximately 175 feet (53.4 m) beneath the fault that produced high yields during air testing. The fracturing and associated permeability at this location does not appear to extend vertically upward based upon exploration drilling. Exploration boreholes showed variable degrees of fault-associated fracturing that range from competent quartzite with minor fracturing to high angle fractures in Niehart quartzite adjacent to the fault. Significant groundwater flow with artesian pressures was only noted at one of the exploration sites.

For this model all of these faults are considered to contain low permeability gouge zones that limit flow across these units. There does not appear to be a well-developed damage zone in the more ductile Newland Formation shales. Fault-related fracturing is locally more notable within the more brittle geologic units (i.e., quartzite and crystalline intrusive rocks).

4.1.3 Groundwater Flow Conditions

Both watershed-scale and local-scale potentiometric maps of the Project area were developed to define the principal directions of groundwater flow within the watershed, and provide a more detailed understanding of groundwater flow. The watershed scale potentiometric map is shown in Figure 4.6. The groundwater flow directions inferred from the potentiometric contours are generally coincident with the larger scale topographic trends. Potentiometric contours indicate that groundwater flow converges on the major drainages which include Sheep Creek, Moose Creek, Little Sheep Creek and Black Butte Creek.

A more detailed potentiometric map of the Project area was developed based on Tintina's network of monitoring wells and piezometers and is shown in Figure 4.7. The underground mine lies beneath the tight group of bedrock wells just west of Strawberry Butte. This map depicts the potentiometric surface in the lower Newland Formation wells, as well as the water table elevation in the shallow alluvial system. The alluvial groundwater system has a hydraulic gradient of approximately 0.008. The hydraulic gradient across the Project area in the shallow bedrock wells is approximately 0.065, but flattens out in Sheep Creek Meadows suggesting there is discharge of groundwater from the shallow bedrock system to the overlying alluvial aquifer in this area. Hydraulic gradients are unit less numbers with gradients measured in feet/foot.



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Date: June 2016, Source: Hydrometrics, Inc. (2016)

TINTINA RESOURCES

Figure 4.6
Watershed Scale Potentiometric Map
Black Butte Copper Project
Meagher County, Montana

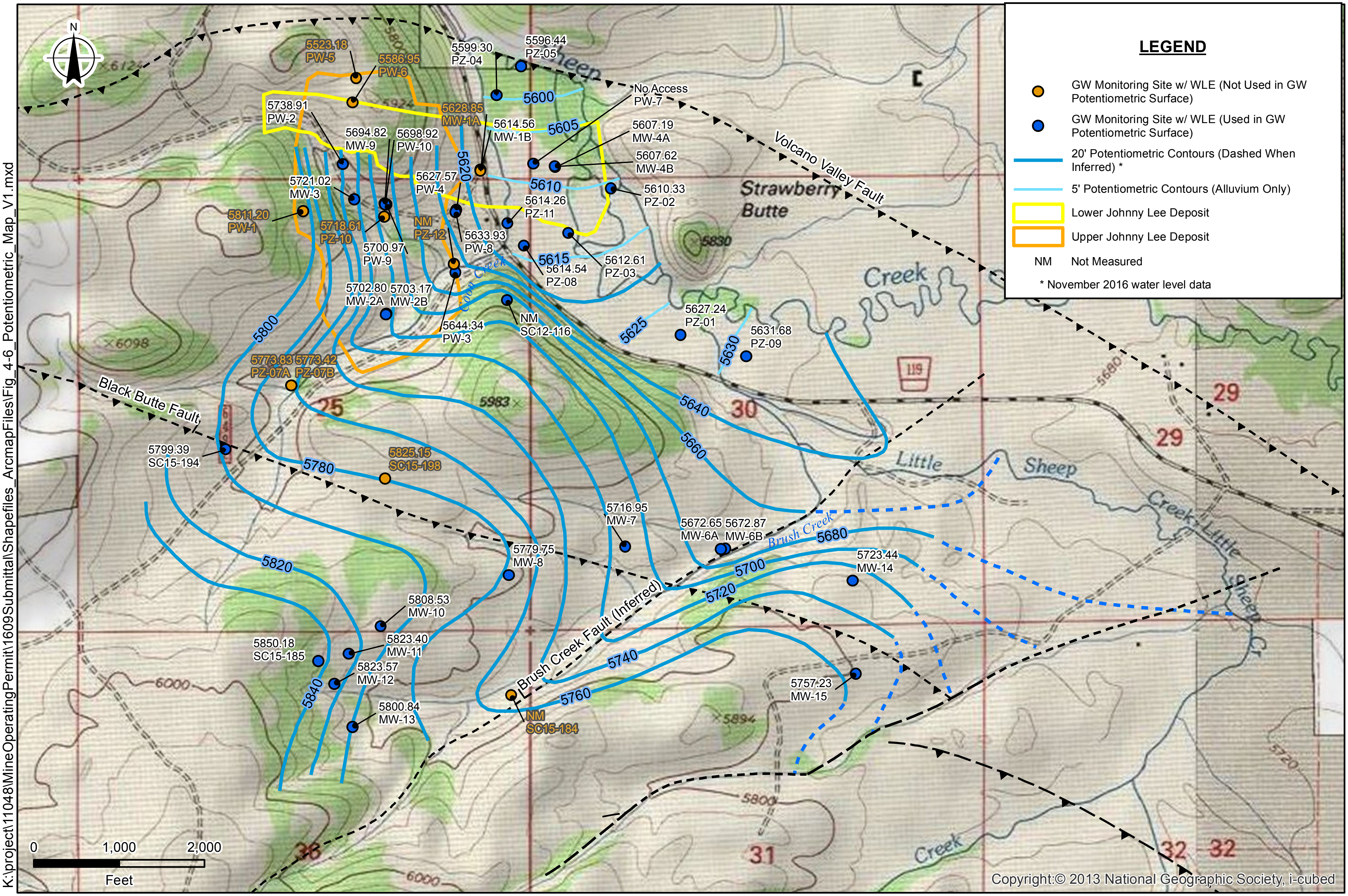

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Figure 4.7
Project Scale Potentiometric Surface Map
Black Butte Copper Project
Meagher County, Montana

Most paired wells show upward hydraulic gradients with the exception of what appears to be shallow perched groundwater over shale bedrock (MW-1A / 1B), and springs that feed the headwaters of Coon Creek (PZ-7A/7B) (Figure 2.3). In the lower elevation areas the wells show a progressive upward gradient between the deeper bedrock units and shallow units. Artesian conditions are evidenced at the depth of the lower sulfide zone (PW-7), and in an exploration core hole in the Neihart Formation quartzite (see the discussion on the Buttress Fault) (Section 4.1.2.2). The upward gradients suggest that recharge occurs from higher elevation exposures upslope, and that more competent overlying layers are producing high confining pressures in the fractured bedrock system. Wells MW-9, PW-9, and PW-10 are clustered within 10 feet (3 m) of each other, and show a large vertical gradient from the *UCZ* to both the *Ynl A* (7.27 feet; 2.2 m) and the *Ynl B* (3.69 feet; 1.1 m).

Groundwater levels typically show seasonal fluctuations in the bedrock wells of 1 to 3 feet (0.3 to 0.91 m), peaking in early June and declining through the summer months (Hydrometrics, 2015b). Groundwater levels continue to decrease at a slower rate through the winter months and reach seasonal lows in February and March. The shallow alluvial system fluctuates 1 to 1.5 feet (0.3 to 0.46 m) seasonally with similar seasonal trends as those observed in the bedrock system. The seasonal early June spike in water levels occurs more rapidly in the alluvial system than in the bedrock system and also tails off more rapidly, stabilizing at a lower level by late August or September through April.

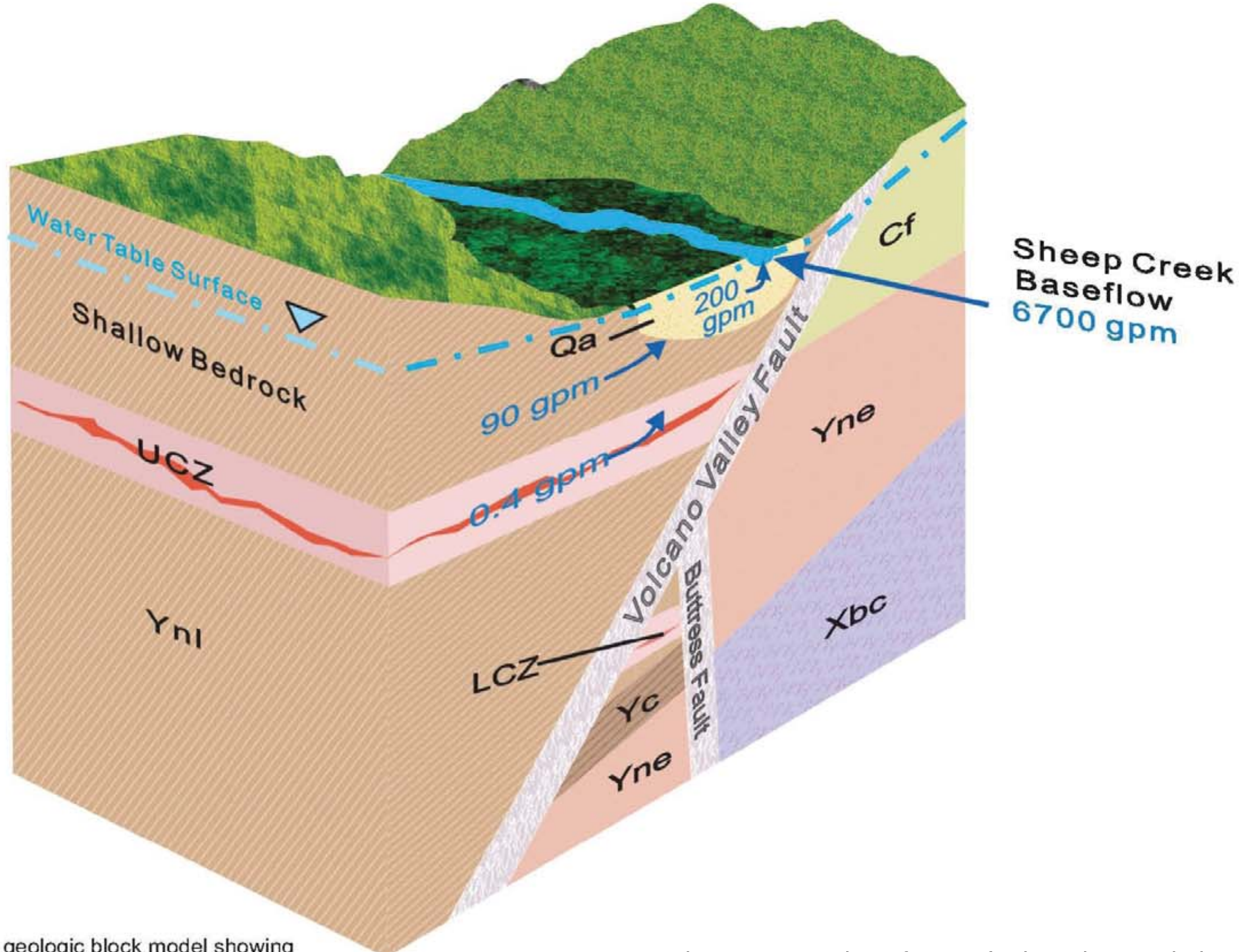
Water levels generally indicate confined or leaky confined conditions in the bedrock aquifers and unconfined conditions in the shallow alluvial system. With a few exceptions water was first encountered in the bedrock wells a substantial distance below the stabilized water level elevations in the completed wells. Low permeability shale layers appear to produce confined pressure conditions in these areas. Leaky confined systems may be present in shallow bedrock wells at MW-4 and MW-6, where saturated conditions were encountered above the primary producing zones in the wells.

Groundwater flux through the Sheep Creek alluvium, the shallow bedrock system (*Ynl A*), and the upper sulfide zone (*USZ*) can be estimated from potentiometric data and hydraulic conductivity data using a simple Darcy's Law calculation (see Section 2.2.6.1. Because this applies a simplified porous media solution to bedrock formations with variable properties, it should only be considered a generalized assessment of the relative flux of groundwater in each of these units. The calculations focus on flow through the bedrock within the footprint area of the upper deposit, and flow through the downgradient alluvial system towards Sheep Creek. Input assumptions and estimated fluxes are shown in Table 4-2.

Table 4-2. Darcy's Law Groundwater Flow Estimates

	Hydraulic Conductivity (ft./day)	Aquifer Width (ft.)	Aquifer Thickness (ft.)	Hydraulic Gradient	Groundwater Flux (gpm)
Sheep Creek Alluvium	200	1,500	16	0.008	199
Ynl A	1.5	3,400	50	0.065	86
Upper Sulfide Zone	0.01	3,400	30	0.0675	0.36

These estimates show the relative groundwater flux through each unit (shown graphically in Figure 4.8) which represents the relative contributions from these units to base flow in Sheep Creek. Flow in the shallow bedrock system may account for up to 45% of the groundwater flow in the sand and gravel alluvial aquifer at this location, while flow in the Upper Sulfide Zone in the deeper *Ynl B* bedrock account for less than 0.2% of that in the alluvial system. The total discharge from the alluvial aquifer in the Sheep Creek Meadows area is approximately 3% of typical late season (steady state) base flow conditions in Sheep Creek (6,700 gpm; 25,400 Lpm) within this reach.



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Note: Generalized geologic block model showing conceptual flow from upper hydro-stratigraphic units

See Figures 1.5 and 1.6 for Geologic Unit Descriptions

Prepared by: Hydrometrics (2016)

TINTINA RESOURCES

Figure 4.8
Block Flow Diagram
Mine Operating Permit Application
Meagher County, Montana

4.1.4 Groundwater – Surface Water Interaction

Exchange of groundwater and surface water is controlled by the relative elevation difference between the water table and the streams, and the permeability of the streambed. With the exception of periods of peak stream flow levels during spring run-off, Sheep Creek is typically lower than groundwater levels in the alluvium and bedrock groundwater systems, and acts as a sink for collection of groundwater discharge. In contrast, some of the tributary drainages such as Coon Creek issue from smaller spring fed perched groundwater systems. These streams become perennial in their lower reaches, where they intercept the regional water table.

Groundwater within the Sheep Creek alluvium is directly connected to Sheep Creek. The alluvial gravels are recharged from the stream during high flow periods. They receive groundwater recharge from adjacent and underlying bedrock systems and alluvial systems in tributary drainages during the remainder of the year. Alluvial groundwater enters the stream where the Sheep Creek channel enters narrow bedrock canyons immediately north of the Project area, and alluvial deposits are extremely minor or absent. The amount of recharge to Sheep Creek from the alluvial aquifer in the narrow bedrock canyon immediately downstream of the Project was estimated at approximately 200 gpm (760 Lpm). This represents a relatively small increase in the total steady state base flow of Sheep Creek (approximately 3%). A similar increase is presumed in stream flow at a second location approximately 3 miles (4.8 km) downstream of the Project area where Sheep Creek again enters a narrow bedrock canyon for which there are no well data. There is a gradual increase in steady state base flow on Sheep Creek from upstream to downstream that represents progressive groundwater discharge to the stream on the order of 300 to 340 gpm (1,136 to 1,287 Lpm) per stream mile (0.66 to 0.75 cfs/mile). This increase excludes surface inflow from the major tributaries.

4.1.5 Water Balance

4.1.5.1 Groundwater Recharge

Infiltration of precipitation and snow melt are the primary sources of recharge to the groundwater system. Infiltration rates of 10 to 15% of annual precipitation are commonly assumed as a reasonable approximation of groundwater recharge rates in modeling analyses of intermontane basins in western Montana (Briar and Madison, 1992). It is assumed that virtually all of the infiltration recharge to the shallow and deeper groundwater flow systems within the drainage reports back to Sheep Creek and its major tributaries. Therefore, generalized flow estimates during steady state base flow periods (December through March) should approximately correlate with the percentage of annual infiltration rate. A 10% infiltration rate appears to closely match observed steady state base flows. Further discussion of groundwater recharge is discussed in Appendix M. The calculated results are shown in Table 4-3.

Table 4-3. Observed Base Flow and Calculated Infiltration Base Flow

Sheep Creek Gaging Stations	USGS-SC1	SW-1
Watershed Area (acres)	27,676	50,162
Watershed Area (m^2)	1.12E+08	2.03E+08
Average Annual Precipitation (in)	28.3	26.4
Average Annual Precipitation (m)	0.72	0.671
Volume (acre-ft.)	6.53E+04	1.10E+05
Volume (m^3)	8.06E+07	1.36E+08
Assumed Infiltration rate	**10%**	**10%**
Baseflow Estimate (cfs)	9.0	15.2
Baseflow observed (cfs)	9.1	15.0

Notes: These average values were calculated from a 30-year average PRISM model. See Figure 2.2 for gaging station locations.

While widespread irrigation can be a significant source of recharge to shallow groundwater systems, the irrigated acreage adjacent to Sheep Creek is a very small fraction of the watershed area (<2%). Hydrographs do not indicate that return flows contribute significantly to steady state base flow conditions in the late winter / early spring. Given the limited acreage in this watershed that is under irrigation and the timing of irrigation returns, irrigation is unlikely to be a significant factor in simulating groundwater flow conditions during steady state base flow periods.

4.1.5.2 Groundwater Discharge

Groundwater flow within the shallow and deeper groundwater systems in the Sheep Creek drainage appears to coincide with general topographic trends and likely reports back to Sheep Creek within the confines of the basin. Stream flow monitoring has been conducted at baseline monitoring sites in the vicinity of the Project site (Hydrometrics, 2015b). There is also a historical USGS gaging site (SW-1) on Sheep Creek below the confluence of Adams Creek (Figure 4.1). Late season stream flow data are not available for many of the tributaries or for Sheep Creek at the confluence of Black Butte Creek (which represents the lower boundary of the study area). Stream flow estimates for these ungauged sites were assessed using a similar method to that used to establish recharge rates. The calculated watershed areas, average annual precipitation rates, annual flow volumes, and resultant steady state base flow estimates are summarized in Table 4-4.

Table 4-4. Baseflow Estimates for Selected Sheep Creek Watershed Areas

Watershed	Watershed Area (acres)	Average Annual Precipitation (ft.)	Precipitation Volume (ac-ft.)	Baseflow Estimate* (cfs)
Sheep Creek at USGS - SC1	2.77E+04	2.36	6.54E+04	9.0
Sheep Creek at SW-1	5.02E+04	2.20	1.10E+05	15.3
Sheep Creek at confluence of Black Butte Creek	1.12E+05	2.10	2.34E+05	32.3
Moose Creek	2.32E+04	2.41	5.61E+04	7.7
Black Butte Creek	1.47E+04	1.57	2.31E+04	3.2
Calf Creek	6.47E+03	2.30	1.49E+04	2.1
Adams Creek	4.73E+03	2.55	1.21E+04	1.7

*Calculated based on 10% of annual precipitation volume

Streamflow measurements were taken on Sheep Creek at the confluence with Black Butte Creek, on Black Butte Creek at the confluence with Sheep Creek, on Moose Creek and at Sheep Creek gaging station in September of 2015. These were compared to precipitation-based flow estimates. These steady state base flow estimates are shown in Table 4-5.

The results from Sheep Creek compare favorably to the previous precipitation steady state base flow estimates at the downstream limits of the model. Sheep Creek and Moose Creek show greater variability. This may reflect the applicability of seasonal Sheep Creek flow adjustments to these other drainages due to seasonal irrigation diversions and seasonality of flow characteristics. However, both are within the assumed accuracy of the estimate (± 20%).

Table 4-5. Seasonally Adjusted Flow Measurements

Site	September 2015 Flow (cfs)	Adjusted to Late Season Norm (cfs)	Precipitation-Based Estimate (cfs)
Sheep Creek at SW-1	9.0	15.3	15.3
Sheep Creek at Black Butte Creek	17.7	30.0	32.2
Moose Creek at mouth	6.0	10.1	7.7
Black Butte Creek at mouth	1.5	2.6	3.2

4.1.6 Summary of Groundwater Numerical Modeling Assessment

4.1.6.1 Introduction

A numerical groundwater modeling analysis was conducted to assist Tintina with mine design and planning, and to assess the potential for impacts to groundwater and surface water from dewatering throughout the mine life and after closure. The hydrogeology has been well characterized in the shallow HSUs in the Project area, and therefore the model has a smaller degree of uncertainty associated with them. There is increasing uncertainty in the properties of the lower HSUs (e.g., *LCZ*). However, flow volumes and hydraulic conductivity from these lower units is very small. Uncertainty associated with the properties of the outlying HSUs also increases.

The model used in the assessment is the USGS three-dimensional finite difference groundwater model MODFLOW-USG. This software uses conservative assumptions (i.e., larger storage capacity in HSUs where data was not available) to assess impacts to water resources. In addition, it simulated the headwaters of both Coon Creek and Brush Creek, despite the fact that hydrological investigations indicate the headwaters of these two drainages are not connected to the deeper groundwater system. This provides additional conservatism to the assessment of effects on surface water.

The model domain is divided into 16 layers and discretized with an unstructured grid into 320,972 cells. The unstructured grid is more tightly discretized around key features (surface water, mine structures, and faults) within each layer. The layers within the model vary in thickness and are designed to provide sufficient discretization to simulate specific hydrologic relationships. Layer 1 is approximately 16 feet (4.88 m) thick which represents the thickness of the alluvial systems and highly weathered shallow bedrock. Layers 2 and 3 are used to define the shallow bedrock flow conditions within the *Ynl A* which is more permeable and fractured than the deeper *Ynl B* bedrock. Throughout most of the model, layers 4 through 6 represent a transitions zone from the more permeable fractured bedrock conditions near the surface to the base bulk permeability of the more competent bedrock at depth. In the Project area layers

4 through 6 correlate with the *USZ* and *UCZ;* Layer 4 and 6 consist of the *USZ* overlying and underlying the *UCZ* in Layer 5. Layers 7 through 16 represent the deeper bedrock system with layer 11 representing the *LCZ* in the Project area.

The model uses equivalent porous media (EPM) assumptions as the most reasonable method to characterize the hydrogeological system. However, the regional bedrock in the model domain is a fracture-controlled system. Using the equivalent porous media approach presumes that each cell in the model represents a combination of fractures and rock matrix. Where fractures are sparse the hydraulic conductivity is very low, and where fracturing is more prevalent the hydraulic conductivity is higher.

The results of the groundwater modeling analysis are discussed below. Details of the model are described in the Groundwater Modeling Assessment Report included in Appendix M (Hydrometrics, 2016a).

4.1.6.2 Summary of Model Results

Simulated mine inflows range from 220 to 500 gpm (833 to 1,893 Lpm). The lowest inflows occurring upon completion of the surface decline at the end of year one (Table 4-6). The highest simulated inflows are in year four (following construction of all access drifts and declines to the full depth of the mine, and at the commencement of full scale mining). The calibrated model indicates that the inflow rates decrease in subsequent years (as more cemented paste is backfilled into the mined out stopes). Sensitivity analyses show that the estimated flow could increase between 10 and 15% if there is higher storage capacity or elevated hydraulic conductivities in the lower layers relative to what was modeled in the steady state model.

The model simulations show that the effects on surrounding groundwater levels (drawdown) are relatively localized, with most of the drawdown occurring within the Project area. The largest magnitude of drawdown is seen in the *LCZ* where drawdown exceeds 1,500 feet (457 m). The drawdown cone is very steep and narrow in the lower zone, and does not extend into the upper layers. A similar trend is seen by comparing the magnitude of drawdown in the *UCZ* (maximum drawdown approximately 500 feet (152 m)) and the top of the water table (maximum drawdown approximately 290 feet; 88 m). Similar to the mine inflow estimates, the largest extent of drawdown is seen in year four (Figure 4.9), with the drawdown extents receding as stopes are backfilled with cement paste and mine inflows are reduced.

The simulated drawdown in the groundwater of the sand and gravel alluvial system of Sheep Creek is approximately 10 feet (3.0 m) near the western edge of the alluvium where Coon Creek flows to the north. Coon Creek appears to limit the drawdown in this area as the drawdown is reduced below 5 feet (1.5 m) just east of Coon Creek. Drawdown in groundwater of the alluvial system beneath Sheep Creek is approximately 1 foot (0.3 m).

Table 4-7 shows the simulated steady state base flow for streams in the primary watershed areas addressed by the model throughout the mine life. The model simulations indicate that surface water depletion from mine dewatering within the Project area are primarily in Sheep Creek upstream of SW-1 with a maximum depletion of 0.35 cfs, which is approximately 2% of the steady state base flow in Sheep Creek at this location. Streamflow reductions in Sheep Creek at its confluence of Black Butte Creek (model domain) were simulated to be approximately 0.45 cfs or 1.4% of steady state base flow. The stream depletion at the model domain is a combination of the depletions in Sheep Creek above SW-1 and a minor simulated depletion in Black Butte Creek of 0.1 cfs (approximately 3 to 4% of the flow in Black Butte Creek). The simulated depletions in Black Butte Creek are a result of capturing groundwater near the groundwater divide between Sheep Creek and Black Butte Creek, which would typically discharge to Black Butte Creek. As noted above and in the groundwater modeling report (Hydrometrics, 2015c), the model uses conservative assumptions with the use of EPM model, and simulation of headwater drainages in the model. The bedrock aquifer likely has less connectivity than the EPM model simulates which would limit the extents of the drawdown and stream depletion. However, the total stream depletion in Sheep Creek would likely not change as it is assumed to be near the predicted consumptive use of the project.

All of the simulated stream depletions are within the measurement error for surface water discharge measurements (generally ± 10%). The total simulated depletion is near the consumptive use rate of the Project (210 gpm; 800 Lpm; 0.47 cfs). The water rights mitigation plan will offset all of the stream depletion in Sheep Creek (and Black Butte if necessary) by mitigating flows at a rate equal to the consumptive use of the project (estimated at 210 gpm; 800 Lpm) as required in closed basins by the Montana Department of Natural Resources and Conservation (DNRC).

Table 4-6. Simulated Annual Average Inflow to Mine Workings

Mining Progress	Surface Decline	Declines and Access Ramps			Mine										
Project Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Mine Structure	**Inflow (gpm)**														
Surface Decline Total	**223**	**159**	**106**	**105**	**108**	**106**	**110**	**110**	**110**	**111**	**113**	**111**	**110**	**113**	**125**
Surface Decline (YNL-A)	203	146	97	96	98	97	101	101	101	102	103	101	101	104	116
Surface Decline (UCZ)	20	12	9	9	9	9	9	9	9	9	9	9	9	9	9
Upper Access and Stopes Total	**0**	**141**	**279**	**292**	**262**	**272**	**249**	**248**	**247**	**244**	**238**	**240**	**239**	**233**	**215**
UZ Access/Stopes (USZ/UCZ)	0	129	268	282	251	261	238	237	236	233	227	229	228	222	204
UZ Access (YNL-B)	0	12	12	10	11	11	11	11	11	11	11	11	11	11	11
Lower Decline Total	**0**	**83**	**84**	**85**	**83**	**80**	**79**	**78**	**78**	**77**	**77**	**76**	**75**	**75**	**75**
Lower Decline (YNL-B)	0	83	84	85	83	80	79	78	78	77	77	76	75	75	75
Lower Access and Stopes Total	**0**	**0**	**2**	**15**	**12**	**9**	**8**	**8**	**7**	**7**	**7**	**7**	**7**	**6**	**6**
LZ Access/Stopes (LCZ)	0	0	0	5	4	3	2	2	2	2	2	2	2	2	1
LZ Access (YNL-B)	0	0	2	10	7	6	6	6	5	5	5	5	5	5	5
Total Mine Inflow	**223**	**382**	**472**	**497**	**465**	**467**	**447**	**445**	**442**	**439**	**434**	**433**	**431**	**427**	**421**

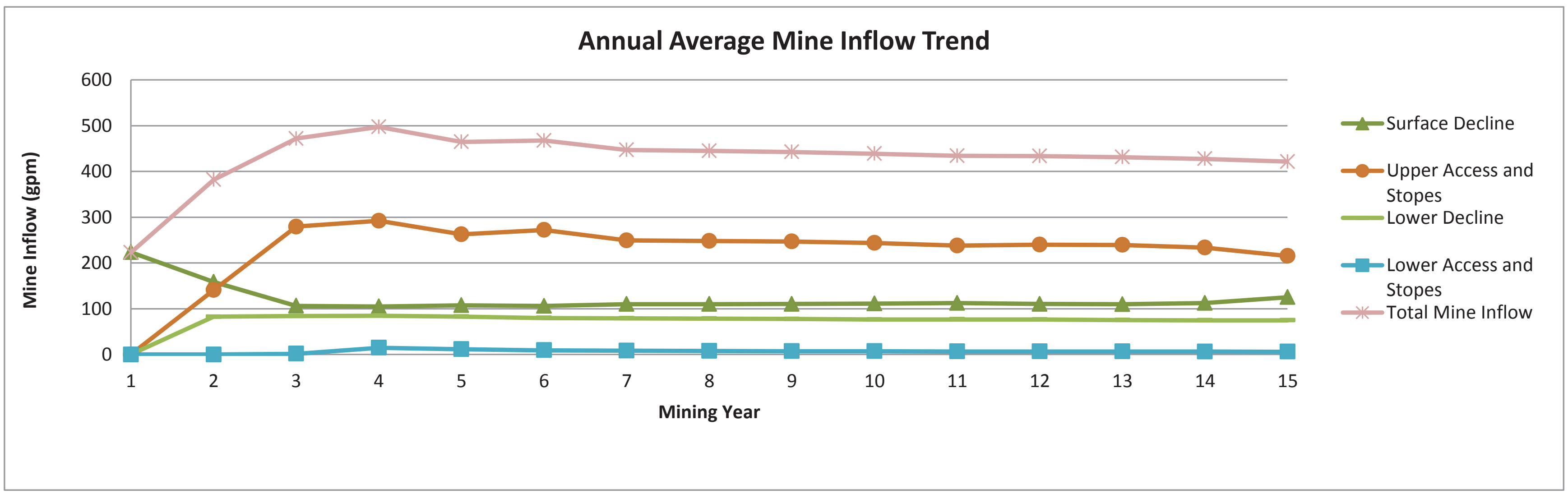
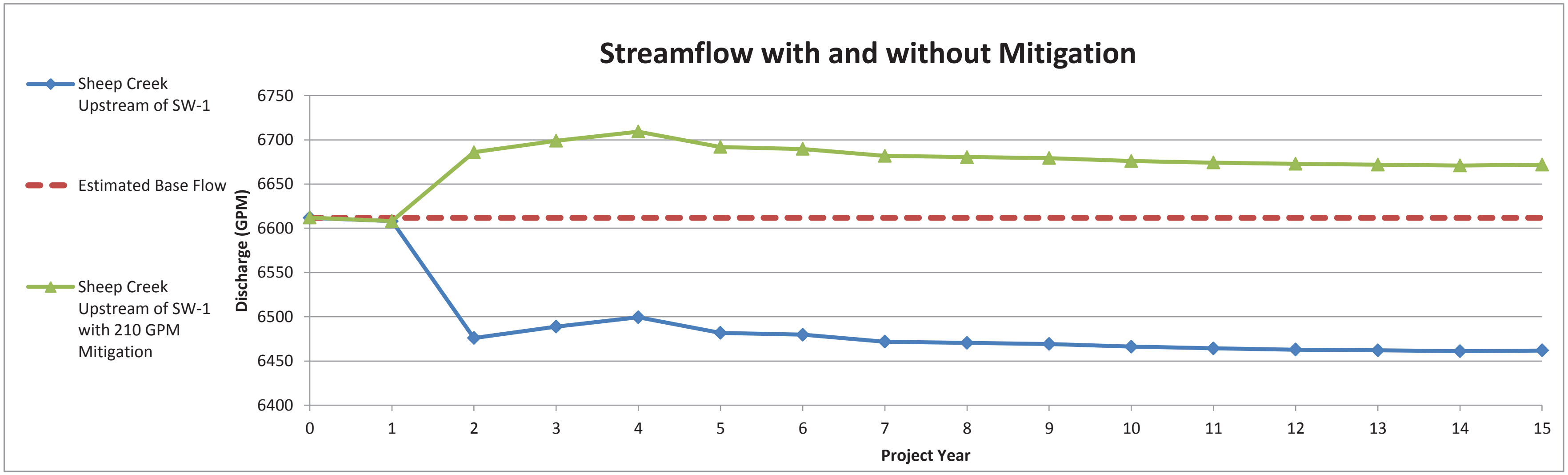
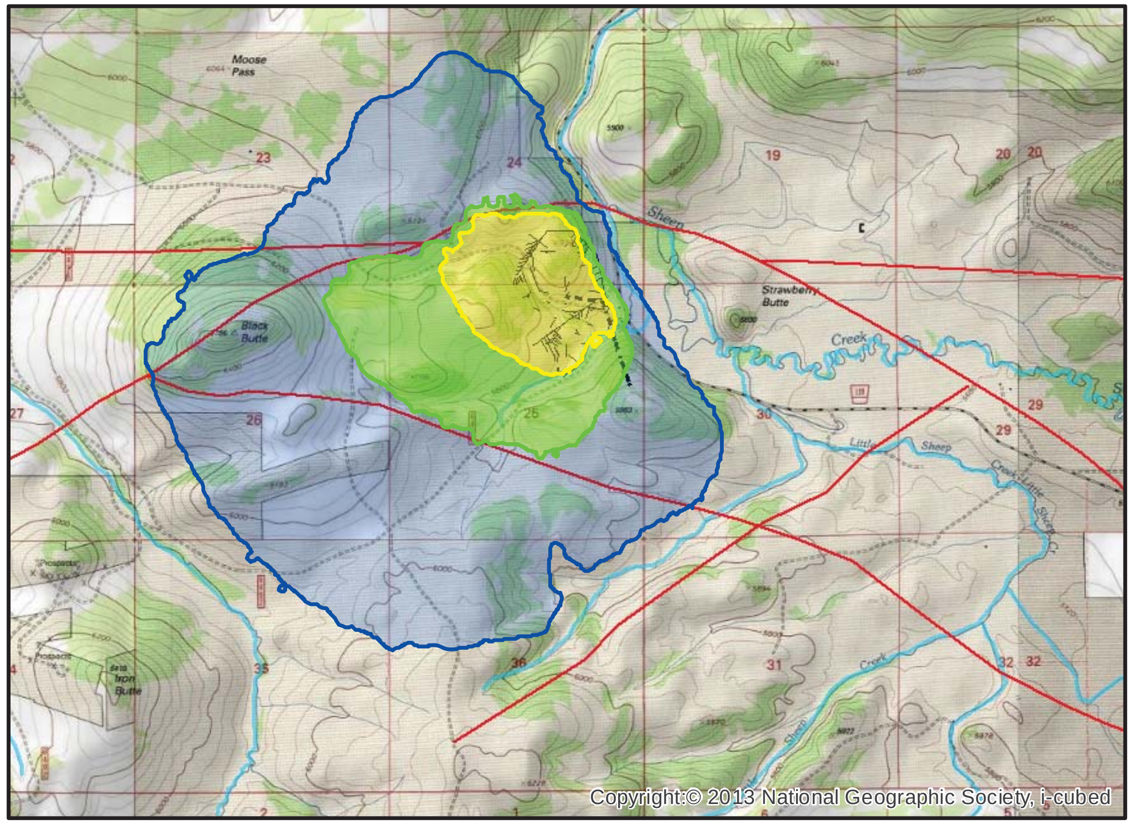


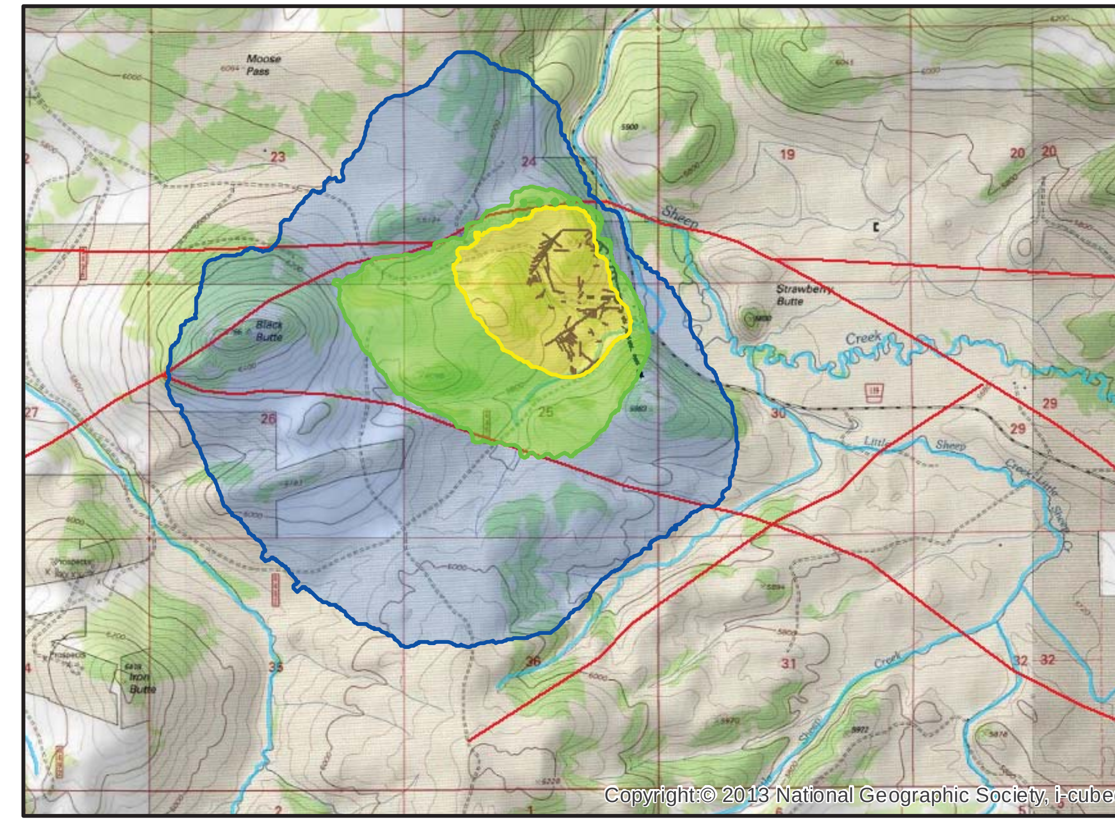
Table 4-7. Surface Water Flow with Water Rights Mitigation

Mining Progress	Pre-Mining/ Steady State	Declines and Accesss		Declines/Access Ramps/Mining		Mining										
Project Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Basin	**Simulated Groundwater Discharge to Surface Water (gpm)**															
Sheep Creek Upstream of SW-1	**6612**	6608	6476	6489	6499	6482	6480	6472	6470	6469	6466	6464	6463	6462	6461	6462
Sheep Creek Upstream of SW-1 with 210 GPM Mitigation	**6612**	6608	6686	6699	6709	6692	6690	6682	6680	6679	6676	6674	6673	6672	6671	6672

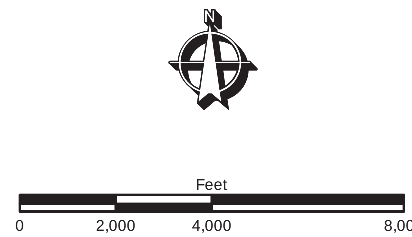




Top of Water Table



Layer 3

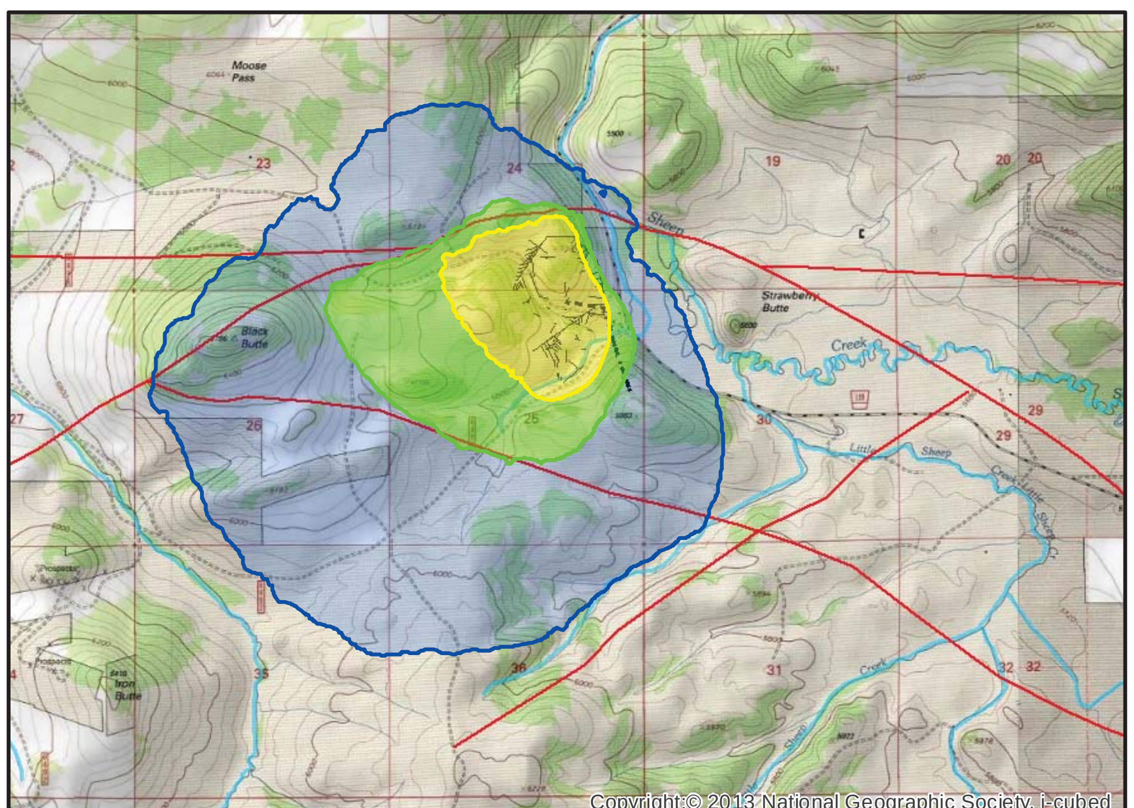


LEGEND

- Upper Decline
- UpperAccess
- Lower Decline
- LCZ Access
- Faults (surface expression)
- Rivers and Streams

Drawdown Interval (feet)

- 10
- 50
- 100
- 500
- 1000



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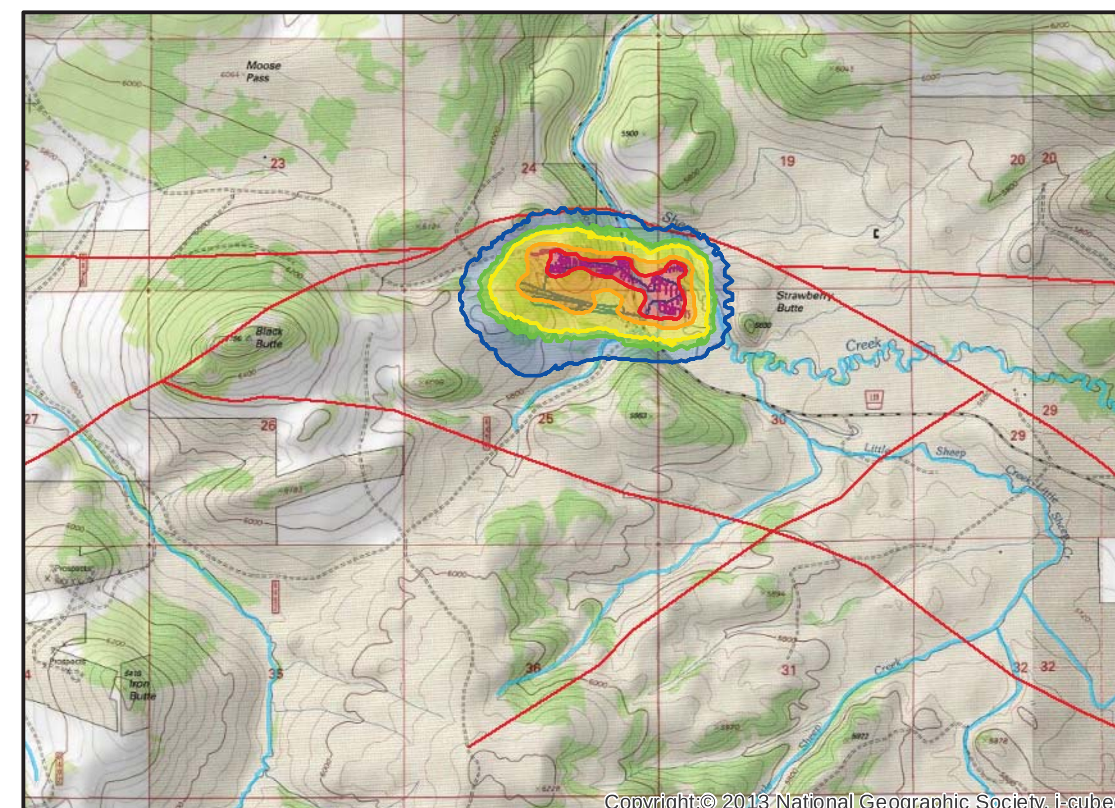

Layer 11

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Revised by Hydrometrics (2016)

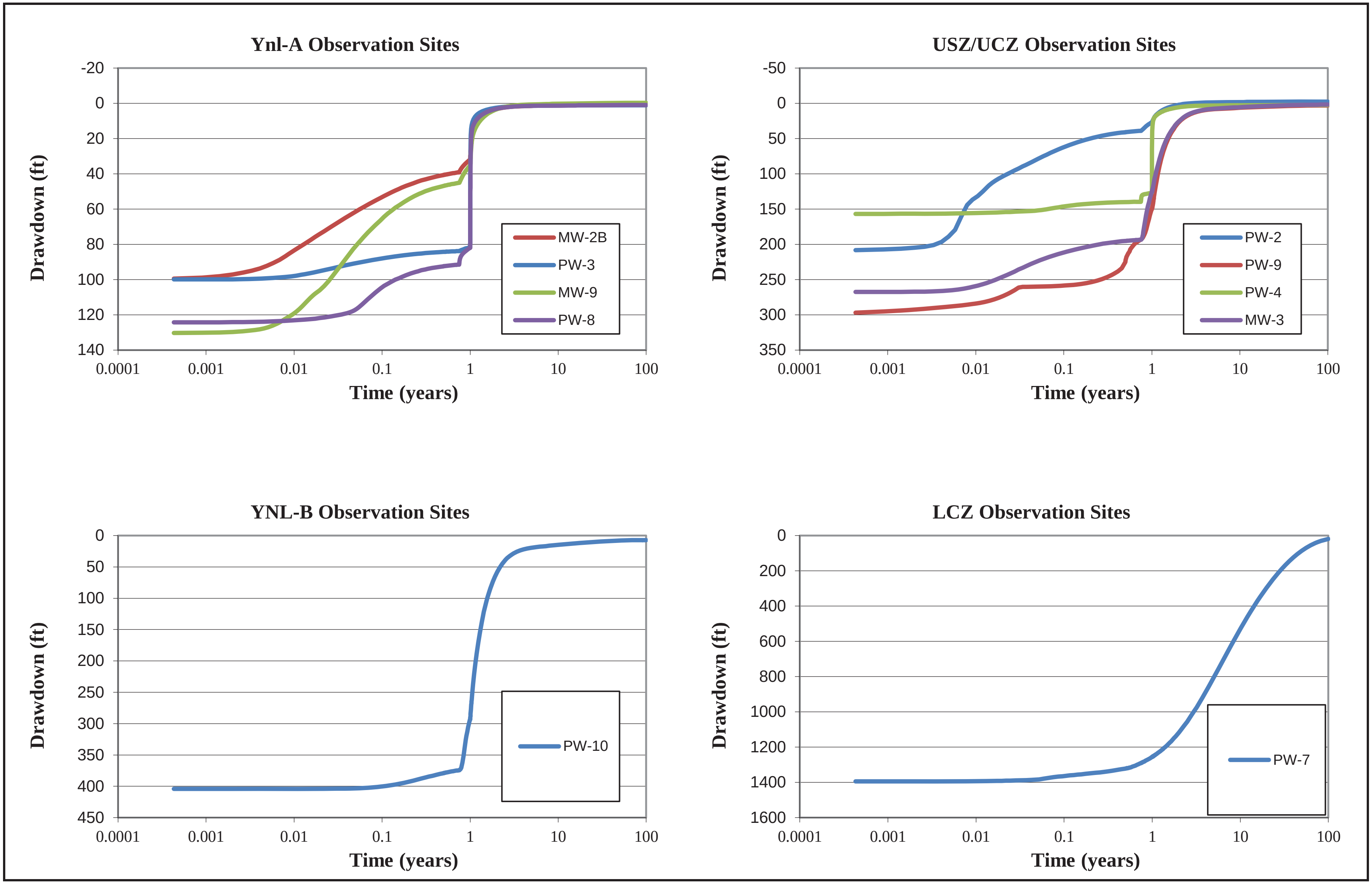
Figure 4.9
Simulated Drawdown - Year 4
Black Butte Copper Project
Meagher County, Montana

The largest relative impacts to streamflow are seen in Coon Creek, which is part of the SW-1 watershed and runs over the southern edge of the *UCZ* and above the surface decline. The model simulates a 70% reduction in steady state base flow at the end of mining; the majority of the reduction is in the lower reach of Coon Creek where it is in connection with the alluvial system. Coon Creek is a small tributary stream to Sheep Creek, and is often fully diverted during the irrigation season and frozen during the winter months. Tintina has an agreement with the water right holder for Coon Creek to utilize the water right if necessary. Based upon these factors, the reduction in flow to Coon Creek itself will not have a substantive effect on water resources in the area. The primary effect on downstream water resources is addressed in the evaluation of the SW-1 watershed and at the model domain.

Post mining simulations indicate that the effects from dewatering will decrease slightly in the groundwater system and surface water resources through the first year of closure. Figure 4.10 shows the recovery over time for wells completed in the *Ynl A, USZ / UCZ, Ynl B*, and *LCZ.* Effects on water resources decrease quickly after the first year. The shallow water table is within 1-2 feet (0.3 to 0.6 m) of pre-mining levels within three to four years of closure and the reduction in stream flows are limited to the SW-1 watershed (≤0.1 cfs). There are no measureable effects to stream steady state base flow resulting from mine dewatering either operationally or during closure. There are no model predicted effects to stream flow 20 years after mining has stopped.

The modeling analysis includes an evaluation of effectiveness of grouting the near surface portion of the decline as a mitigation alternative to reduce mine inflow and corresponding effects on nearby surface water streams and groundwater. The grouting mitigation simulations show a large decrease in mine inflows to the surface decline; with the first year having a 10-fold reduction. However once additional mine workings are developed the flow draining to the mine workings is only reduced by 15% to 25% (66 to 84 gpm) from the simulation without grouting. This reduction has no effect on the simulated depletion to the streams as the mine dewatering rate is still larger than the consumptive use rate of 210 gpm (800 Lpm).

The Project is located in the Upper Missouri River Basin, which is closed to new surface water appropriations. Tintina is in the process of developing an application for a groundwater right for the use of water produced from underground and put to beneficial use in the mill, tailings paste plant, and other water needs, of which an estimated 210 gpm (800 Lpm) are consumptive. A mitigation plan is being developed with the assumption that all of the consumptive use will result in depletion in surface water, which is similar to what the model shows. The mitigation plan will recommend providing water indirectly to the surface water system at the consumptive use rate (210 gpm, 800 Lpm) to offset any depletion in the streams, including those below the CTF. A table of estimated values for consumptive use of groundwater by component is provided as an inset to Figure 3.44. This is shown by adding the water right mitigation rate of 210 gpm (800 Lpm) to the simulated steady state base flow in the streams during mining resulting in the net flow in the streams being equal or greater than the steady state base flows prior to mining. Table 4-6 shows the steady state base flow in Sheep Creek in the watershed upstream of SW-1 throughout the mine life, and the resultant steady state base flow with water rights mitigation.



Date: June 2016 Source: Hydrometrics (2016)

TINTINA RESOURCES

Figure 4.10

Water Level Recovery - Post Mining

Black Butte Copper Project

Meagher County, Montana

4.1.7 Post Closure Analytical Model

In addition to the numerical modeling analysis, analytical models were developed to evaluate the potential effects the open mine workings (access drifts and ventilations raises) may have on water resources. The numerical modeling analysis did not include open mine workings (declines, access drifts, or ventilation raises) as these are discrete features and they are not currently supported in the Graphical User Interfaces that support MODFLOW-USG. Although the open mine working are discrete features they extend across an area with a large change in hydrostatic head. In an open mine working, the potentiometric head in the working will equilibrate to the average head (weighted by permeability if large difference between HSUs) occur across or along the workings; resulting in large draw-down and mounding at the ends of the tunnel workings. Differences in head between HSUs that are encountered by the ventilation raises has the potential to increase the flux from one HSU to another. The post-closure analytical models were evaluated based on a fully recovered water table as that is when the potential effects from the open mine workings would be greatest. A detailed summary of the three analytical models is summarized in a technical memorandum (Hydrometrics 2017c) and included in Appendix M-3. The general methodology and results are summarized below.

4.1.7.1 Access Tunnels (Drifts) and Decline Analytical Models

The Lower Decline and the Southwest Access drift (SW) extend through an area with a potentiometric head change of 200 feet (61 m) and 140 feet (42.7 m), respectively (Figure 4.11). The potentiometric head in the open mine workings will equilibrate to the average head across (along) the workings; therefore the head in the mine opening will draw-down by 100 feet (30.5 m) in the lower decline and 70 feet (21.4 m) in the Southwest Access drift to the *USZ* in the up-gradient portion of the tunnels and mound by an equal amount in the down-gradient portion of the tunnels. However this large change in head only exists in the open tunnel; the change in head in the bedrock immediately adjacent to the tunnel is dependent on the flow rate in the bedrock either in or out of the access drift tunnel. The analytical model looks at the mounding on the down-gradient portion of the open workings. The inverse would occur in the up-gradient portion of the tunnel. In the down-gradient portion of the access tunnel the mound at the top of the water table is dependent on how the flow from the tunnel dissipates through the different hydro-stratigraphic units. The mounding and flow through the tunnel and subsequently through the different hydro-stratigraphic units were evaluated using Darcy's Law to calculate flux and Hantush mounding analysis to estimate mounding in each hydro-stratigraphic units. Figure 4.12 shows the flow path and modeling steps for the *USZ* access drift (ramp) and the Lower (LCZ) Decline.

The Lower Decline is completed in the *Ynl B*, therefore flow and mounding were evaluated using a flow path from the tunnel to the *Ynl B,* then vertically to the *USZ / UCZ* and a final analysis in the *Ynl A* (Figure 4.13). The Southwest Access Drift (tunnel) is completed in the *USZ / UCZ* resulting in a flow path from the tunnel to the *USZ/UCZ* and then vertically to the *Ynl A* (Figure 4.14). The estimated flow from the access tunnels to the bedrock is approximately 0.04 gpm for the Lower Decline and 0.23 gpm for the Southwest Access drift. The resultant mounding at the top of the water table is less than 0.01 feet (3mm) from the Lower Decline and approximately 0.5 feet (15cm) from the Southwest Access drift. With the unsaturated zone being about 30 feet (9 m) and 50 feet (15.2 m) at the downgradient end of the Lower Decline and Southwest Access, respectively, the potential mounding from the access tunnels will not result in any seepage to the surface.

4.1.7.2 Ventilation Raise Post-Closure Analytical Model

The analytical analysis of open ventilation raises during post-closure was conducted on the EVL ventilation raise to estimate the flux from different HSUs that are encountered by the ventilation raise

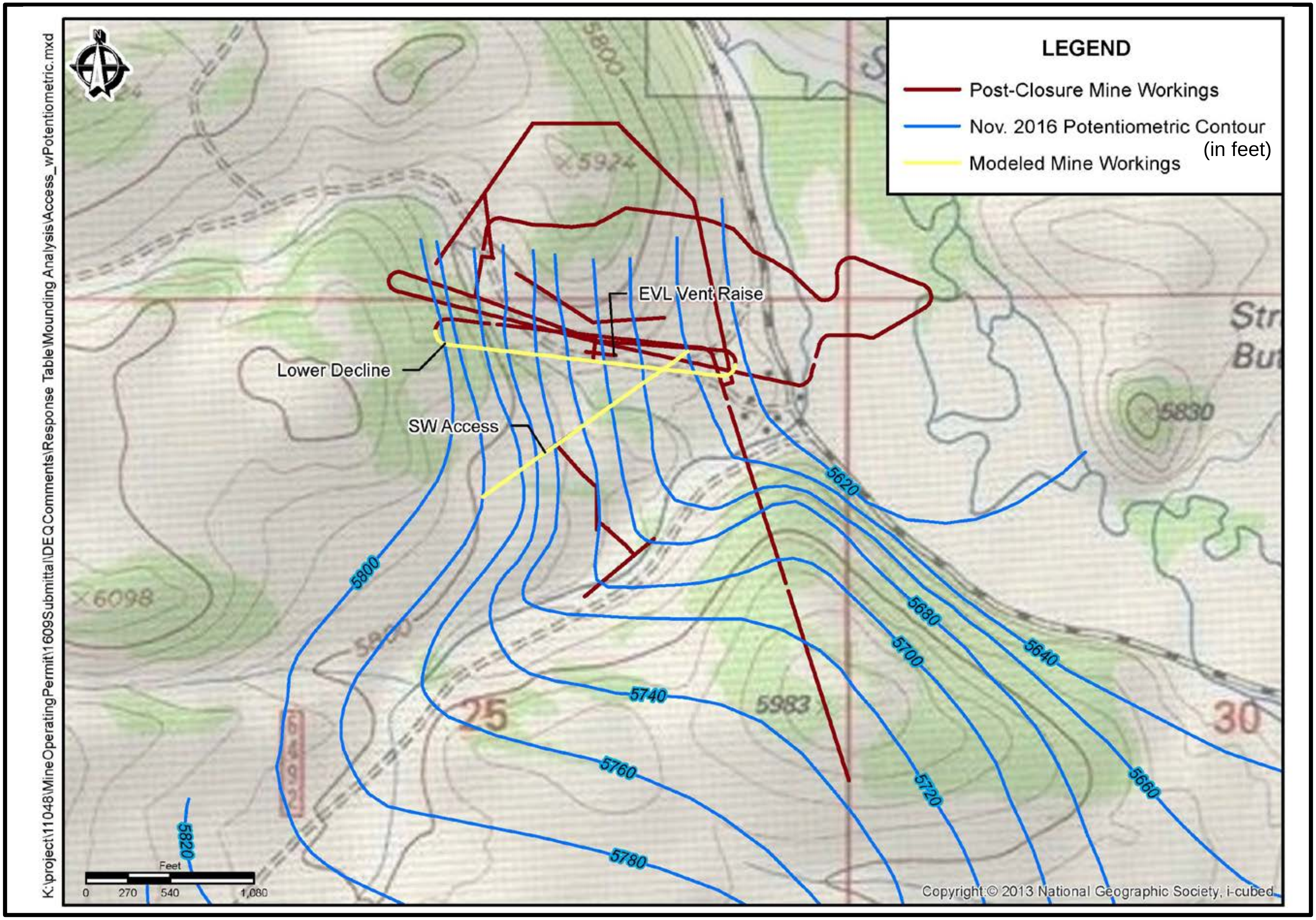
(Figure 3.2). The EVL ventilation raise was selected as it is located near wells MW-9, PW-9, and PW-10, which provide water level and hydraulic conductivities of the different HSUs the ventilation raise will encounter (*Ynl A*, *USZ / UCZ*, and *Ynl B*, respectively). It was assumed that November 2016 water levels represent the steady-state post-closure water levels. The ventilation raise analysis assumes that the water level in the raise will equilibrate to the weighted average head of all the HSUs through which the ventilation is completed. The weighted average is based on the head and permeability of the different HSUs. A schematic of the ventilation raise analytical analysis is shown in Figure 4.15. The ventilation analysis was conducted using a large diameter well in AQTESOLV v4.5 to estimate the flow between HSUs to create the change in head within the ventilation raise.

The data used in the ventilation raise analysis and corresponding results are shown in Table 4-8. The weighted average head in the ventilation raise results in about 6.4 and 2.7 feet (1.95 to 0.82 m) of drawdown in the *USZ / UCZ* and *Ynl B* respectively and a mound of 0.9 feet (0.27 m) in the *Ynl A*. The resulting drawdown or mound and associated aquifer characteristics for each HSU were held as constants in the AQTESOLV analysis and the flow rate was adjusted to match the drawdown/mound after 100 years. As shown in Table 4.6, the flux from the USZ / UCZ to the ventilation raise is 0.27 gpm; which is similar to the flux going from the ventilation raise to the Ynl A (0.27 gpm). The flux from the Ynl B to the ventilation raise is minimal (0.02 gpm). Although the ventilation raise causes a more direct flow path of water in the USZ / UCZ to the Ynl A, in the natural conditions (without any open accesses) all of the water co-mingles with the Ynl A as the USZ intersects the flow path of the Ynl A just west (up-gradient) of where the Ynl A and USZ / UCZ flank the Sheep Creek alluvial system.

The ventilation raise analysis assumes that the simulated raise is isolated from the access ramps and is open between the USZ and Ynl A. However, the closure plan proposes to plug all four ventilation raises to separate the USZ and Ynl A as described in Section 7.3.3.5. The hydraulic barriers (plugs or walls) will limit flow through the ventilation raises as simulated in this analysis and the flow of groundwater between the USZ and Ynl A will be similar to pre-mining conditions.

Table 4-8. Post-Closure Ventilation Raise Summary

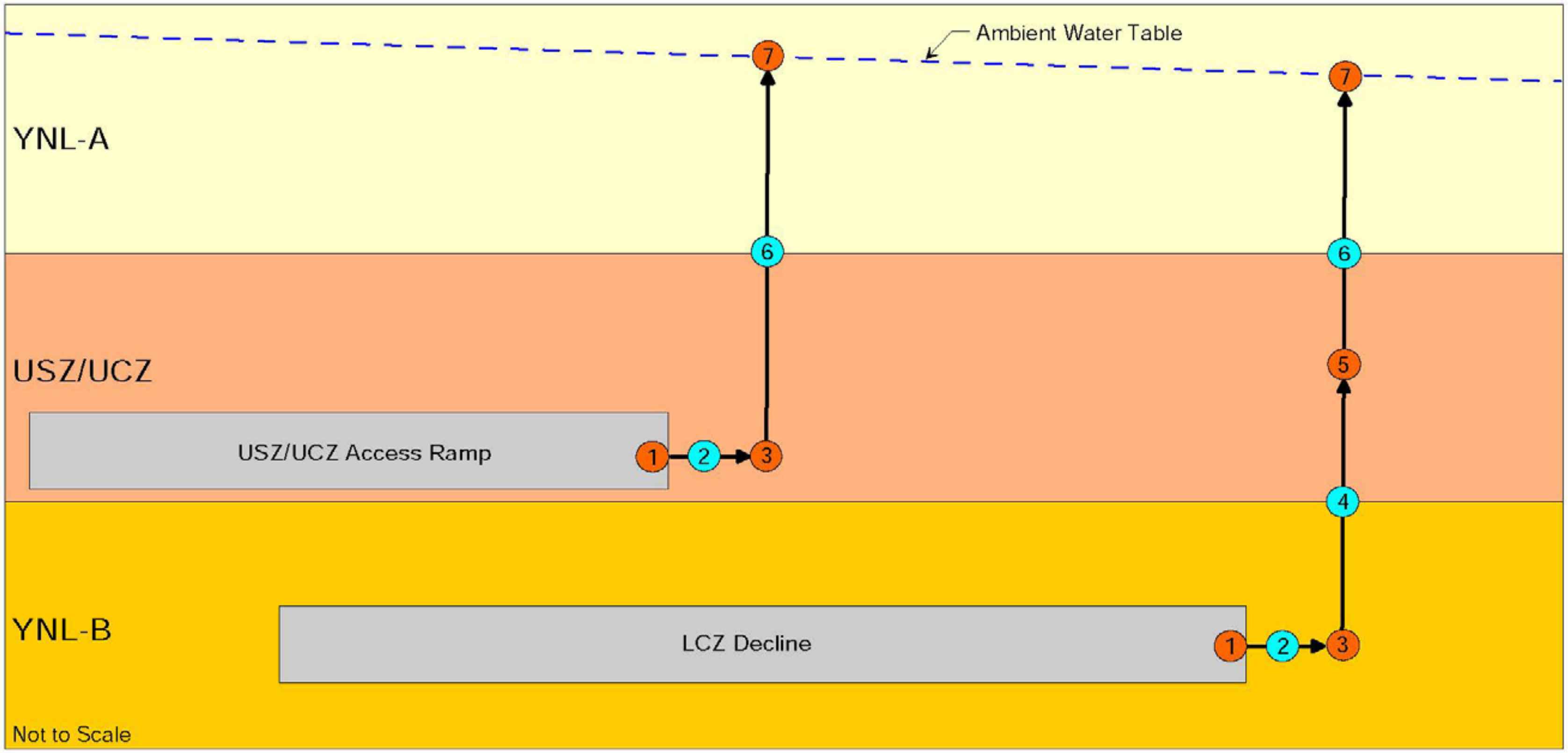
Parameter	*Ynl A*	USZ/UCZ	*Ynl B*
Hydraulic Conductivity (ft./day)	1.3	0.16	0.03
Ambient Head (feet)	5696.12	5703.39	5699.7
Permeability Multiplier	2.62	0.32	0.06
Weighted Average Head in Vent Raise (feet)	5696.97	5696.97	5696.97
Head Difference (feet)	-0.85	6.42	2.73
Estimated Flux (gpm)	0.27	-0.27	-0.02



Prepared by: Hydrometrics, Inc. (2017)

TINTINA RESOURCES

Figure 4.11
Post Closure Mine Workings
Mine Operating Permit Application
Meagher County, Montana



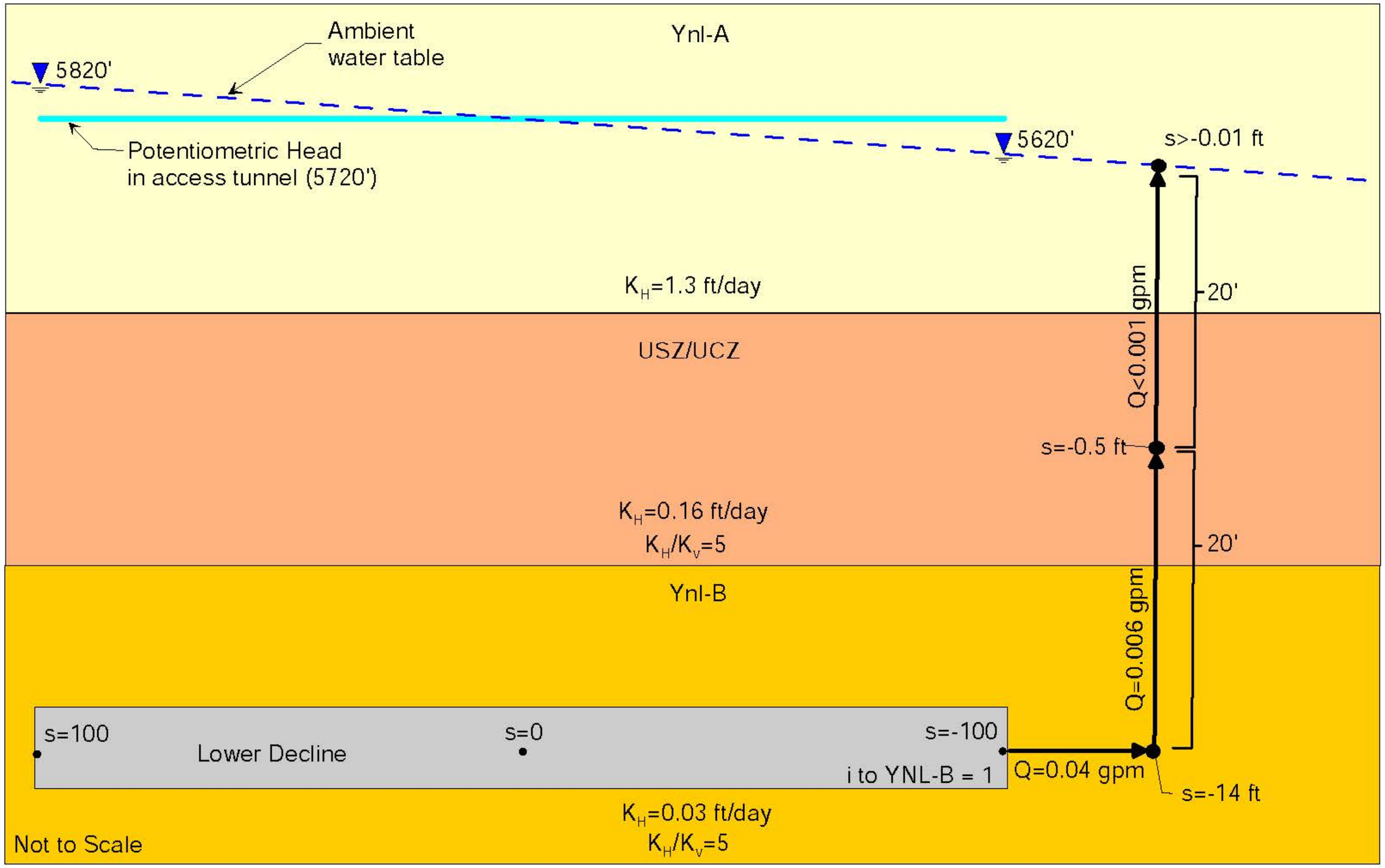
Analytical Model Steps

1) Calculate mound in decline or access ramp
2) Flux from decline or access ramp
3) Mounding analysis adjacent to decline or access ramp from flux calculated in Step 2 (skip to Step 6 for USZ/UCZ access ramp analysis)
4) Vertical flux to USZ/UCZ from mounding calculated in Step 3
5) Mounding analysis in USZ/UCZ from vertical flux calculated on Step 4
6) Vertical flux to YNL-A from mounding calculated in Step 5 (LCZ decline) or Step 3 (UCZ access ramp)
7) Mounding at top of water table from vertical flux calculated in Step 6.

Prepared by: Hydrometrics, Inc. (2017)

TINTINA RESOURCES

Figure 4.12
Post-Closure Analytical Model Steps
Mine Operating Permit Application
Meagher County, Montana

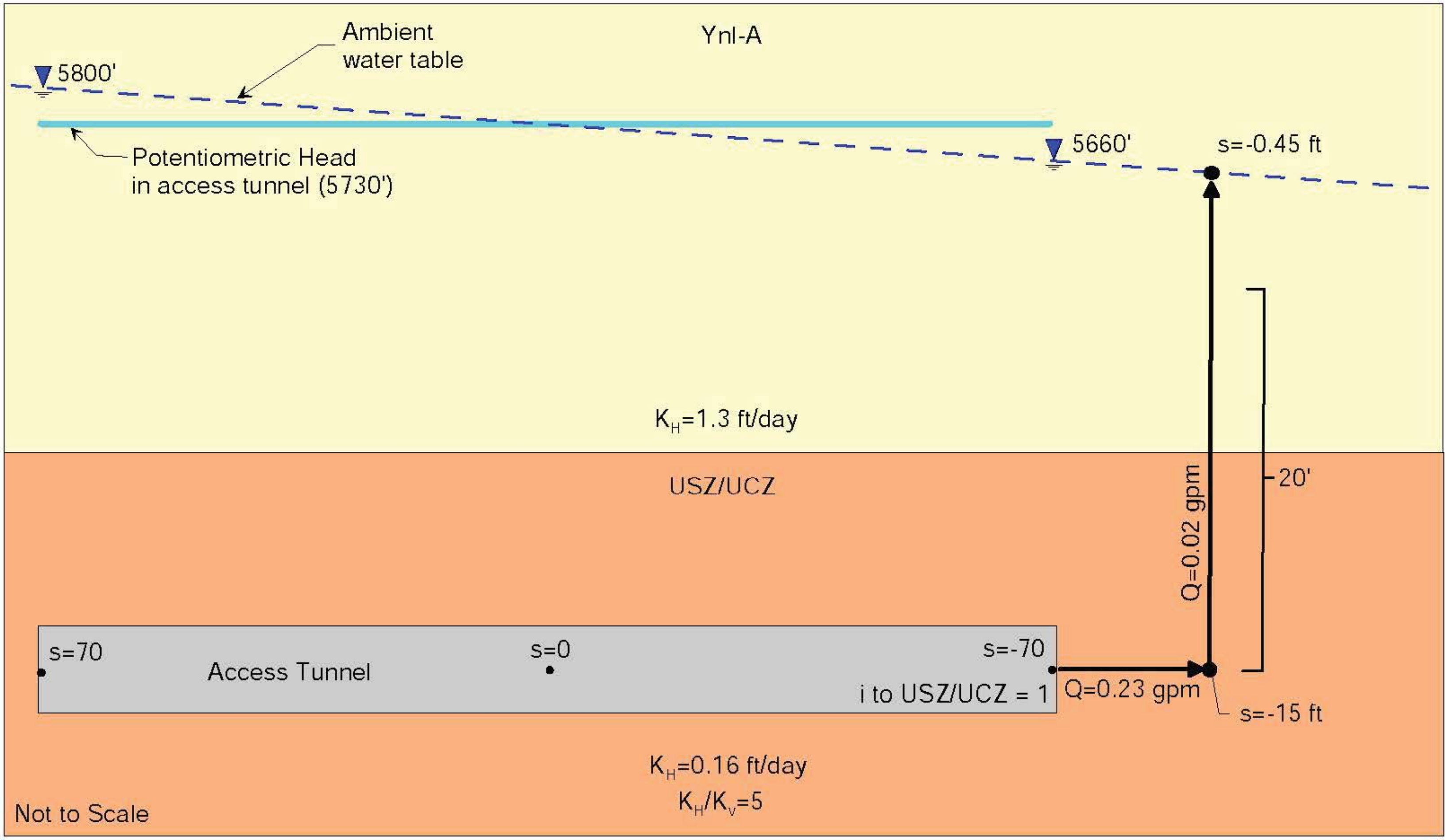


Assumptions:
Q=Flux; s= drawdown (negative for mounding)
Area (A) of tunnel face 17' x 17'
Gradient (i) between tunnel and bedrock is 1
Mounding calculations based on flow across a 17' x 17' area where mounding causes flow to overlying HSU
Distance between center of HSUs is approximately 20 feet at downgradient end of tunnel
Unsaturated zone above access tunnel approximately 40 to 50 feet; based on PW-4 and PW-8 water level data

Prepared by: Hydrometrics, Inc. (2017)

TINTINA RESOURCES

Figure 4.13
Lower Decline Analytical Model
Mine Operating Permit Application
Meagher County, Montana



Assumptions:

Q=Flux; s= drawdown (negative for mounding)

Area (A) of tunnel face 17' x 17'

Gradient (i) between tunnel and bedrock is 1

Mounding calculations based on flow across a 17' x 17' area where mounding causes flow to overlying HSU

Distance between center of HSUs is approximately 20 feet at downgradient end of tunnel

Unsaturated zone above access tunnel approximately 40 to 50 feet; based on PW-4 and PW-8 water level data

Prepared by: Hydrometrics, Inc. (2017)

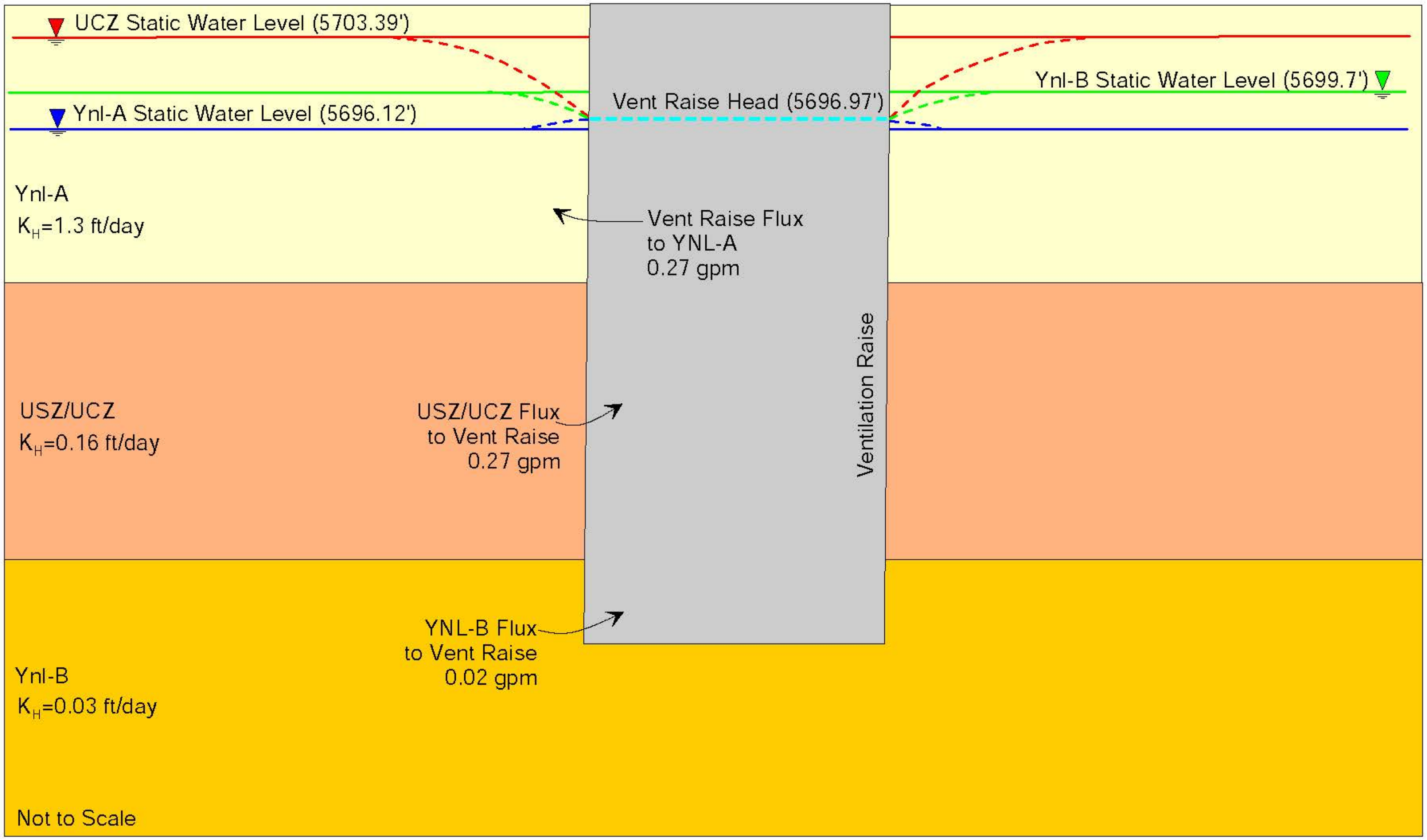
TINTINA RESOURCES

Figure 4.14

Southwest Access Tunnel Model

Mine Operating Permit Application

Meagher County, Montana



Notes:
Water level (head) in each HSU are based on November 2016 water levels from MW-9 (YNL-A), PW-9 (USZ/UCZ), and PW-10 (YNL-B)
Ventilation raise head is based on weighted average head based on the head and permeability of each HSUs.
Flux in and out of ventilation raise is calculated based on AQTESOLV pumping/injection analysis for each HSU.

Prepared by: Hydrometrics, Inc. (2017)

TINTINA RESOURCES

Figure 4.15
Ventilation Raise Analytical Model
Mine Operating Permit Application
Meagher County, Montana

4.2 Predictive Water Quality Modeling

4.2.1 Introduction

Tintina has used hydro-geochemical monitoring, hydrogeological modeling and geochemical testing data to design its underground (UG) workings, temporary waste rock storage pad (WRS), cemented tailings facility (CTF), process water pond (PWP), contact water pond (CWP), and water treatment plant (WTP) to minimize impacts to water quality. Apart from groundwater in the underground workings at closure, water from all facilities will be collected and treated to meet non-degradation criteria prior to discharge.

Enviromin (2017c, Appendix N of this document) has developed water quality model predictions for key facilities during operations and at closure. Models predict future water quality, and related uncertainty based on sensitivity analyses, at the four locations discussed below.

- UG at year six of mining operations and again under post-closure conditions, when the water table has recovered to near pre-mining conditions.
- WRS seepage, which will be collected and transported to the CWP. Water quality is predicted at the end of year two, when the WRS pad will begin to be dismantled to provide material for the tailing impoundment interior protective layer and interior basin drain system on top of the liner.
- CTF seepage / run-off, which will ultimately return to the PWP and WTP for treatment prior to discharge to an underground infiltration gallery. Water quality is predicted for year six of tailings production and at the start of closure, prior to placement of the cover which is designed to eliminate subsequent seepage.
- Updated water quality predictions for the PWP water reporting to the WTP, based on CTF and RO brine predictions in year 6 of production.

4.2.2 Modeling Methods

Enviromin used Tintina's operational plans (described in Section 3), together with the groundwater quality data (Appendix B), geochemical test results (MOP, Appendix D), hydrogeological modeling results (Appendix M), and water treatment design data (Appendix V) to develop a mass-load calculation of water quality for each facility under base case and sensitivity scenarios. These data are described in detail in Appendix N (Water Quality Modeling Report) by Enviromin (2017c).

Conceptual models, assumptions, and modeling details unique to each of the four models are described with results below.

4.2.3 Model Calculations and Results

4.2.3.1 <u>Underground Mine</u>

The access tunnels, decline, access drifts and stope workings will transect various rock types in the subsurface, as shown in Figure 1.7. Detailed modeling methods and results are provided by Enviromin (2017c) in Section 4 of Appendix N. To be consistent with groundwater flow data (from Hydrometrics, 2017a), Enviromin divided the underground model into seven hydro-stratigraphic units as shown in Figure 4.16.

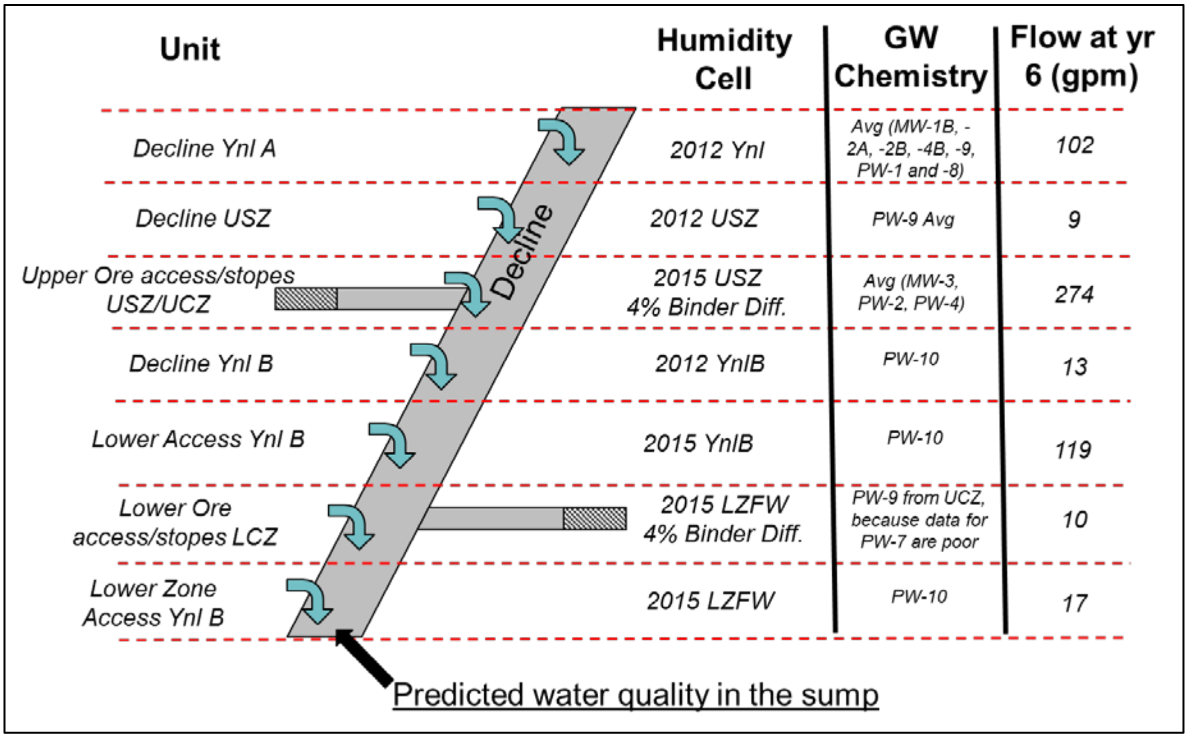


Figure 4.16. Conceptual Model of the Hydro-stratigraphic Units, with Flow to Mine Sump

Each of the units was assigned a total flow, a surface area (based on operational plans), and a rock type that correlates with kinetic test data. For the model, each unit can be conceptually viewed as a large kinetic test, scaled based on surface area and flow rate. The conceptual model for reaction of groundwater flowing through a blast-induced fracture zone is described in Figure 4.17. The scaling approach, illustrated in Figure 4.18, corrects solute release for differences in surface area and water flux between laboratory humidity cell tests and the mine workings. Further detail is provided in Section 4.3.3 of Appendix N. The mixed solution incorporating inflow from all seven units is allowed to reach geochemical equilibrium, using the USGS PHREEQC software to calculate mineral precipitation and metal sorption, with an analytical model of metal attenuation by sulfides in the exposed bedrock. Removal of solutes via mineral precipitation and sorption allows calculation of final water quality for the mine sump which is then collected for treatment to meet water quality standards and non-degradation criteria.

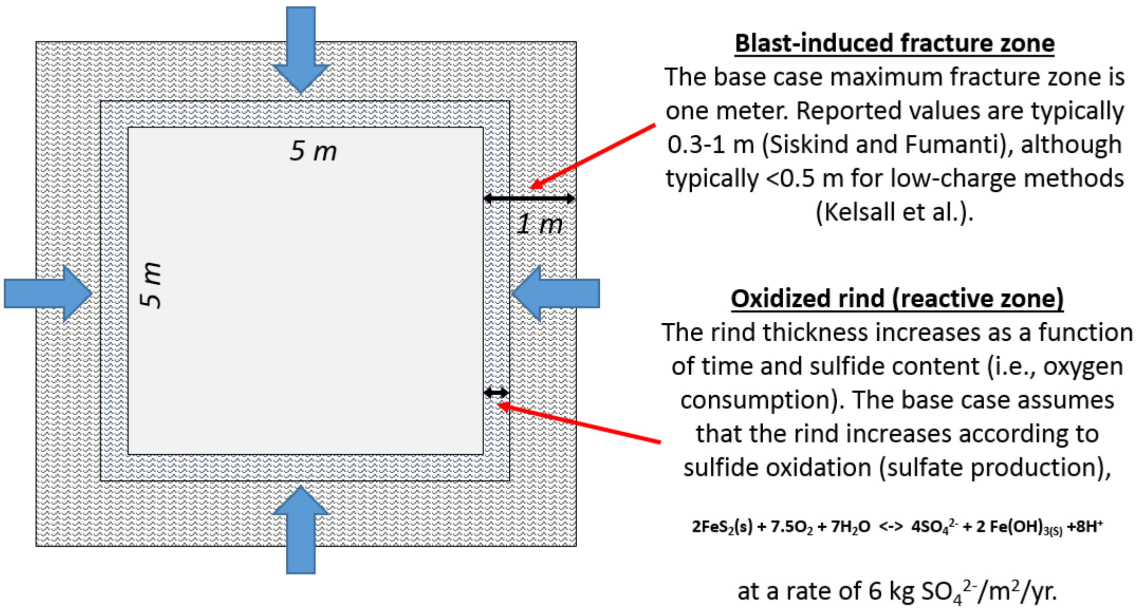


Figure 4.17. Conceptual Model of Reactive Surface Area in Underground Workings

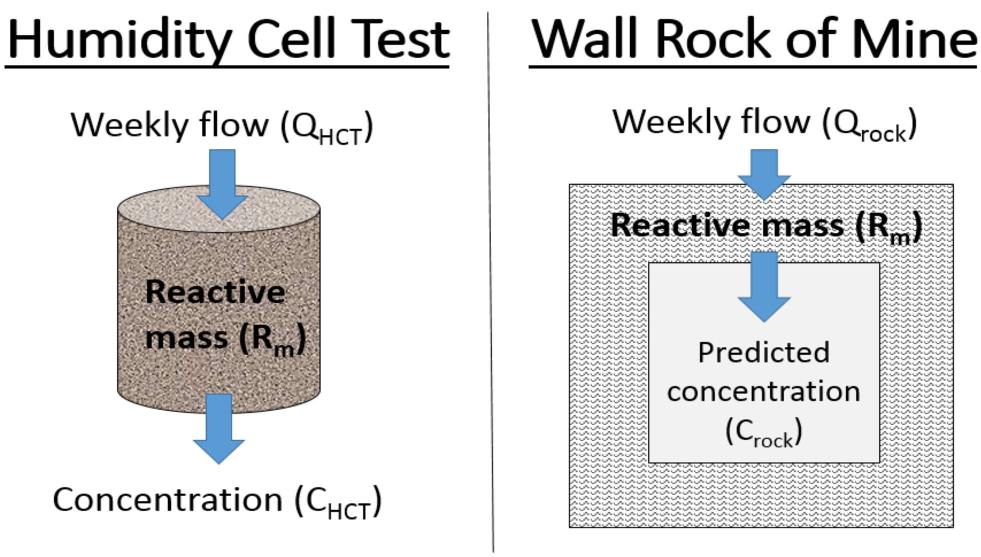


Figure 4.18. Conceptual Framework for Scaling Laboratory Data to Field Conditions

For the underground model, Enviromin predicts water quality in year six of operations to be near-neutral, with a pH of 6.67 s.u., abundant alkalinity (183 mg/L) and a moderate increase in sulfate (above background conditions) to 304 mg/L (Table 4-4 in Appendix N). The highest local contributions of acidity, metals, and sulfate come from the *LCZ*, but the rate of groundwater flow from the *LCZ* is low so the net contribution is minor. Enviromin predicts precipitation of alunite, $Ba_3(AsO_4)_2$, Cr_2O_3, ferrihydrite, and quartz, based on PHREEQC calculations of supersaturation in the mixed water in the sump. The formation of these minerals, followed by metal sorption, removes solutes from the water and allows calculation of final water quality. The metals Ba, Be, Zn, Cu, Pb, and As are predicted to sorb to ferrihydrite in the base case and most sensitivity scenarios, apart from the "All HCT" scenario which does not predict ferrihydrite precipitation. No sorption to sulfide is allowed under oxidizing conditions.

The model includes several sensitivity analyses of the predicted underground water quality, addressing uncertainty in model inputs for 1) HCT data (i.e., all data vs. weeks 1-4 data), 2) fracture density, 3) fracture zone thickness, 4) estimated surface area, and 5) sulfide oxidation rate (Table 4-4 in Appendix N). In general, the assumptions about fracture density and reactive-zone thickness have the greatest effect on predicted metal release, and the inclusion of all week HCT data has the greatest effect on the pH.

Alkalinity is abundant in all sensitivity scenarios, including the analysis of several upper bound estimates of rim thickness, sulfide oxidation rate, and fracture density which together create a conservative evaluation of the reactive mass. Predicted pH ranges from 4.87 to 6.68 s.u. and sulfate ranges from 262 to 672 mg/L across the various sensitivity analyses (Table 4-4, Appendix N). Nitrate, As, and U are predicted to exceed the DEQ groundwater quality standards in the operational base case as well as in several sensitivity scenarios (Table 4-4, Appendix N). Antimony, Sr and Tl are predicted to exceed the groundwater standard only in select sensitivity analyses which include conservative (upper bound) estimates of input parameters. However, because all water will be collected for treatment to meet water quality standards, these operational exceedances will not affect downgradient water.

At closure, following completion of mining, backfilling, and recovery of the water table to its original elevation, the pH (6.81 s.u.) is predicted to be higher, with slightly lower alkalinity (144 mg/L), sulfate (115 mg/L) and metal concentrations, than predicted during operations, as sulfide oxidation will be inhibited in the flooded workings (Table 4-5, Appendix N). The predictive model is most sensitive to the estimate of reactive surface area for cemented backfill. The lower mine workings are separated from the surface by the Volcano Valley Fault (VVF) and the *LZ FW* rock below the fault zone's permeability is so low there is little to no flow through these units. In addition, the lower workings will be separated from the upper groundwater system by construction of two hydraulic plugs where the main decline ramps penetrate the VVF. Since the lower mine workings transmit little to no water, and will be separated from the upper workings and shallower hydro-stratigraphic units, they were not considered a viable aquifer and were not included in the closure model. Enviromin predicts potential precipitation of $Ba_3(AsO_4)_2$, barite, Cr_2O_3, ferrihydrite, gibbsite, and quartz, based on PHREEQC predictions of supersaturation in the mixed water at closure. Metals sorb to both ferrihydrite and sulfide under closure conditions.

Mine water will be collected during dewatering operations for treatment, so the predicted chemistry at closure is the most important from an environmental perspective. The predicted changes at closure represent minor changes in water quality relative to the background water quality (pH of 6.97 s.u., with alkalinity of 193 mg/L and sulfate 111 mg/L). The limited variation between the base case and sensitivity scenarios reflects the robust design and plan for management of the UG, which limits open stope areas through concurrent backfilling with a low transmissivity material; provides for water treatment in operations and early closure; floods the lower workings with RO treated water at closure, and isolates the upper and lower workings using hydraulic plugs.

4.2.3.2 WRS Facility

As described previously in Section 3.2.2.5 (Mining Rates and Schedules) and Tables 3-5 and Table 3-6 of the MOP Application, 453,642 tons (411,537 tonnes) of mostly *Ynl A, USZ*, and *Ynl B* waste rock will be generated by the end of year two of mining operations. This rock will be stockpiled on the temporary WRS facility before it can be co-disposed with tailings in the CTF. The WRS will be constructed in three

16-foot (4.9 m) lifts, with 8-foot (2.4 m) benches, up to a maximum height of 50 feet (15 m) above a 0.1 inch (100 mil) thick HDPE-lined pad (Figure 4.19). Additional waste rock to be produced from the *LZ FW* and *LCZ* after the CTF is completed and prepared for waste rock will report directly to that facility and will not be placed on the stockpile. The waste rock has some potential for acid generation and metal leaching (see Enviromin, 2017a, Appendix D (Baseline Environmental Geochemistry Evaluation of Waste Rock and Tailings).

The model assumes that three types of waste rock will be stored on the WRS facility. *Ynl A* will be deposited first, followed by *USZ* and then *Ynl B*, based on the order they will be encountered during mine development (Figure 4.19). The *LZ FW* will not be produced in time for placement on the WRS. The model thus uses the following relative tonnages of waste rock: 6% *Ynl A*, 44% *USZ,* and 50% *Ynl B*. However, not all of this mass is assumed to be reactive. Instead, the reactive mass is estimated based on the maximum volume of material that could be saturated by six months of water flow at the predicted flow rate of 0.9 gpm (3.4 Lpm) (Section 3.6.5.4). Precipitation is assumed to flow preferentially through the partially saturated waste rock after an initial year of wetting and collects in a drain system that then reports to the CWP for temporary storage prior to water treatment. This model predicts the chemistry of water that will report to the WRS drain.

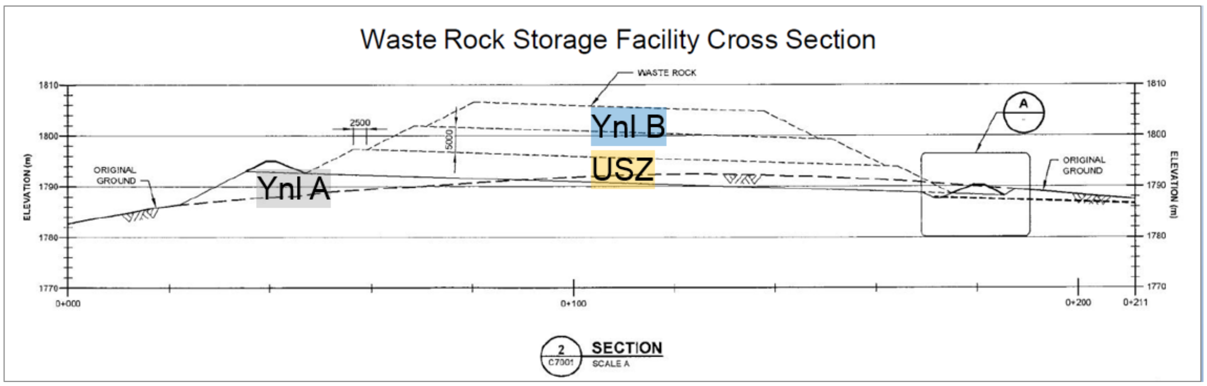


Figure 4.19. Conceptual Cross-section of WRS Facility showing Waste Rock Types.

The environmental geochemistry testing methods, assumptions and results are described by Enviromin, 2017a (Appendix D). For the WRS facility, Enviromin used HCT data from 2012 *Ynl* to describe the *Ynl* A portion, 2015 *USZ* data to describe the *USZ* portion, and 2015 Ynl B data to describe the Ynl B portion. These HCT's tested composites of rock that will be encountered in the Johnny Lee decline, which is rock that will report to the WRS in the first two years of mining.

Hydrology for the proposed WRS facility was modeled by Hydrometrics, Inc., using the Hydrologic Evaluation of Landfill Performance (HELP) model, developed by the US Army Corps of Engineers (Hydrometrics 2016c; Shroeder et al., 1994) (Section 3.6.5.4). The HELP model uses climate data to predict one-dimensional moisture flow through a soil profile, accounting for evapotranspiration, snow removal, solar radiation, and average precipitation. The HELP model predicts an average flow rate of 0.9 gpm (4.31 Lpm) through the WRS facility, once steady state saturated flow is achieved after year 1.

Water quality predicted for the WRS base case at year two of mining is moderately acidic (pH 5.80 s.u.) and high in sulfate (2,212 mg/L), with some elevated metals (Table 5-1**,** Appendix N). However, the volume of WRS seepage is small (0.9 gpm average in year two) and water will be collected on a lined pad for treatment. This prediction is thus conservative, as a result of the very small amount of water into which the mass of solutes released from the aggressively weathered HCT is scaled. Potential precipitation of alunite, barite, celestite, and jarosite, are predicted with no sorption due to lack of ferrihydrite precipitation. Sensitivity analyses looking at reactive mass assumptions (double and half of the base case) show that the model is sensitive to the rock-to-water ratio and surface area (reactive mass) assumptions which influence predicted water quality. The sensitivity analysis of 2X reactive mass predicts a slightly lower pH of 5.48 and a higher sulfate of 3,811 mg/L; in contrast, the 0.5X reactive mass scenario predicts a pH of 6.10 and a sulfate of 1,111 mg/L. Because the WRS will be removed in years before year three, no closure evaluation was needed.

4.2.3.3 CTF Facility

As described above, Tintina proposes to place 0.5 to 2% cemented paste tailings together with waste rock into a double-lined CTF. Either granodiorite or waste rock from the WRS will be used to construct a lower 24 inch (60 cm) lift of crushed and screened waste rock as a protective layer in the CTF. This layer has been modeled as waste rock to represent a worst case scenario. This protective layer will be overlain by a minimum of 3.3 feet (1 m) of ROM waste rock as a rock drain, and a ramp. Cemented paste will be spigotted into the facility in thin lifts with the upper surface of these lifts being exposed 7 to as many as 30 days (average range 7 to 15 days) before a new lift is deposited over the top. The upper surface of each lift will weather sub-aerially until covered by a fresh lift of tailings. Waste rock will be end dumped from the ramp for co-disposal, and encapsulated within subsequent lifts of cement paste tailings. The conceptual design of the CTF is shown in Figure 4.20, showing waste rock ramp and local placement of waste rock mined from UG, Year 6 of tailings production.

The CTF facility will be finished with a final lift of 4% cemented paste tailings thick enough to support trucks and dozers to place and spread any required reclamation fill or sub-grade bedding material. Engineers would determine the type of equipment to be used for placement of the reclamation materials on top of the 4% cemented tailing, and use this information to determine the thickness of the 4% cement layer required. If they determined that a 1-foot (0.3 m) thick layer of 4% cemented tailings was required to minimize dust from the exposed tailings surface and support the proposed equipment (particularly as this will be overlain by a layer of reclamation materials), this would require approximately 87,291 m^3 of material to be deposited (1-foot, thick layer over 71.9 acres). At an approximate cemented tailings paste dry settled density of 2.0 tonnes per m^3, the total amount of cemented tailings paste material required to construct a one-foot cap layer is estimated at 174,582 tonnes of cemented tailings (or about 3% of the total cemented tailings paste estimated to be placed in the CTF over the LOM). At a production rate of 3,300 tonnes per day through the mill, 88% of which (2,904 tonnes per day) would be tailings (the remaining being concentrate), it would require about 60 days (2 months) of cemented tailings paste production to produce and deposit the 1-foot thick 4% cemented paste tailing layer. This will be followed by placement of a synthetic cover and a minimum of 5.2 feet (1.6m) of fill to make the CTF cap (consisting of a layer of sub-grade bedding and an overlying layer of reclamation material). The CTF will be finished with additional upper layers of sub soil (1.7 feet; 52 cm) and topsoil (0.6 feet; 18 cm) that will be revegetated.

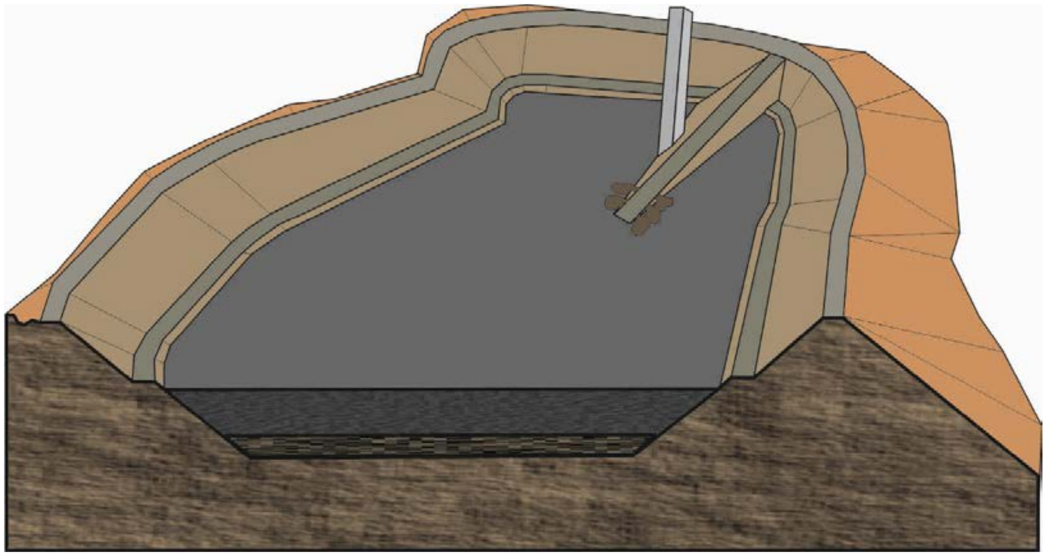


Figure 4.20. Conceptual Model of CTF at Year Six of Tailings Production

Although water will not be stored on the facility, rain and snow will react with the weathered cemented tailing surface, dissolving oxidation products including acidity, sulfate, and metals. This water will mix with water produced during consolidation of cemented paste tailings and react with the waste rock deposits, the rock drain and ramp prior to collecting in the sump. Because the run-off water will contact the cemented-paste surface for only a short time (i.e., the material will not be submerged in water like the cemented pasted backfill in the underground in closure), Enviromin used humidity cell test data for the 2% paste to estimate a mass load on a weekly basis for the year six model and 4% paste for the closure model.

To calculate the mass load of solutes for the CTF run-off, Enviromin applied an approach similar to that used for the WRS facility, where the surface area and water flow was estimated, and then scaled according to a proportionality between flow and surface area. The relative surface areas of the CTF and rock in kinetic tests were based on different extents of weathering, using the sulfate concentrations measured in the 2% and 4% cells, as described in Section 6.3 of Appendix N.

At any given time during the filling of the CTF, approximately 4,409 tons (4,000 tonnes) of co-disposed waste rock will be exposed. This material will be comprised of 40% *USZ*, 21% *Ynl B*, and 39% *LZ FW*. Enviromin assumes that all of this mass is reactive and the surface area per mass is given by the particle sizes in the blast fragmentation of waste rock reported for the Ashanti mine (as shown in Figure 5-2 of Appendix N).

Additionally, the basin drain system, including the access ramp will be constructed of 363,537 tons (329,795 tonnes) of waste rock, composed of *Ynl A* (14.5%), USZ (1.5%), *Ynl B* (50%), and *LZ FW* (30%). Sub 3/8 inch (9.525 mm) screened fragments of *Ynl B* (4%) will first be deposited as an initial lift (protective layer) to prevent punctures to the liner. Because this mass is large, and it is unlikely or impossible that all surfaces would react with water, Enviromin used the same approach taken for the WRS facility by calculating a reactive mass for the fraction of rock that could be saturated by water flow in one week, assuming a 40% porosity for the compacted ramp. For a sensitivity analysis, Enviromin also assumes that all mass in the waste rock drain is reactive. The reactive surface area for the waste rock samples is estimated from sieve analyses of the humidity cell test reject. Assuming spherical particles, the specific surface areas are 9.81 ft^2/lb. (2.01 m^2/kg) for *USZ*, 14.35 ft^2/lb. (2.94 m^2/kg) for *Ynl A* and 14.70 ft^2/lb. (3.01 m^2/kg) for *Ynl B*.

Given the footprint of the CTF, the model assumes 84,000 m^3/year (109,868 cubic yards/year) of precipitation and run-on, based on climate data collected by Knight Piésold (2017a). This value accounts for snow accumulation, plowing, etc. All of this water is assumed to contact and react with the top surface of the CTF and the co-deposited waste rock at year six. The model assumes that 29,029 m^3/year (37,969 cubic yards/year) of water comes from the wet paste dewatering. This estimate is based on 5% dewatering (by mass) of the 1,595 tonnes of paste (55% of 2,900 tonnes) deposited per day on an annualized basis. Combined with the run-on water, this means that 113,029 m^3/year (147,836 cubic yards/year) of water reports to the sump. At closure, before placing the HDPE cover, the dewatering contribution is removed, and only 84,000 m^3/year (109,868 cubic yards/year) of precipitation reports to the sump.

Finally, the model assumes that 10% of the run-off and the dewatered paste water also flows through the waste rock drain (access ramp) and receives additional load from the waste rock. This is based on the fact that the drain occupies 10% of the CTF surface area in year six.

For the CTF, water quality predicted at year six of mining is acidic (pH 4.13 s.u.) with 765 mg/L sulfate and elevated metal concentrations (Table 6-1**,** Appendix N). More acidity and metals are contributed by the surface of cemented tailings than the co-deposited waste rock or access ramp/rock drain, while most sulfate comes from the wet paste and the waste rock contribution. The minerals predicted by PHREEQC to form during operations include alunite, barite, jarosite, and quartz.

Water quality predictions for the CTF are sensitive to the calculated surface area, implying that the surface area should be managed to limit weathering through frequent placement of fresh lifts of pasted tailings. Higher concentrations of cement (e.g., 4%) could be used to reduce disaggregation of the surface if a delay in operations will prevent frequent placement of fresh lifts. The drain should be also designed to avoid plugging with secondary minerals. However, the drain is unlikely to be fully saturated with the predicted flow of seepage, leaving multiple paths for water flow.

The CTF closure model accounts for the increased surface area of the cemented paste and removes the contribution from dewatered paste. However, Tintina proposes to seal the entire CTF upon closure. The CTF will be covered with a welded HDPE cover, followed by regraded fill, subsoil and topsoil (at a slope designed to preclude standing water), and re-vegetated. This plan will eliminate long-term exposure to oxygen and water, and the double lined facility with no standing head of water should eliminate seepage from the facility. The CTF wet well sump will continue to be pumped in closure until water can no longer be effectively removed from the sump and minimum volume objectives are met. The time estimate for the CTF sump pumping in closure is expected to be on the order of 30 days since the CTF is designed to contain mostly solids (i.e. cemented tailings paste and waste rock) and only minor aqueous phases. Regardless the pump and piping dewatering the sump will remain in place for pumping to the water treatment plant as necessary until agreement is reached with DEQ that it can be removed. The closure predictions shown here thus represent water quality at the end of tailing production, prior to placement of the cover, when the entire surface remains exposed to oxygen and water. The mass loads for each input source are shown with results in Table 6-2 of Appendix N.

At closure, following placement of a 4% cement paste lift immediately prior to cover placement, a more neutral solution (pH 4.95 s.u.) is predicted, with no exceedances of groundwater standards for metals predicted for the base case following precipitation of $Ba_3(AsO_4)_2$, barite, and jarosite (Table 6-2**,** Appendix N). Limited exceedances of groundwater standards for As and Tl were predicted for the high surface area sensitivity scenario in closure. The planned reclamation procedures (e.g., welded HDPE cover, revegetation, etc.) are not accounted for in the model, which predicts water quality prior to use of the cover to eliminate infiltration.

4.2.3.4 PWP Facility

All water from the CTF, and some of the water from the WTP, will report to the PWP where it will mix with water from the mill (i.e., thickener overflow), direct precipitation and run-on. In the PWP model, solutions were mixed and the solution was equilibrated using PHREEQC. Figure 4.21 shows the water balance for the PWP, including the source and disposition facilities. The water balance is provided by Knight Piésold (2017d) for year six. Minor deviations from Knight Piésold's water balance model result from the 5% seepage from the cement tailings paste that separates from the cement and flows into the CTF sump, and reports to the PWP. This additional seepage ultimately goes to surface water transfer and is part of the "Run on and precipitation from CTF sump" input water volume reported in Figure 4.21 below. Figure 4.21 shows the overall water balance in the PWP, including the sources and annual flow rates.

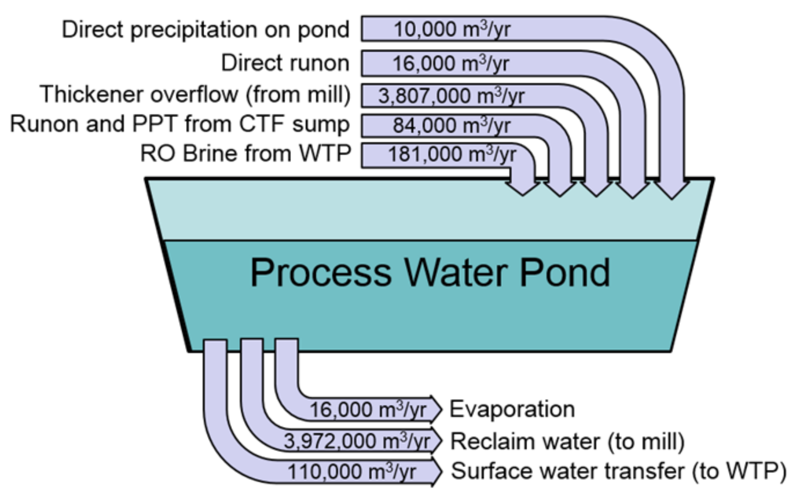


Figure 4.21. Water Balance for Process Water Pond

Enviromin used water quality predictions for the CTF facility and the RO brine from the WTP. For the thickener overflow (from the mill), process water chemistry provided by Amec Foster Wheeler (2017, Appendix V of this MOP report) in collaboration with International Metallurgical and Environmental Inc. (2015) was used. For the RO brine, chemistry provided by Amec Foster Wheeler (Appendix V, May 2017) was used. In addition to these solutions, run-on and direct precipitation (assumed to be deionized water) are added and water is removed as evaporation. These three fluxes of deionized water add up to a net influx of 10,000 m^3/yr. of water, which dilutes the system by only a small amount. The final mixed solution is equilibrated in PHREEQC to predict the PWP chemistry that will report to the WTP.

All water from the CTF sump and some water from the WTP will report to the PWP. These inflows mix with thickener overflow from the mill and direct precipitation. The model predicts that the overall chemistry of the PWP is dominated by the thickener overflow, which provides 93% of the flow. The predicted solution has a pH of 5.81 s.u., moderate sulfate (903 mg/L), and elevated concentrations of NO_3 and metals, including Cu, Ni, Pb, Sb, and Tl (Table 7-1**,** Appendix N). Alkalinity is higher due to mixing with process water. PHREEQC predicts that alunite, $Ba_3(AsO_4)_2$, barite, and jarosite could form, based on supersaturation, with no sorption of metals to ferrihydrite.

4.2.4 Underground Infiltration Galleries

Enviromin has predicted the chemistry of buffered reverse osmosis (RO) water below the underground infiltration gallery (UIG) where it encounters groundwater after reacting with disturbed rock immediately below the infiltration galleries. Solutes acquired within an oxidized and flushed zone immediately beneath the UIG will be transported through the unsaturated bedrock along fractures, where some attenuation will occur. Water quality is predicted below the reactive zone within the bedrock, and immediately above the mounded groundwater where compliance with non-degradation standards will be assessed. To this end, water quality predictions were compared to both calculated non-degradation standards for groundwater in bedrock, and surface water in alluvium receiving discharge from bedrock (Hydrometrics, 2017d). The UIG calculations are described in detail in Appendix N-3 (Enviromin, 2017e).

This prediction is based on the conceptual model described in Figure 4.22, which defines the geometry of the physical system, the profile of oxygen, the solute release zone and the attenuation zone. The near-trench zone of disturbance, where freshly-exposed surfaces will oxidize and release solutes during flushing by discharged buffered RO water, is the source of potential solutes entering the groundwater. This trench will be 2 meters deep, but the upper 0.7 meters (2.3 feet) will be backfilled with soil, with bedrock and bedrock spoils exposed over the lower 1.3 meters (4.3 feet) of depth. This models assumes that all of the bedrock in the 1.3 meter (4.3 feet) portion of the trench sees groundwater, which is conservative; no exposure to soil is expected or included in the model. The total reactive surface area is thus estimated to be 8 m^2 (86 sq. ft.) per lineal meter, accounting for radial flow in all directions out of the trench up to 1.3 meters (4.3 feet) of height from the discharge point.

Enviromin estimates that the fracture density of the disturbed zone will be 10%, which is the same as the fracture density estimated for the blast-induced zone of the underground workings. This zone is calculated to be 0.34 meters (1.1 feet) in thickness, based on a sulfide oxidation rate of 6 kg SO_4/m2/year, for an average *Ynl Ex* sulfide content of 0.006 weight percent (Enviromin, 2017b). Fracture density is used to directly scale the surface area from the unconsolidated material in the *Ynl Ex* humidity cell test (HCT, Enviromin, 2017a) to the expected surface area in the shallow bedrock galleries, using the methods discussed in detail in Appendix N (Enviromin, 2017b). The average total flow rate through the infiltration gallery will be 398 gpm (1,507 L/min.). The minimum length of pipe needed for the average discharge rate is ~904 meters (2,965 feet), which equates to a discharge rate of approximately 0.44 gpm (1.7 liters) /meter of trench. After equilibration, the water will pass through the undisturbed zone where solutes may potentially sorb to surfaces, but those attenuation calculations have not been addressed here due to the very low anticipated rates of solute release. Recognizing the influence of the carbonate mineralization in the trickling filter, the effluent chemistry was calculated by adding the predicted solute released from the *Ynl Ex* HCT to the buffered RO permeate chemistry predicted by AMEC (2017, Appendix V of the MOP). The average HCT data from weeks 1-4 was used as a basis for predicting solute release. Sensitivity scenarios addressed the anticipated depletion of oxidation products from the gallery surface, using an average HCT chemistry for all weeks of testing. Further, to evaluate the effect of uncertainty in reactive mass (e.g., rind thickness), water quality was also predicted for scenarios using twice (and half) the reactive mass.

Much like rainwater, with its low solute content, the buffered RO permeate will equilibrate with bedrock, acquiring a small mass of solutes as it transits the disturbed and oxidized infiltration gallery. Given the relatively low reactive mass, and the larger volume of discharged water, the predicted solute concentrations are low. As shown in Table 4-9, the water quality predicted using the average of weeks 1 to 4 HCT data meets non-degradation criteria for both bedrock and surface water settings. The same is true when an average of all weeks of humidity cell test data are used. Criteria for both settings is also met when the reactive mass is halved, and when it is doubled. Water discharged to the UIG following RO treatment is thus expected to meet both surface and groundwater non-degradation standards under all cases and in all sensitivity scenarios. The only anticipated impacts to groundwater in the vicinity of the UIGs is dilution resulting in somewhat improved water quality.

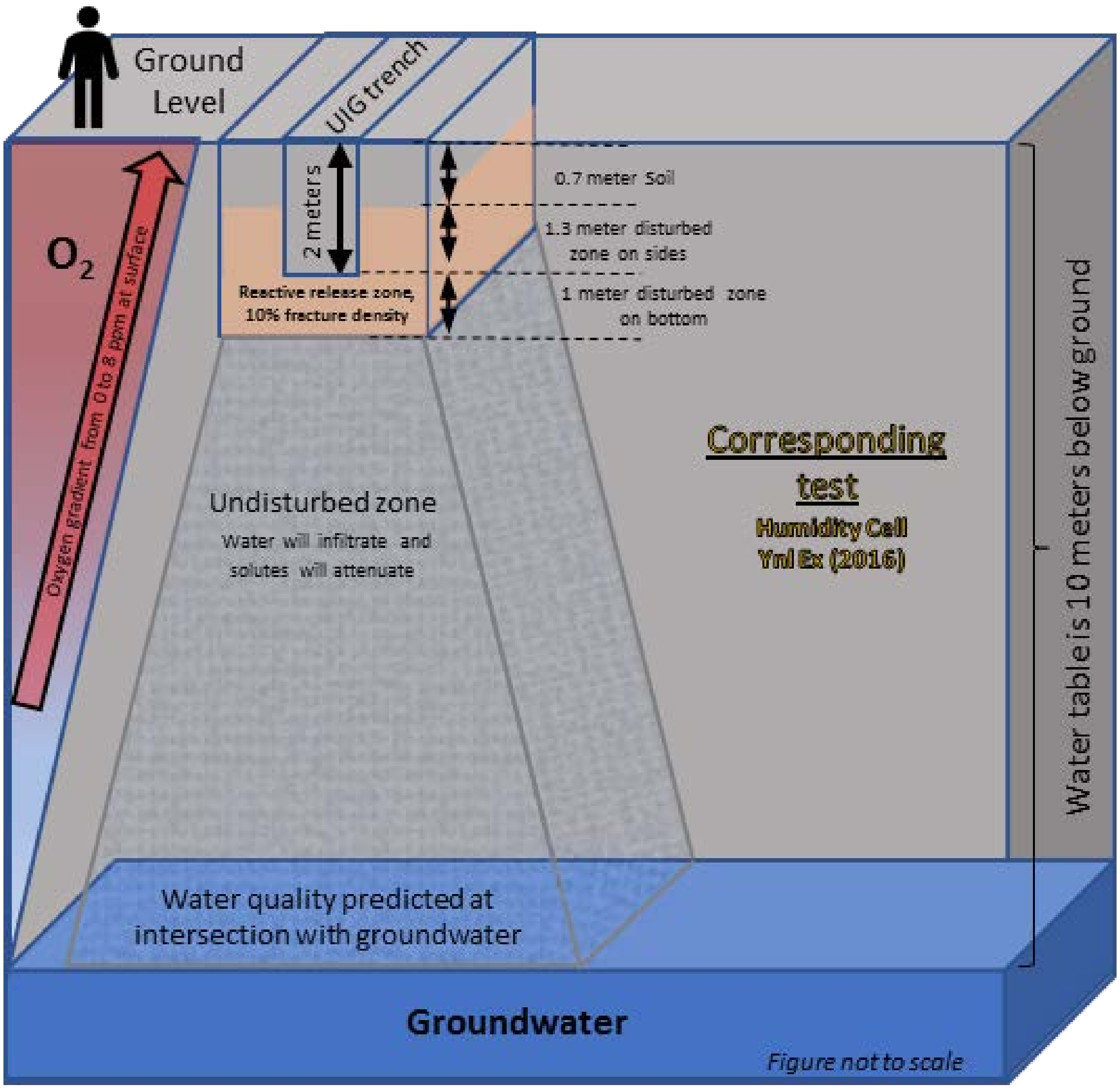


Figure 4.22. Conceptual Model of Underground Infiltration Gallery Groundwater Hydrology/Geochemistry

In Figure 4.22, the upper (i.e., disturbed) zone describes the release of solutes according to HCT data from Ynl Ex material. The undisturbed zone provides rock surfaces for the released solutes to attenuate as water flows towards the compliance point just above the water table.

4.2.5 Summary of Water Quality Predictions

The likely and foreseeable (base case) predictions made for Project facilities are summarized in Table 4-9. These results show that water quality predicted for the UG is circum-neutral, with modest sulfate and appreciable alkalinity. During operations, the UG water collected in the sump will exceed groundwater standards for nitrate and several metals prior to being treated to meet non-degradation criteria. The WRS is predicted to have more acidic water quality, with elevated sulfate and predicted exceedances of Ni and Tl. The CTF is also predicted to be acidic, with concentrations of several metals predicted to exceed water quality standards, although sulfate concentrations are predicted to be lower due to precipitation of sulfate-rich minerals. Quality is predicted to improve at closure for CTF water, with higher pH and lower metal concentrations, when paste dewatering is complete and a final lift of 4% cemented paste has been put in place. As noted in the table, all water except for that moving through the backfilled UG workings at closure will be collected on liner and routed to the PWP prior to treatment to meet non-degradation criteria prior to discharge to groundwater in UIGs. During closure, however, the predicted UG water quality meets both groundwater standards and non-degradation criteria for all parameters. These results are discussed in context of non-degradation criteria in the following section. Operationally and during closure, water discharged to the UIGs following buffered RO treatment is expected to meet both surface and groundwater non-degradation criteria.

Table 4-9. Base Case Results for Water Quality Predictions

	pH s.u.	**SO_4** mg/L	**Alkalinity** Mg/L $CaCO_3$	**Parameters > MT GW standards**	**Metals >MT non-degradation criteria**
UG					
Year 6 operations	6.67	304	183	NO_3, Sr, Tl, U,	*
Post-Closure	6.81	115	144	NO_3, Tl	--
WRS	5.80	2,212	24	NO_3, Sr, Tl	*
CTF					
Year 6 tailings	4.13	765	97	NO_3, As, Be, Cu, Ni, Pb, Sb, Tl	*
Closure	4.95	90	53	NO_3, Tl	*
PWP	5.81	903	205	NO_3, Cu, Ni, Pb, Sb, Tl	*
UIG	8.1	0.16	100.3	None	None
** Collected water treated by RO to meet non-degradation standards.*					

4.3 Non-degradation Evaluation of Predicted Water Quality

All of the water for which quality is predicted above will be collected for treatment to meet non-degradation criteria prior to discharge, except for the underground workings under flooded, post-closure conditions. This section discusses Montana's non-degradation requirements and evaluate the post-closure underground and embankment facilities relative to these criteria.

4.3.1 Montana Water Quality Act

Montana law prohibit discharges that degrade the quality of certain surface and ground water resources. Where applicable, the non-degradation rule provides that discharges must not increase the concentration of certain constituents above limits established by the State or the existing concentration of the constituent in the receiving water (background). The Project will comply with this requirement in all phases (construction, operation, closure, and post-closure). Most mine affected water will be collected underground during operational dewatering or on liner, with subsequent treatment to meet non-degradation criteria (Section 3.7.3.3). Zones of potential non-degradation compliance are regulated discharge to the UIGs; the post-closure UG workings; and surface embankments to be constructed off liner. Hydrometrics has analyzed the quality of the potential receiving waters for discharges from the Project and has established non-degradation standards in accordance with Montana law (Section 4.3.2).

As described above in Section 3.7.3.3, all water will be treated to meet applicable non-degradation standards prior to discharge via UIGs. This includes polishing treatment of RO permeate to ensure that discharged water meets hardness and alkalinity of background solutions.

As described in Appendix N, all water will be treated to meet applicable non-degradation standards during construction and operation. During closure, treatment will continue until mine facilities are closed and no longer generating water for discharge. In the post-closure period, after backfilled mine workings have been flooded and achieve steady state groundwater flow, the only potential discharge from the mine will be groundwater that acquires solutes from the cement pasted backfill. Enviromin has used geochemical models to predict the chemistry of this water, under representative base case and sensitivity scenarios, and their results demonstrate that interaction with the backfilled mine workings will not degrade groundwater quality (Sections 4.3.2 and Appendix N).

Although near-surface materials will be excavated and compacted for use in constructing embankments, infiltration will be sufficiently low so that no measurable discharge is expected from these facilities (Section 4.3.3.1). The CTF facility embankment will be the only one to remain in closure.

4.3.2 Non-degradation Evaluation of Post-Closure Regional Groundwater

Non-degradation provisions are set out in the Water Quality Act (Act) in 75-5-303 MCA and in rule ARM 17.30.700. To meet the intent of the Act, new discharges which meet the non-significance criteria are not required to submit an application to degrade state waters. However, all new dischargers must provide protection for existing and anticipated beneficial uses (ARM 17.30.705(2) (a) and ARM 17.30.715(1) (h).

The criteria used to determine nonsignificant changes to water quality are established in rule under ARM 17.30.715 and are based on the changes to existing surface or groundwater quality. This rule lays out the governing methods to apply the non-degradation criteria in determining if significant changes of water quality will occur. The methods used in determining the non-significant criteria are summarized below, followed by a summary of the estimated non-degradation criteria determination. Temperature is not considered in the non-significant determination as all proposed discharges are to groundwater and it is assumed that the temperature of the discharge will equilibrate to the ambient groundwater temperature prior to discharging to any surface water resources.

4.3.2.1 Non-Significant Criteria Determinations

Flow: ARM 17.30.715(1) (a): Criteria to determine significant changes in flow are based on two methods: 1) increases or decreases to the mean monthly flow by 15%, or 2) or changes to the 7_Q10 by 10%.

Carcinogen and Bio-concentrating Parameters: ARM 17.30.715(1) (b): Parameters that are categorized as carcinogens or toxics with a bio-concentration factor >300 must be discharged at or below their concentration in the receiving water (no allowable increase).

Toxic Parameters: ARM 17.30.715(1) (c): Discharges containing toxics that exceed the DEQ trigger value are allowed to increase the receiving water by 15% of the lowest applicable water quality standard.

Nitrate: ARM 17.30.715(1)(d)(i)U: Non-significance criteria are established at 7.5 mg/L for sources other than domestic sewage.

Harmful Parameters: ARM 17.30.715(1)(f): Non-significant changes to the receiving water allow for an increase of 10% of the water quality standard if the existing receiving water quality level is less than 40% of the water quality standard.

Notable Exceptions (Purer than Natural Unnecessary): MCA 75-5-306: The non-significance criteria for parameters that exceed the water quality standard were established based on the provision in MCA 75-5-306 which states, "It is not necessary that wastes be treated to a purer conditions than the natural condition of the receiving stream..." Parameters that exceed the water quality standard in the receiving water were given a non-significance criteria equal to the concentration in the receiving water.

Hydrometrics (2016f) has conducted an evaluation of non-degradation criteria for water flowing through the UG post-closure (Appendix N-1). The *UCZ* mine workings are proposed to be developed in four hydro-stratigraphic units: Upper Newland Shales (*Ynl A*), Upper Sulfide Zone (*USZ*), Upper Copper Zone (*UCZ*) and the Lower Newland Shales (*Ynl B*). The non-degradation analysis was conducted using water quality data from wells completed within these hydro-stratigraphic units in the vicinity of the *UCZ* as discussed below and listed in Table 4-10. The non-degradation criteria were evaluated as described below.

- Ambient groundwater conditions are based on wells completed in the *Ynl A, USZ, UCZ*, and *Ynl B*. Water quality data from wells MW-1B, MW-2A, MW-2B, MW-3, MW-9, PW-2, PW-3, PW-4, PW-8, PW-9, and PW-10 were combined; statistics were generated for the 25th, mean and 75th percentiles values. In most cases the 75th percentile value was used to represent ambient water quality.
- Only those parameters that have groundwater standards were evaluated.
- The non-degradation criteria were developed using the procedures found in ARM17.30.715. Based on the parameter category, the criteria were developed as:
    - No increase allowed in the receiving water for carcinogens and toxics with a bioconcentration factor (BCF) >300.
    - An increase (in the receiving water) of 15% of the most stringent water quality standard for toxic parameters.
    - An increase (in the receiving water) of 10% of the most stringent water quality standard for harmful parameters. When water quality standards were not promulgated, and a trigger value was available, the ambient water quality and trigger value were used to set the non-degradation criteria.

Compliance with the non-degradation nonsignificant policy is evaluated by comparing the predicted water quality at closure to the non-degradation criteria calculated by summing the preexisting water quality and the non-degradation criteria. The statistical non-degradation evaluation of the groundwater data is summarized in Table 4-10.The non-degradation criteria developed by Hydrometrics (2016f) are compared with the post-closure water quality predicted by Enviromin in Table 4-11.

The results of the base case model for post-closure water quality (see Appendix N) and the sensitivity scenario which doubles the surface area of reactive paste backfill are presented in Table 4-11; both predicted chemistries meet groundwater standards and non-degradation criteria. This is because flooding of the mine will eliminate sulfide oxidation. The rate of groundwater inflow will also be much slower following return of the groundwater table to its original elevation, because the hydraulic head differences will be much smaller.

Tintina's proposed practice of concurrent backfilling with a low transmissivity cemented paste material and placement of hydraulic plugs will further reduce groundwater flow. The sensitivity scenario with twice the backfilled surface area addresses uncertainty regarding increased paste exposure, as discussed in detail in Appendix N.

Groundwater quality monitoring for determination of permanent closure will be evaluated through wells completed within the *USZ* and *Ynl B* HSUs. These wells will be completed between the downgradient edge of the mine workings and the *USZ* outcrop (*USZ* monitoring) and the bedrock wells completed in the *Ynl B* below the Sheep Creek Alluvial system (*Ynl B* monitoring). All groundwater wells will meet the groundwater non-degradation criteria for each of the HSUs that the wells are completed in (*USZ* and *Ynl B*, respectively) prior to permanent closure. Estimated non-degradation criteria are included in Table 4-10 for the *USZ* based on the data collected since July 2015. The final non-degradation criteria will be determined based on all water quality data from when the wells are installed to when the mine workings advance below the water table.

Table 4-10. Estimated Groundwater Non-Degradation Criteria for Underground Workings Closure

Constituent	Groundwater Wells (MW-1B, MW-2A, MW-2B, MW-3, MW-9, PW-2, PW-3, PW-4, PW-8, PW-9, and PW-10)			Groundwater Human Health Standard	Category	Non Deg Trigger Level	Ambient + Trigger	Applicable Nonsignificance Factor ARM 17.30.715	Non Deg Threshold	Required Reporting Limit (RRL)	Estimated Non-Degradation Criteria
	25%ile	75%ile	Average								
ALUMINUM (Al)	<0.009	0.028	0.015	--	Toxic	0.03	0.0580	--	--	0.009	--
ANTIMONY (Sb)	<0.0005	0.0011	0.0012	0.006	Toxic	0.0004	0.0015	0.15	0.0009	0.0005	0.002
ARSENIC (As)	0.003	0.064	0.034	0.010	Carcinogen	NAI	NAI	NAI	NAI	0.001	0.064
BARIUM (Ba)	0.013	0.043	0.035	1.0	Toxic	0.002	0.0448	0.15	0.1500	0.005	0.193
BERYLLIUM (Be)	<0.0008	0.0010	0.0009	0.004	Carcinogen	NAI	NAI	NAI	NAI	0.001	0.0010
CADMIUM (Cd)	<0.00003	0.00007	0.00004	0.005	Toxic	0.0001	0.0002	0.15	0.0008	0.00008	0.00082
CHROMIUM (Cr)	<0.001	0.010	0.006	0.1	Toxic	0.001	0.0110	0.15	0.0150	0.001	0.025
COBALT (Co)	<0.01	0.01	0.01	--	--	--	--	--	--	0.01	--
COPPER (Cu)	<0.001	0.002	0.002	1.3	Toxic	0.0005	0.0025	0.15	0.1950	0.001	0.197
FLUORIDE (F)	0.30	0.60	0.43	4.0	Toxic	0.005	0.6050	0.15	0.6000	0.001	1.20
IRON (Fe)	0.068	2.140	5.513	--	Harmful	--	--	--	--	0.05	--
LEAD (Pb)	<0.0003	0.0005	0.0015	0.015	Toxic	0.0001	0.0006	0.15	0.00225	0.00050	0.0028
MANGANESE (Mn)	0.012	0.085	0.052	--	--	--	--	--	--	0.005	--
MERCURY (Hg)	<0.000005	0.000010	0.000007	0.002	Toxic w/ BCF >300	NAI	NAI	NAI	NAI	0.00001	0.000010
MOLYBDENUM (Mo)	<0.002	0.005	0.003	--	--	--	--	--	--	0.002	--
NICKEL (Ni)	0.001	0.010	0.005	0.1	Toxic	0.0005	0.0105	0.15	0.0150	0.010	0.025
SELENIUM (Se)	0.0002	0.0010	0.0006	0.05	Toxic	0.0006	0.0016	0.15	0.0075	0.0010	0.009
SILVER (Ag)	<0.0005	0.0200	0.0106	0.1	Toxic	0.0002	0.0202	0.15	0.0150	0.001	0.0350
STRONTIUM (Sr)	0.10	6.48	3.84	4.0	Toxic	0.1	6.5800	0.15	0.6000	0.0002	6.48
THALLIUM (Tl)	0.0004	0.0039	0.0040	0.002	Toxic	0.0003	0.0042	0.15	0.0003	0.0002	0.0039
URANIUM (U)	0.0010	0.0080	0.0047	0.03	Carcinogen	NAI	NAI	NAI	NAI	0.008	0.0080
ZINC (Zn)	0.002	0.01675	0.01573	2.0	Toxic	0.005	0.0218	0.15	0.3000	0.01	0.32
NITRATE + NITRITE AS N	0.0100	0.0450	0.0637	10	Toxic	7.5	7.5	0.15	7.5	0.01	7.5
NITROGEN (N) TOT	0.5	0.5	0.5	--	Nutrient	--	--	--	--	0.01	--
PHOSPHORUS (P) TOT	0.0	0.0	0.0	--	Nutrient	0.001	--	--	--	0.001	--
PH FLD (S.U.)	6.5	7.3	6.9	6.5-8.5	Harmful	0.5 s.u.	--	--	--	--	6.0 -7.8
SPECIFIC CONDUCTIVITY (UMHOS/CM)	451.0	751.0	592.7	<1000	Class I GW	--	--	--	--	1	<1000
SULFATE (SO4)	39	230	146	250*	SMCL	--	--	--	--	1	250*
CHLORIDE (Cl)	1	2	1	250*	SMCL	--	--	--	--	1	250*
CALCIUM (Ca)	52	79	63	--	--	--	--	--	--	1	--
SODIUM (Na)	3	10	6	--	--	--	--	--	--	1	--
MAGNESIUM (Mg)	28	49	36	--	--	--	--	--	--	1	--
TOTAL ALKALINITY AS CaCO3	190.0	220.0	185.8	--	--	--	--	--	--	4	--
TOTAL SUSPENDED SOLIDS (TSS)	10.0	10.0	20.0	--	--	--	--	--	--	10	--
TOTAL HARDNESS AS CaCO3	244	405	306	--	--	--	--	--	--	--	--

Units in mg/L unless otherwise noted

NAI = No Allowable Increase (applies to all Carcinogen and Toxics with BCF >300); -- = Not Applicable

Statistics calculated using the value of detection limit when less that detection results. Average value assigned < when 50% or more of samples below detect.

* Based on EPA Secondary Standard (SMCL)

Table 4-11. Predicted Water Quality for UG Workings Post-closure

		Underground model predictions at closure, after PhreeqC			Groundwater Standards (MT DEQ-7)	Estimated Groundwater Non-degradation Criteria
		BASECASE	Paste backfill surface area doubled	Detection limits = 0		
pH	s.u.	6.81	6.77	6.81	na*	6.0-7.8
Al	mg/L	0.015	0.016	0.015	na	0.058
Alkalinity	mg/L $CaCO_3$	144	147	144	na*	na
As	mg/L	0.0000	0.0000	0.0000	0.01	0.064
Ba	mg/L	0.0169	0.0159	0.0169	1	0.1928
Be	mg/L	*0.0002*	*0.0003*	*0.0001*	0.004	0.00095
Ca	mg/L	64	71	64	na	na
Cd	mg/L	0.000042	0.000042	0.000042	0.005000	0.0008
Cl	mg/L	1.7	2.0	1.7	na*	na
Cr	mg/L	0.00048	0.00052	0.00048	0.1	0.025
Cu	mg/L	*0.0002*	*0.0003*	*0.0001*	1.3	0.1970
F	mg/L	*0.36*	*0.40*	*0.33*	4	1.2
Fe	mg/L	0.00	0.00	0.00	na**	na
Hg	mg/L	0.000006	0.000006	0.000006	0.002	0.000010
K	mg/L	2.9	3.8	2.9	na	na
Mg	mg/L	22.1	20.9	22.1	na	na
Mn	mg/L	0.053	0.054	0.051	na**	na
NO_3	ppm as N	3.30	3.30	3.30	1	7.5
Na	mg/L	4.8	5.3	4.8	na	na
Ni	mg/L	*0.0049*	*0.0057*	*0.0042*	0.1	0.025
P	mg/L	0.001	0.001	0.001	na	na
Pb	mg/L	0.00001	0.00001	0.00001	0.015	0.0028
SO_4	mg/L	115	124	115	na**	250**
Sb	mg/L	0.0032	0.0037	0.0032	0.006	0.002
Se	mg/L	*0.0009*	*0.0012*	*0.0005*	0.05	0.0085
Si	mg/L	1.55	1.55	1.55	na	na
Sr	mg/L	2.1	2.2	2.1	4	6.48
Tl	mg/L	0.0037	0.0038	0.0037	0.002	0.0039
U	mg/L	0.00504	0.00511	0.00497	0.03	0.008
Zn	mg/L	*0.018*	*0.021*	*0.015*	2	0.317

Italicized predictions affected by detection limit propogation in the mc *narrative standards may exist

prediction of endpont, not based on modeling **secondary standard

Supersaturated phases in basecase: Ba3(AsO4), barite, Cr2O3, ferrihydrite, gibbsite, quartz

4.3.3 Seepage from Embankments and Pads Constructed with Near-Surface Materials

Tintina proposes to construct embankments for multiple facilities using near-surface rock to be excavated from highly weathered and oxidized surface exposures of *Ynl Ex* and *Tgd*. Infiltration of precipitation and snowmelt through embankment construction materials derived from near-surface materials has the potential to affect downgradient water. Compliance with non-degradation criteria was evaluated for operations at all facilities and in closure for the CTF.

The relative magnitude of any discharge to groundwater beneath constructed embankments depends on the rate of infiltration and the quality of consequent seepage. The acid generation and metal release potential of the near surface *Ynl Ex* and *Tgd* has shown to be low using static and kinetic test methods (Section 2.4.4).

Groundwater infiltration and subsequent seepage rates were estimated for the CTF, PWP, CWP and NCWR embankments and the mill, portal and temporary WRS pads. Facilities will be constructed as follows (Section 3.4.2.1):

1) Embankments and pads will be constructed with fill material excavated from the facility basins/footprints as part of the cut / fill construction. The majority of this fill will be *Ynl Ex*, with minor amounts of *Tgd* rock fill.
2) Embankment / pad fill materials will consist of hard, durable, fresh to moderately weathered rock fill with a maximum particle size of 0.98 feet (300 mm) which will be placed in 1.64 feet (500 mm) thick lifts within the main embankment zones. The embankment / pad material will be compacted to 95% Modified Proctor laboratory density with a smooth drum vibratory roller.
3) The sub-grade liner bedding material will consist of durable fresh to weathered rock fill with a maximum particle size of 1-inch (2.54 cm), placed in 0.98 foot (300 mm) thick lifts on the basin surface and upstream side of any embankment. The sub-grade bedding material will be compacted to 95% Modified Proctor laboratory density with a smooth drum vibratory roller.
4) Approximately one-foot of topsoil will be placed over all unlined exposed surfaces of the embankments and pads. These surfaces will be vegetated operationally during the 15 year active mine life.

4.3.3.1 <u>Seepage Analysis using HELP Model</u>

Hydraulic (seepage) analysis of the embankment areas including the CTF, PWP, CWP and NCWR and the mill, portal and temporary WRS pad, was performed by Hydrometrics (2016e) using the HELP model (Section 3.6.5.4). All details of this seepage analysis including the modeling approach, input parameters, and analysis results are reported in Appendix M-2 and are summarized below. To calculate percolation through the embankments, the HELP model was run for the full 15 years of active mine life.

<u>Climate Input Parameters:</u> The HELP model uses climate data to predict one-dimensional moisture flow through a user-specified soil profile. The HELP model runs in one-year increments, but can provide daily or monthly results summaries. The four climate parameters inputs required for the HELP model include: precipitation, mean daily temperature, solar radiation, and evapotranspiration. The Helena weather station located 50 miles (80 km) from the Project site provided HELP climate default data and were modified using data from Tintina's local weather station near the site from May 2012 through November 2014 (Knight Piésold, 2015a) to synthetically generate 15 years of daily data in HELP.

The HELP precipitation inputs resulted in an average expected precipitation of 18.3 inches (46.5 cm) annually. The daily precipitation dataset was synthetically generated using the Helena dataset with the monthly precipitation averages edited to reflect those from the Tintina station. The average annual temperature was 35.9°F (2.2°C) and synthetically generated in the same way as the precipitation data. Daily solar radiation data were generated by modifying the latitude of the Helena weather station to 46.77º which is the latitude at the Project site. Evapotranspiration values were based on the default Helena dataset while the site latitude was modified to 46.77º. A soil evaporative zone depth of 12 inches (30.5 cm), the depth of the topsoil layer, was used. A maximum leaf area index of 2.0 was used to represent a fair stand of grass.

Physical Input Parameters: The rock to be placed in the facility embankments consists of compacted (to 95% Modified Proctor Laboratory density) near-surface shales (*Ynl Ex*) and granodiorite (*Tgd*) overlain by approximately one foot of top soil. The top soil material was represented by the HELP soil properties for a sandy loam. Physical properties include an effective saturated hydraulic conductivity of 0.00072 cm/s and porosity of 0.453. The compacted shales and granodiorite material was represented by the HELP soil properties for gravel and then modified for compaction. Physical properties include an effective saturated hydraulic conductivity of 0.013 cm/s and porosity of 0.370.

All embankments were assumed to have a top slope of 40% and an average bank height to be half the total bank height estimated based on plan and profile drawings for each facility mentioned above (Knight Piésold, 2017a). Average slope length was calculated based on total bank height and the top slope. A run-off curve number was calculated in HELP based on the top soil texture, the average slope and slope length, and a fair stand of grass for vegetation condition. Calculated curve numbers for all areas ranged from 73.4 to 77.0. Both layers were modeled as vertical percolation layers. The HELP model calculated approximate steady state conditions for initial moisture content of each layer. A summary of the soil and design input data are included in Attachment 1 of Appendix M-2.

Embankment Seepage Hydraulic Analysis Results: The predicted average monthly percolation (in inches) was multiplied by the estimated embankment footprint to determine an average monthly percolation volume and summed to determine the average yearly percolation volume for each embankment. All of the Hydrometrics HELP model results for each facility are reported in Attachment 2 of Appendix M-2.

Using these data, the HELP model estimates very low percolation rates through the CTF, WRS, PWP, and CWP embankments and the mill and WRS pads. Predicted values range from 0.01 to 0.11 gpm (0.03 to 0.42 Lpm) for the different facilities. The highest modeled percolation rate results of 0.11 gpm (0.42 Lpm) were for the CTF and the mill pad embankments whereas the lowest modeled percolation rate (0.009 gpm; 0.034 L/min.) is associated with the CWP embankment (2017c). The modeled percolation rate associated with the PWP embankment is 0.07 gpm (0.27 Lpm).

When the modeled percolation results for each facility are reported as a flow per unit area (gpm/square foot), they range from 2 x 10^{-6} to 3 x 10^{-6} gpm/ft^2. These very low modeled embankment seepage percolation rates indicates that embankment seepage will not significantly impact the regional groundwater system. There is therefore no need for the embankment seepage to be considered further as it is a non-issue.

5 MITIGATIONS

5.1 Summary

Tintina has aggressively sought out and implemented a number of innovative process variations and modified the ways in which facilities are sited and constructed. These will reduce risks to human health and the environment. The mitigations and their justifications include:

- Process variations:
  - Use of cemented paste tailings backfill underground
    - Provides structural strength for ground support and prevents surface subsidence
    - Results in extremely low hydraulic conductivity of backfill (water flows through at a rate of about 10^{-8} cm/s (less than 3/100,000ths of a foot per day) (Figure 3.29. CWP and Brine Pond Plan)
    - Helps neutralize acid-generation because paste fluid properties are highly alkaline (high pH of 9 to 10 s.u.)
    - Significantly reduces or eliminate sulfide oxidation (and acid production) because paste tailings will reside below groundwater table after closure in a chemically anoxic (non-oxidizing) environment
    - Reducing conditions also inhibit the solubility of many metals
    - Allows drift and fill mining which provides for 100% extraction of copper-enriched rock.
    - Reduces potential surface disturbance by minimizing the amount of tailings stored on surface
    - Eliminates risk of subsidence to surface
  - Use of cemented paste tailings in surface tailings facility
    - Cemented paste tailings are a stable non-flowable low strength solid
    - Cemented paste tailings establish a 1-2^{o} slope towards sump, allowing for drainage to CTF sump
    - Cemented paste properties provide extremely low hydraulic conductivity to tailings (water flows through at a rate of about 1.6 x 10^{-6} cm/s (less than 5/100ths of a foot per day) on the facility (Table 3-29)
  - Use of sealed containers for shipping
    - Concentrate loaded in enclosed concentrate shed
    - No loss of material during transport
    - Eliminates off-site contamination because no intermediate load-out, transfer or storage -areas are required
    - Reduced risk of spillage in event of accident
  - Contact water containment
    - Contact water transported in lined ditches or HDPE pipelines to lined storage facility prior to pump back to PWP or WTP
- Facility siting:
  - Mine openings (portal and ventilation raises) all located well above the water table therefore no risk of any discharge to surface water in closure
  - Locations sited off of all main streams (> 0.4 miles from Sheep Creek, and 19 river miles from Smith River)
  - All facilities confined to one sub-basin drainage (Sheep Creek)

    - All facilities locations selected to minimize impacts to wetlands (less than 0.85 acres (0.34 ha) of wetlands impacted by all Project disturbances and activities)
    - Portal and decline location selected over alternatives sites to minimize amount of sulfide-bearing rock brought to surface for storage on the temporary waste rock facility
- Facility construction:
    - Water-bearing mine waste facilities
        - All water-bearing facilities have foundation drains (beneath the facilities) with foundation drain collection ponds that pump back to treatable storage
        - All water-bearing facilities have double HDPE-lined basins with geonet sandwiched between liners for drainage; drainage from geonet layer reports to sump in CTF
        - The CTF facility has an internal basin drain system with water collected off of the top of liners and directed to PWP storage facilities or treatment
        - The high hazard dams (CTF and PWP) are designed to store the Probable Maximum Flood Event (equivalent of 33 inches (830 mm) of precipitation in a single storm event, about 1.5 times larger than total annual precipitation),
        - Additional minimum of 6.6 feet (2 m) of freeboard storage in excess of PMF event (CTF and PWP)
        - One smaller facility (CWP) and one fresh water facility NCWR can store the 1:200 year storm event
        - PWP designed to operate less than half full
        - CTF, PWP, NCWR and CWP facilities are designed to withstand the Maximum Credible Earthquake event, and the 1 in 10,000 year event (as required by recent Montana Legislation SB 409, see Section 3.4.2.1)
        - Have foundation factors of safety for stability well in excess of what is needed to avoid risk of failure (see Section 3.5.5).
        - Have third-party engineer of record and panel of 3 independent tailings engineers that oversee the design, construction, operation, and closure of the CTF
        - Water can be continuously removed from CTF and CWP; little water will be stored on either of these facilities as ponds or in sump
            - Low water storage reduces or eliminates hydrostatic head of water on facility liners
            - With almost no head on the CTF and CWP liners, seepage through the liners will be negligible
- Underground grouting of fractures under Coon Creek
    - Minimizes risk of surface subsidence from mining
    - Minimizes loss of surface and groundwater into mine workings, thereby reducing potential for impacts to creeks and associated wetlands (however, no impacts to either detected in pump testing)
- Tailings release from pipelines and storm water control
    - Tailings transport pipe system to use secondary containment measures to protect the environment
- Use of BMPs to route storm water in diversion and drainage ditches around facilities and deliver water and sediments to discharge points with sediment collection.

5.2 Failure Modes Effects Analysis (FMEA)

Tintina developed a number of these mitigations by searching for ways to reduce risks to human health and the environment, through an examination of the effectiveness of proposed operational processes and examination of facility designs and their modes of failure using a methodology called Failure Mode and Effects Analysis (FMEA). FMEA is a systematic method for examining processes or facility designs to identify where and how they might go wrong or fail; and to assess the relative impact of different types of failures.

Once this is accomplished, the parts of the process that are most in need of change are identified. A FMEA is often used for structure mitigation for risk reduction based on either failure (mode) severity reduction, or on lowering the probability of failure's occurrence or both. FMEA is used to evaluate processes and facilities for possible failures and to prevent them, by correcting the processes or design proactively, rather than reacting to adverse events after failures have occurred. This emphasis on prevention can significantly reduce risk of harm to human health and the environment.

An example of one of the graphic outputs from this process is presented in Figure 5.1. This figure evaluates the change in risk associated with project facilities that results from having ample versus marginal water storage capacity and the ability to pump back water from a facility in order to prevent a discharge. As can be seen from this figure, facilities with ample storage and pump back capabilities greatly reduces the risk of failure relative to many of the historically constructed facilities that lack those attributes. A portion of the FMEA evaluated during planning for process selection and facility design for the Black Butte Project is included in this report as Appendix R.

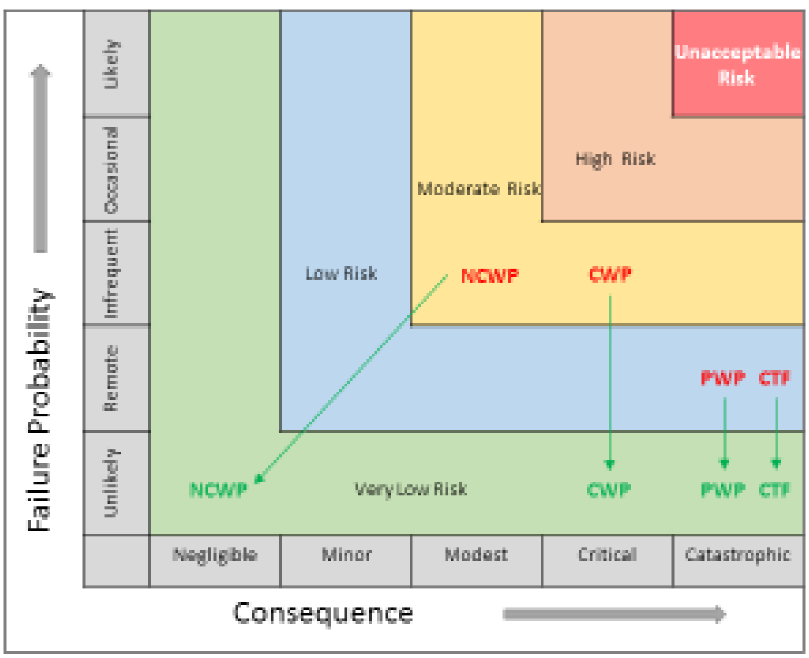


Figure 5.1. FMEA Graphic Example for Overfilling of Facility and Discharge Risk

6 MONITORING

6.1 Monitoring Introduction

Baseline monitoring has been conducted and will continue throughout the mine permitting period to assess environmental conditions prior to surface disturbing activities. This monitoring characterizes existing conditions at the site, and provides a baseline against which to identify potential impacts to resources. Baseline resource study results are described under the resource evaluations in the Existing Conditions portion of this report (Section 2).

Operational monitoring is designed to identify potential environmental impacts to resources. The frequency of monitoring for resources is stipulated by DEQ, and intended to detect potential impacts in a timely manner and trigger the implementation of operational changes and / or mitigation measures. Various means of protecting specific resources are discussed below as well as in the Mitigations section (Section 5).

Post mining monitoring continues after closure to monitor potential impacts. This monitoring will continue until such time that DEQ determines that the frequency and number of sampling sites for each resource can be reduced or that closure objectives have been met and monitoring can be eliminated.

6.2 Ongoing Baseline Monitoring

Expected ongoing monitoring programs during the permitting period include weather, water quality and quantity, aquatic resources, and ongoing environmental geochemistry.

The existing water quality and quantity monitoring program currently evaluates 11 surface water sites. Flow, stage, and field parameters (temperature, pH and SC) are monitored quarterly at all of these sites. Water quality samples are collected at six of the sites during quarterly (or more frequent) monitoring. In addition, 12 groundwater monitoring wells and 10 seeps and springs are monitored for water quantity (or water levels) and quality on at least a quarterly basis. Nine aquifer test wells and 12 piezometers are monitored for water levels only, on a quarterly or more frequent basis (Section 2.2.3). These monitoring sites are depicted on Figure 2.2 and Figure 2.3. Soil, wildlife, vegetation, cultural, socio-economic, and visual and transportation resources are unlikely to change as a result of, or during the permitting process. Any significant changes to these resources, should they occur, will be assessed and reported to DEQ.

6.3 Operational Monitoring

6.3.1 Water Quality and Quantity Monitoring

6.3.1.1 Proposed New Operational Monitoring of Facility Sites

As permitting proceeds and construction of new mine support facilities are anticipated, additional water resource monitoring of these facilities will be warranted. Tintina proposes new facility monitoring sites, to provide a technically sound and regulatory sufficient monitoring program. These sites will be monitored on a quarterly basis for the same surface and groundwater parameters as for the current baseline study programs (Section 2.2). Table 6-1 lists and Figure 6.1, Figure 6.2, and Figure 3.2 show proposed new sampling site locations for surface water (3), piezometers (28), and groundwater monitoring wells (18 during the permitting process and mine facility construction, and an additional 4 installed during closure; with an additional 7 existing pump test wells).

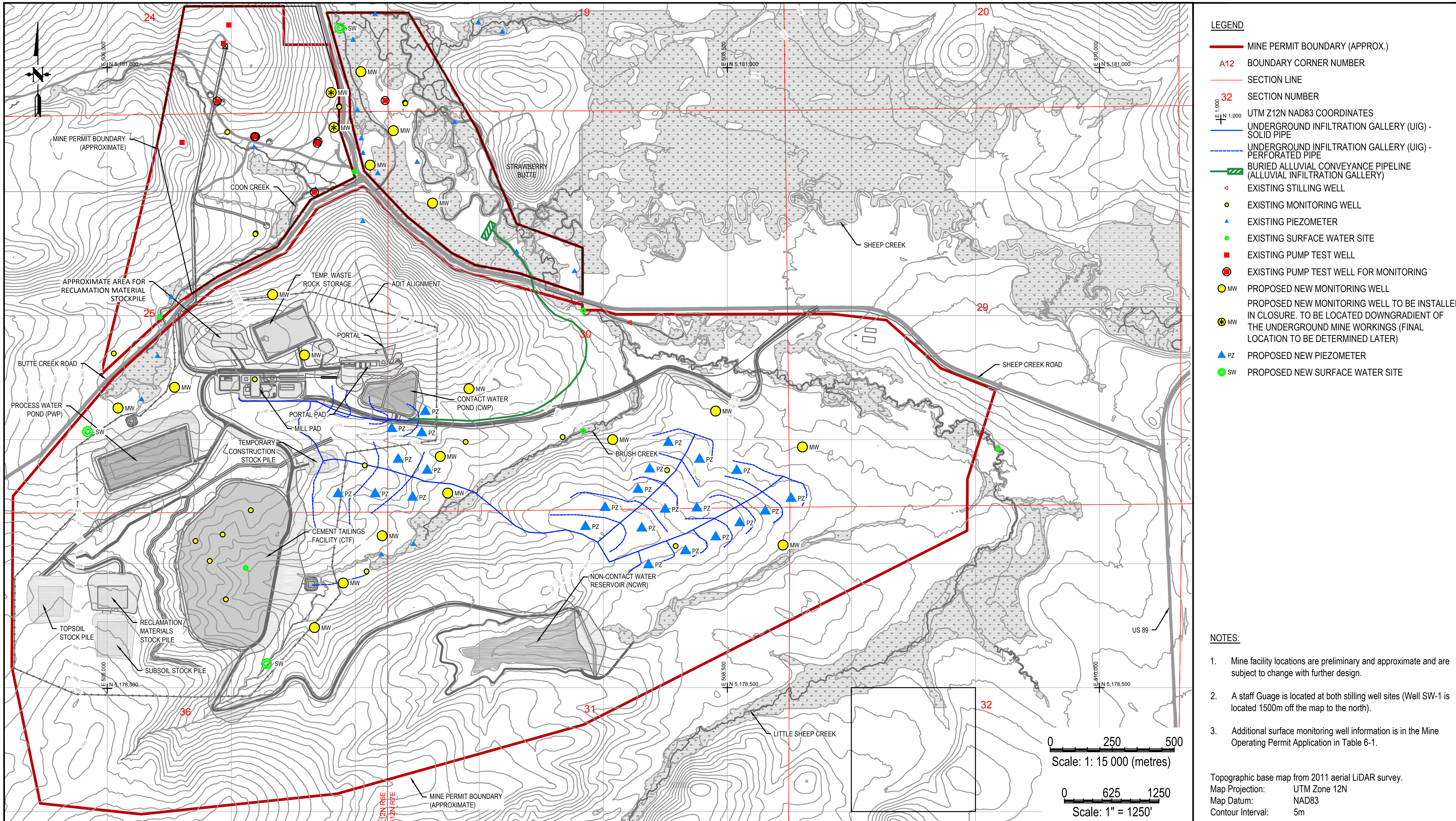
Eight (8) of the 18 new monitor wells (excluding the 4 to be installed in closure) are strategically located downgradient of proposed water-bearing / waste facilities. Two of the proposed new surface monitoring wells will be located downgradient of the underground workings and installed in closure (well locations to be finalized in closure but are generally located on Figure 6.1). Two additional proposed monitoring wells will also be installed in the underground workings in closure (final locations to be determined later). Four new piezometers (numbers BB WMR5 through BB WMR8) are located in Copper Creek (upstream tributary of Black Butte Creek) wetlands as reference wetland monitoring sites (Figure 6.2). In addition, sampling of seven existing pump test wells (see Figures 2.3 and 6.1) overlying the mineral deposits (PW-2, 3, 4, 7, 8, 9 and 10) as monitoring wells for water levels and water quality in specific hydro-stratigraphic units began in the third-quarter of 2016. Twenty-four (24) new piezometers will measure depth of saturation in near surface materials in and adjacent to the infiltration gallery.

It is intended that all three newly proposed surface water sites, eight of the new downgradient monitor wells for major facilities, and all five new wetland piezometers (see Section 6.3.1.1) be installed prior to or early in the EIS process. This will allow at least one year of new baseline facility monitoring data collection before construction. An additional 10 operational downgradient facility monitoring wells, and 24 new piezometers for the underground infiltration galleries are proposed to be installed during the facility construction period. Baseline data from this latter set of wells and piezometers are not required as their locations are paired with the initial set of wells installed.

Table 6-1. Additional Operational Facility Monitoring Sites

Site	New Surface Water Station	Pumping Wells and Downgradient Monitoring Well initial / construction[1] (closure)[2]	Wetland/Alluvial Piezometers	Inlying Infiltration Gallery Piezometers
Upper Coon Creek	1			
Upper Brush Creek	1			
Lower Brush Creek	1			
WRS		1 / 1		
CWP		1 / 1		
PWP		1 / 1		
CTF		1 / 1		
NCWR		0/ 0		
Mined Out Deposit Zones[2]		0 / 0 (4)		
Sheep Creek Hay Meadow Area		1 / 3	0	
Copper Creek[3]			4[3]	
Infiltration Gallery Central		1 / 1	0	8
Infiltration Gallery - East		2 / 2		16
Pump Test Wells[4]		7		
Total[5]	**3**	**25 (4)**	**4**	**24**

[1] Initial wells to be installed prior to or early in the EIS period; whereas, construction wells will be installed prior to facility construction. Most of the new proposed wells in this table are shown in Figure 6.1 in the MOP Application.
[2] New monitoring wells to be located and installed in closure; 2 will be surface wells located downgradient of the mined out deposit zones in closure, and 2 others will be installed underground.
[3] See Figure 6.2 for map location, not shown on Figure 1.3.
[4] Existing Pump Test wells to be sampled for water levels and water quality and shown in Figures 2.3 and 6.1.
[5] The total number of new proposed monitoring wells and existing pumping wells includes those for both initial and construction; those monitoring wells needed for closure are listed separately within the parentheses



Prepared by Tetra Tech Inc. (Revised July 2017)

FIGURE 6.1

Baseline and Proposed New Water Quality Monitoring Sites
Black Butte Copper Project
Mine Operating Permit Application
Meagher County, Montana

TINTINA RESOURCES

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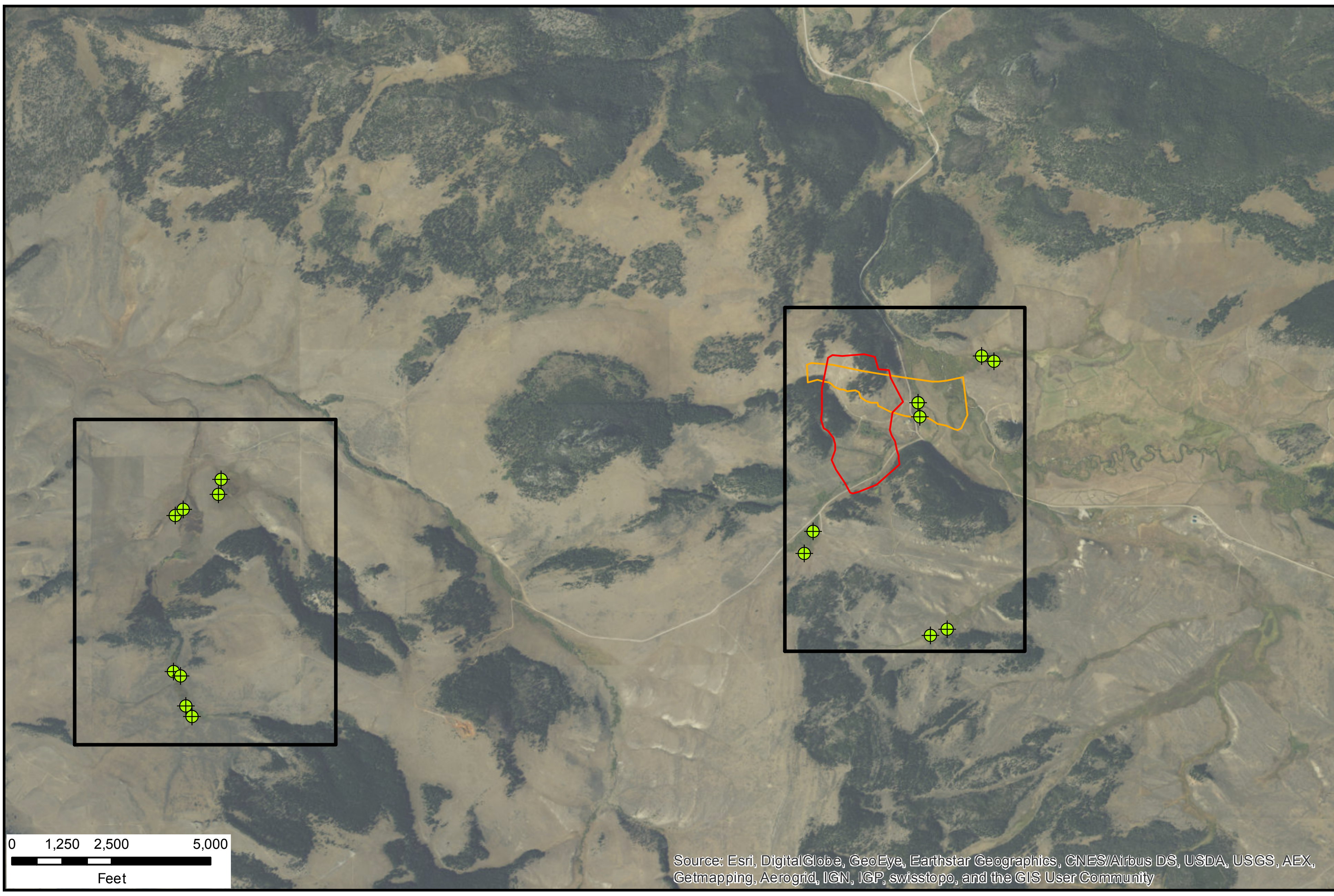
Reference and Project Area Wetland Monitoring Sites

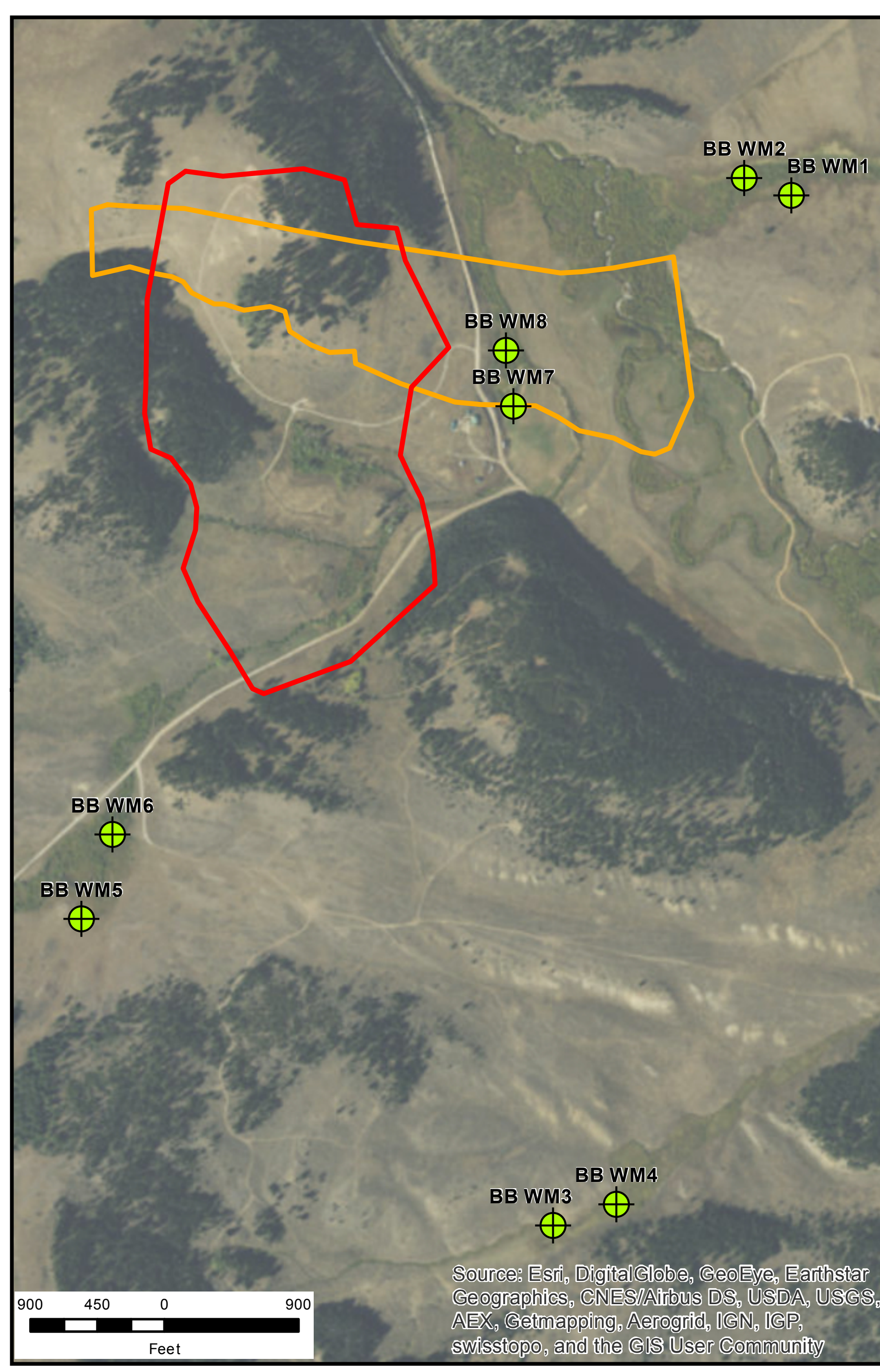


N

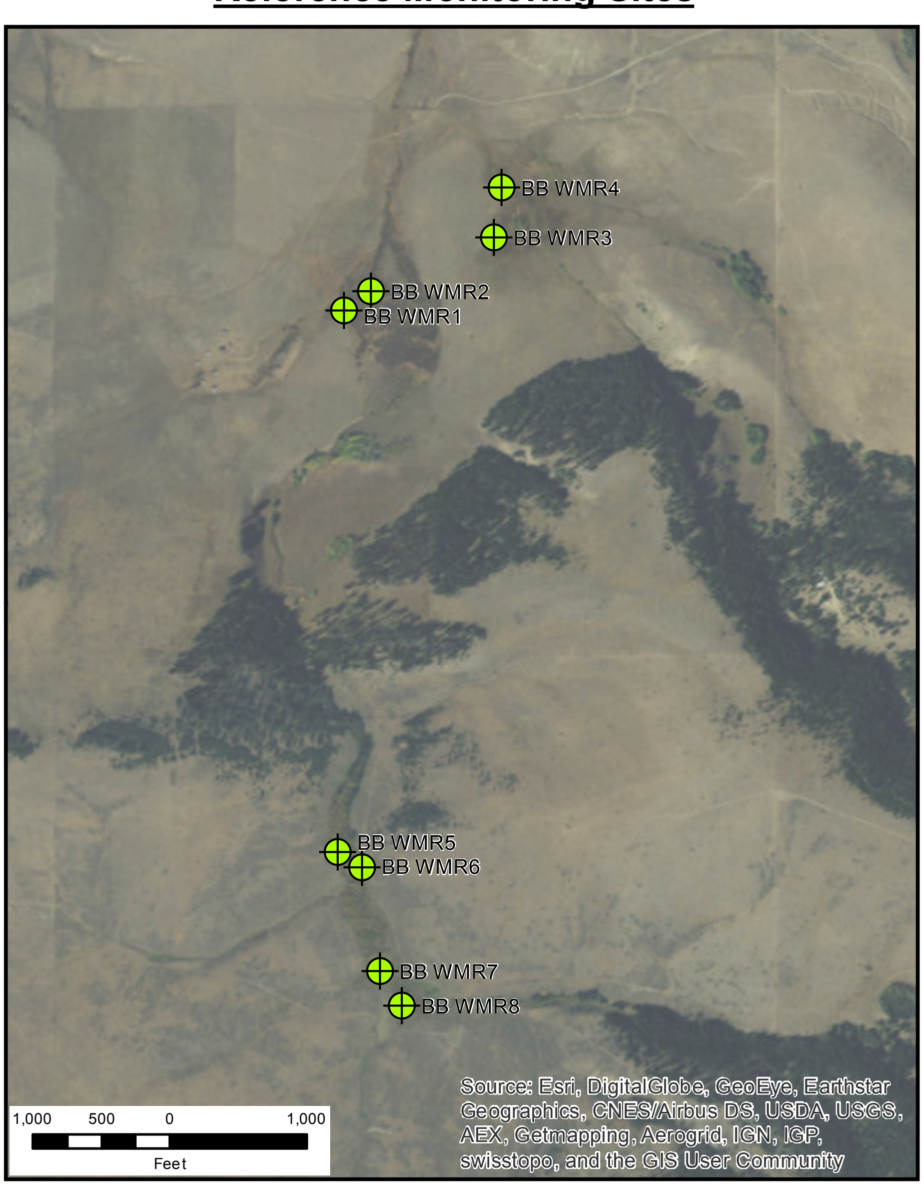
LEGEND

- Wetland Monitoring Site
- Upper Johnny Lee Deposit
- Lower Johnny Lee Deposit

Project Area Monitoring Sites



Reference Monitoring Sites



TINTINA RESOURCES

Figure 6.2
Wetland Monitoring Sites
Black Butte Copper Project
Meagher County, Montana

The proposed increased monitoring is believed to be sufficient, as a minimum of two groundwater well locations monitor water resources downgradient of each of the new facilities. In addition, a total of eleven (11) downgradient groundwater monitoring wells (new and existing) and 24 new internal and external piezometers will monitor the effects of underground infiltration galleries discharges to groundwater. Changes in groundwater quality (other than improvement) near the infiltration galleries are not expected because the discharges will be treated to non-degradation criteria for groundwater. Information provided by static test results and kinetic testing suggests that it is unlikely that either the *Ynl Ex* or *Tgd* material will produce acid or release significant concentrations of metals. Static test were confirmed by kinetic testing, and metal release has been very low. As demonstrated in Figure 2.24 and Figure 2.25, effluent from these humidity cell tests met MT groundwater quality standards in all weeks. These effluents also met surface water quality standards, with the exception of selenium exceedances in weeks 0 through 4 in *Ynl Ex.* No metals were detected above standards for the *Tgd*.

Frequency of Monitoring: New surface water sites, monitoring wells, and pumping wells will be sampled quarterly for water quality, flow and / or water levels (Table 6-2). Water levels in new wetland piezometers will be measured continuously using data-logging pressure transducers. Sampling of pumping wells began in the third quarter of 2016. Other sites will enter the monitoring schedule upon completion or installation.

Sampling protocols (SOPs) (Appendix U), parameters and detection limits (Table 2.8) and frequency will follow those established for the MOP as presented in in Appendix U.

Table 6-2. New Proposed Baseline and Operational Monitoring

a. Monitoring Initiated to Acquire One Year Baseline data, Continues Operationally and in Early Closure					
Monitoring Types	Number of Sites	Flow or Water Level	Field Parameters	Lab Parameters	Frequency
Surface water	3	X	X	X	Quarterly
Monitoring Wells	8	X	X	X	Quarterly
Pumping Wells	4	X	X	X	Quarterly
Wetland Piezometers[1]	4	X			Continuous
Subtotal	*19*				
b. Monitoring Initiated in Construction - Sampled Operationally and During Initial Closure					
Monitoring Types	Number of Sites	Flow or Water Level	Field Parameters	Lab Parameters	Frequency
Surface water	0	X	X	X	Quarterly
Monitoring Wells	10	X	X	X	Quarterly
Pumping Wells	3	X	X	X	Quarterly
Subtotal	*13*				
Grand Total	**33**				

[1] See Figure 6.2 for map location, not shown on Figure 1.3.

Piezometers for the infiltration galleries will be installed during construction of the galleries. Underground infiltration gallery sites will be visually inspected to ensure that surface ponding, seep and spring development, and surface water run-off is not occurring. The piezometers water levels will be used to track groundwater mounding and to avoid soil saturation. It is expected that monthly adjustments will be required to the amount / time water is applied to each cell(s), or distributed along individual lines in the gallery system. Because the mine discharge rate is expected to be low during the initial first two year of development (<300 gpm; 1,136 Lpm), there will be an opportunity to better understand and calibrate application rates and cell rotation using piezometer water level measurements of soil saturation. Piezometers in all three areas (central, southwest and southeast) will be monitored monthly, and areas with active discharge will initially be monitored weekly until such time that DEQ determines sampling frequency can be decreased.

6.3.1.2 Water Quality and Compliance Monitoring of Facilities

The facilities will require water quality sampling and monitoring during operations. Tintina recommends that the following be sampled for water quality and flow or water levels:

- Underground discharge
- Water treatment facility discharge point (non-degradation compliance),
- Foundation drain (PWP, and CTF) water quality sampling to monitor effectiveness of the liners and foundation drains,
- WRS pad drain, and

- Copper-enriched stockpile drain.

It is recommended that water treatment facility discharge be measured weekly, that facility down-gradient foundation drain ponds be sampled monthly, and that the WRS pad and the copper-enriched stockpile drains be monitored quarterly.

Other sites are recommended for monitoring for flow for operational water balance and water right's needs. These include:

- Underground dewatering rate,
- Process water pond discharge to the WTP, and
- WTP discharge to infiltration galleries.

6.3.1.3 Trigger Level Values for Implementation of Mitigations and DEQ Notification

Tintina will notify DEQ within 48 hours if any of the monitoring results indicate an operating condition outside the permitted design parameters. If a preliminary laboratory report showing that a contaminant has exceeded local background non-degradation criteria for groundwater at any of the groundwater monitoring sites is received, Tintina will notify DEQ within 48 hours and submit a corrective action plan for addressing the exceedance.

6.3.2 Facility Operational Monitoring

Proper operation, monitoring, and record keeping are critical to the operation of all waste and water management mine facilities. A Tailings Operations, Monitoring and Surveillance (TOMS) Manual has been prepared for the following waste and water management systems: PWP, CTF, and NCWR. This document will be reviewed and updated on an ongoing basis (i.e. during the initial construction program and during operations). The TOMS Manual outlines regular monitoring, inspection, and reporting requirements as well as emergency response measures in the event of an upset of operating conditions. The TOMS Manual should be referenced for all operations and monitoring activities relating to the PWP, CTF, and NCWR and ancillary waste and supply lines and water control structures.

Activities or inspections to be carried out during construction and operation of the PWP, CTF, and NCWR will include where appropriate:

- Monitoring of construction and commissioning of the foundation drain,
- Seepage collection and sump and pump back systems,
- Construction / extension and management of tailings discharge pipe works,
- Basin drains,
- Water reclaim systems, and/or
- Pipe works and seepage recycle systems.

Concurrent reclamation of the downstream embankment slopes will be undertaken for all facilities following the completion of embankment construction.

Extensive monitoring will be undertaken as part of the ongoing operation of these facilities, and will provide important input for performance evaluation and refinement of operating practices. Monitoring will be conducted throughout the life of the facility including construction, operation, decommissioning, and post-closure.

The proposed monitoring falls into three basic types as follows:

- **General Monitoring** - This includes items such as:
  - Tailings deposition locations,
  - Checks on pipe joints and pipe integrity,
  - Performance of pumps and valves,
  - Embankment freeboard, and
  - Water levels in sumps and ponds.

Regular inspections will help identify any areas of concern that may require maintenance or more detailed evaluation. General monitoring will largely be undertaken through visual inspections carried out by designated personnel. Detailed inspection checklists, action sheets, and recording and reporting procedures will be developed for daily, weekly, and monthly inspections.

- **Performance Monitoring -** This includes items such as:
  - Tailings solids content,
  - Volume of tailings deposited,
  - Groundwater monitoring well sampling and testing,
  - Analyzing piezometer levels within the tailings mass,
  - Analyzing settlement gauge data,
  - Analyzing inclinometer data,
  - Reviewing tailings level and density surveys,
  - Surveying of the cemented tailings surface slopes,
  - Monitoring movement detection monuments,
  - Completing embankment surveys, and
  - Water flow measurements.

The monitoring program will be used to verify the performance of the facility, and to ensure that the Project is operating safely and that the facilities are secure. Monitoring of the waste and water management facilities will also provide performance evaluation information that will help refine operating practices.

During operations, a surface and groundwater quality monitoring program will be conducted in order to determine seasonal and temporal changes in the foundation drain flows and receiving water quality from the CTF and PWP. This program will be carried out to confirm compliance with downstream receiving water quality requirements and to protect groundwater quality from changes over time. The program will consist of sampling and analyses of:

- Foundation drain flows from the CTF collection sump, and
- Monitoring wells located throughout the mine site, especially those down gradient from the PWP and CTF drains.

6.3.3 Facility Geotechnical Monitoring

Geotechnical monitoring will include survey monuments on the crest and downstream slopes of all embankments. These monuments will require initial quarterly surveying and then at regular semi-annual intervals in order to indicate any settlement or movement of the embankments. Inclinometer measurements will also be recorded simultaneously as part of the geotechnical monitoring program. Additional monitoring will include the ongoing monitoring of the pore pressures within the foundation drain (if any), basin drain system, and wet well sump and pump system in the CWP, PWP, and CTF. This will include monitoring of the vibrating wire piezometers installed during operations. These piezometers will be monitored quarterly during initial operations. Longer term monitoring frequency will be optimized during operations based on an observational approach.

The initial quarterly and subsequent semi-annual survey monitoring schedule assumes that daily facility inspections of both the CTF and PWP area will occur, which include the following:

- Embankment crests
- Abutments
- Downstream fill slopes
- Upstream liner faces
- Tailings/water levels
- Tailings spigot locations and conditions at these locations
- Reclaim and seepage collection system pumps, pipelines and valves
- Foundation Drain System flows, noting changes in the quality or clarity of flows, and
- Unusual conditions
- Record line pressure from tailings and reclaim pipelines

Details of the inspection and monitoring of the facilities are included in the Tailings Operations, Maintenance, and Surveillance Manual (TOMS Manual) that will be a document separate from the MOP Application. Inspection and monitoring frequency are confirmed in the TOMS Manual. TOMS manuals are periodically updated during operations as additional information and data is collected and reviewed.

6.3.4 Waste Rock Geochemistry Monitoring

Geochemical monitoring of waste rock will not be required. Temporary storage of waste on the WRS pad will only be necessary for rock produced during the first 2 years of development mining. All waste rock produced during this time will be assumed to be PAG. The temporary WRS pad will have a 0.1 inch (100 mil) HDPE liner. A basin drain system to collect seepage from precipitation or snowmelt will be constructed on the upper surface of the liner. Seepage will be transferred by a pipeline and / or geotextile-lined drainage channel directly to the CWP and from there will be piped to the RO water treatment system. Water will be treated to non-degradation groundwater criteria prior to discharge to the underground infiltration drain system. Some waste rock stored on the temporary WRS pad will be crushed and used as a protective layer for the upper liner of the CTF once it is operational. Excess waste rock stored on the temporary WRS pad, and waste rock produced operationally over the life-of–mine will be co-disposed of with the cemented tailings in the CTF.

6.3.5 Air Quality Monitoring

Air quality monitoring is designed to ensure that fugitive dust generated from cut and fills, tailings surfaces, and other construction, storage, and disposal areas does not become a public nuisance, or detriment to flora or fauna of the area. Air quality rules require reasonable precautions to be taken to prevent emission of airborne particulate matter. Tintina will be required to obtain a Montana Air Quality Permit under the Montana Clean Air Act that specifies requirements for applicable State and Federal air quality standards. The permit could specify dust control, monitoring, and reporting requirements in detail.

The air quality permit application requires that the applicant demonstrate compliance with all applicable State and Federal regulations and ambient air quality standards. Tintina plans to monitor air quality at its weather station location, and additionally monitor for particulates and fugitive dust as specified in an air quality permit. Monitoring of ambient air quality will be conducted to the extent required under the terms of the air quality permit.

Dust control associated with the internal and external atmosphere of the mill, and in the vicinity of the crusher are described in the operation plan (Section 3.3.2). Fugitive dust management is discussed in Section 3.6.1 for construction areas and roads and in multiple sub-sections of Section 3.2.2 for facilities.

6.3.6 Wetlands Monitoring

Wetland monitoring identifies indirect impacts, should they occur, and consists of monitoring shallow groundwater levels and vegetation conditions at four project area wetlands and four reference wetlands (Figure 6.2). Baseline wetland monitoring began in 2016. At each of the eight wetlands, vegetation monitoring plots were placed in drier and wetter portions of the wetland to record any changes that could occur under either hydrologic condition. In total, there are eight plots monitored at four wetlands within the project area, and eight plots monitored at four wetlands within the reference area. As of June 2017, all vegetation monitoring plots have been established and vegetation has been monitored; piezometers have been installed at all sites except BB-WMR5 through BB-WMR8. Piezometers and transducer data loggers will be installed at these remaining four sites in the summer of 2017 to provide continuous water level data in the wetland areas. Existing wetland piezometers will continue to be monitored throughout the life of the mine.

Water level changes in the project area will be compared to other wetland water levels in the area and the water level changes at the reference sites to determine if impacts to groundwater are associated with mine dewatering or other seasonal or regional trends. The wetland vegetation will be monitored on a bi-annual basis (early summer and early fall) to document the wetland vegetation seasonally and throughout the mine life. Wetland vegetation measurements will be conducted in accordance with Environmental Protection Agency (EPA) Methods for Evaluating Wetland Condition (2002) and U.S. Army Corps of Engineers (USACE) regulatory guidance for wetland monitoring. Wetland monitoring sites will be established at least one year prior to dewatering activities in order to begin to provide baseline data.

As a potential mitigation for identified indirect impacts to wetlands, Tintina plans to grout fractures in bedrock in the area where the development decline ramp passes some 90 feet (27.5 m) under Coon Creek and its associated wetlands. In addition, Tintina also plans to augment flows to wetlands, including those downgradient of the CTF from water stored in the NCWR should impacts to wetlands develop over the relatively short period of the mining (13 years). This discharge would not be expected to be necessary until year 3 of mining (completion of the CTF). In order to accomplish this, water would be pumped from the NCWR to the underground infiltration galley shown on Figure 1.3 that runs from near the foundation drain pond of the CTF in the floodplain adjacent to upper Brush Creek and allowed to infiltrate to groundwater to supplement flows and mitigate potential loss of water to wetlands in this upper reach of Brush Creek. In addition, Section 404 permitting may require additional mitigation for indirect impacts to wetlands. Pending approval by the USACE of proposed potential wetland mitigation, this discharge will be reevaluated with respect to EPA Underground Injection Control permitting requirements.

The risk of surface disturbance to wetlands (other than those anticipated under the mine plan will be avoided by marking wetland locations proximal to proposed construction areas prior to commencement of construction activities.

6.3.7 Aquatic Resource Monitoring - Construction and Operational

A second full year of seasonal baseline surveys for the assessment of fish, mussels, macroinvertebrates, periphyton, and habitat evaluation at sites in the Project area and Sheep Creek drainage basin was completed during 2016 using Tenderfoot Creek as a reference reach (see Section 2.7. Project goals will continue to be:

1. To conduct standardized surveys and collect baseline information on the aquatic communities present at stream sites associated with established surface water-quality monitoring sites prior to mine development, and
2. To assess aquatic community integrity with key indicators comparing these against biotic thresholds of reference condition standards.

A summary of current findings from the 2014 through 2016 aquatic baseline studies are presented in Section 2.7. A final compilation report of 2014 through 2016 aquatic baseline studies is presented in Appendix G.

Aquatic resource sampling during construction (two-years) and the operational mine life (13-years) is proposed to follow the plan outlined in Table 6-3. Sampling locations are shown on Figure 2.26. Sampling will be done annually during construction and during the first year of operations (a total of a three-year period, 3 events), and then every year throughout the operational mine life (13 remaining operational years, 6 events). A Draft Aquatic Monitoring Plan for the Black Butte Copper Project in Upper Sheep Creek Basin, Meagher County, MT was submitted to DEQ –Hard Rock Mining Bureau on April 17, 2017 for their review and subsequent review by MT Fish, Wildlife, and Parks. A revised Draft Aquatic Monitoring Plan has been included as Appendix G-1 in this MOP Application (Revision 3) dated June 2017.

Table 6-3. Construction and Operational Aquatic Sampling Plan

Aquatic Indicator	Frequency	Timeframe	Locations (Figure 2.26)
Fish Populations	Construction and Operations: 3 consecutive years then every year for active mine life.	Spring Summer Fall	• 4 representative Sheep Creek reaches downstream from Johnny Lee project (AQ1, AQ4, AQ10, AQ11) • 2 Sheep Creek reaches upstream of the proposed project area. (AQ2, AQ3) • 2 sites in Little Sheep Creek above and below the project access road (AQ7, AQ8) • 2 control stream reaches in Tenderfoot Creek out of the sub-basin (AQ5, AQ6) • 1 Coon Creek impact stream (AQ9)
Macroinvertebrates	Same as fish	Summer	Same locations as fish reaches
Whole Body Fish Metals Analysis	Same as fish and macroinvertebrates	Summer	2 locations below the mine (AQ4 and AQ1) and 2 locations upstream of Coon Creek (AQ3 and AQ2)

6.3.8 Noise Monitoring

Noise levels will be monitored to comply with worker safety as required by MSHA in surface and underground areas during all construction and operational phases of the Project. Tintina also proposes to monitor the four original baseline study sites (identified in Section 2.11 and shown on Figure 2.28) during year three once the underground mining and mill facilities are in operations to characterize routine operational noise levels and compare them with baseline predictions. In addition, Tintina will investigate and evaluate noise complaints received by the company or the DEQ that result from local residents, landowners or business owners as necessary. Tintina does not propose to conduct baseline site monitoring during construction as noise is typically highly variable and temporary.

6.3.9 Reclamation Monitoring

Qualified revegetation specialists will conduct quantitative reclamation surveys on an annual basis beginning the next growing season following reclamation of disturbed areas. The objectives of the revegetation survey are to:

- Assess overall vegetation establishment and soil stability
- Identify listed noxious weed populations
- Document vegetative cover (by morphological class) for reclaimed areas and control areas on the adjacent undisturbed landscape
- Identify sites with poor soil stability and/or low desirable vegetative cover.

Reclamation surveys will be designed to compare the stability and utility of the reclaimed landscape to pre-mining conditions. However, it is recognized that the CTF facility's east embankment cannot be reclaimed to pre-mining slope angles.

6.3.9.1 Soil Erosion and Construction Monitoring

Soil erosion and construction monitoring includes monitoring during active construction as well as maintenance monitoring during closure. Monitoring will be conducted at all Project-related disturbances to identify areas where slumps, rills, gullies, and sheet-wash might occur. Any identified erosion problems will be immediately corrected.

6.3.9.2 Revegetation Monitoring and Management

Revegetation will be monitored annually during the growing season to identify areas where vegetation may be failing, to determine the cause, and to document successful revegetation efforts. Revegetation monitoring will be conducted in conjunction with routine soil maintenance monitoring. Systematic pedestrian inspections will be conducted to identify areas that have inadequate cover, poor seedling growth, damage (winter die off), obvious nutritional deficiencies, or weed infestation.

Annual monitoring of reclaimed areas will continue until all reclaimed areas have achieved a vegetative cover of desirable species that is at least 70% of the comparable vegetative cover on undisturbed control areas in the adjacent landscape. Control sites will be established, in coordination with DEQ, to use sites with similar vegetation, topography, aspect and soils on adjacent areas that were not disturbed by mine activities. These reclamation objectives comply with the conditions and definition of final stabilization contained in the General Permit for Storm Water Discharges Associated with Construction Activities that are administered by DEQ (http://deq.mt.gov/Water/WPB/mpdes/stormwater). Tintina will prepare an annual monitoring report that documents the results of the reclamation monitoring, the report will be provided to DEQ on an annual basis.

Areas that lack successful establishment of desirable species (seeded species plus desirable volunteer species) compared to adjacent vegetation will be reseeded. Supplemental seeding will be conducted during the first appropriate seeding window. Site-specific evaluations will be undertaken to address areas that may be impacted by grazing, off-road vehicle use or noxious weed presence.

Upon complying with the DEQ requirements for final stabilization described above, Tintina will conduct reclamation monitoring on a 5-year cycle to coincide with 5-year bond reviews. The 5-year monitoring program will specifically document noxious weeds and erosion or site stability issues. Monitoring under this schedule will continue until the conditions of final bond release are satisfied.

Once sites have achieved reclamation success, defined as final stabilization and with concurrence from DEQ, they will be removed from the annual survey.

Post operation land use management will provide for reestablishment of pre-mine land uses of livestock grazing and hay production as discussed in the Vegetation section (Section 2.8) and in the Land Use section (Section 2.13). Upon cessation of mining operations, cattle will be excluded from grazing on revegetated areas (through appropriate fencing) until vegetation is well-established and hardy enough to withstand moderate grazing. Noxious weeds will be monitored and treated with herbicide on reclaimed and adjacent areas.

6.3.9.3 Weed Control

The most common noxious weeds observed in the Project area include Canada thistle, musk thistle, and hound's tongue. Their distribution is described in greater detail in the vegetation baseline study summarized in Section 2.8 and discussed in detail in Appendix H (Westech, 2017b).

Tintina has a weed management program in place (Appendix O), whose effectiveness has been significantly improved as a result of site visits by DEQ personnel. The program will be expanded to include new areas of proposed construction activities and surface disturbances. The focus of Tintina's weed management program is to protect weed-free vegetation communities by monitoring and treating new or expanding weed populations within the Project area..

The weed management plan outlines strategies to prevent and / or control the spread of noxious weeds during operation and closure. It focuses on preventative measures, management methods, and education. Noxious weeds will be controlled using appropriate mechanical, biological, and chemical treatments which meet the requirements of Meagher County, and Federal laws. The weed control plan is designed to prevent the establishment and spread of weeds along mine access roads, areas disturbed by construction, mining, and processing activities, and in the vicinity of soil stockpiles. This scope of the plan will be developed between the landowners, Meagher County weed control officials, DEQ and Tintina. Tintina's current Weed Mitigation and Management Plan is presented in Appendix O.

6.4 Post Operational Closure Monitoring

Once mining operations are complete and final reclamation and closure plans have been implemented, post-operational and closure monitoring plans will be developed in consultation with DEQ. These plans will be based on the final mine facilities layout and operational phase monitoring plans and results. Typically these plans will focus on long-term water quality and quantity monitoring, effectiveness of erosion control, and monitoring of vegetative success to document post-closure conditions at the former mine site. Post-operational monitoring will continue until the mine is certified by DEQ as being fully reclaimed by meeting closure goals and all bonding release milestones have been met.

6.4.1 Facility Closure Monitoring

The goals of the reclamation plan (Section 7) for the waste and water management facilities are to achieve long-term stability of each facility site including the one remaining CTF embankment, to develop a self-sustaining productive vegetative cover over the cemented tailings and its synthetic cover, and to ensure long term protection of the surrounding environment. In order to document the success in achieving these goals, a post-closure monitoring program will be developed including geotechnical monitoring, hydrogeological monitoring, revegetation monitoring, erosion control, and the continuation of approved water quality monitoring and water treatment plans.

Geotechnical monitoring in closure will include surveying monuments on the crest and downstream slopes of all remaining embankments, as well as on fill material used to cap the CTF at closure. These monuments will be surveyed semi-annually in order to document any settlement or movement in the facilities, until such time that the DEQ determines that it can be terminated. Inclinometer measurements will also be recorded simultaneously as part of the geotechnical monitoring program. Following closure, all monuments and inclinometers will be monitored annually until such time that it DEQ determines that it can be terminated.

Additional monitoring will include the ongoing monitoring of the pore pressures within the basin drain system and wet well sump and pump system in the CTF. This will include monitoring of the vibrating wire piezometers installed during operations, as well as any others required at closure. The piezometers will be monitored regularly during operations and for a post-closure period until the reclamation has been deemed complete and the bond released.

6.4.2 Water Quality Monitoring

Monitoring conducted over the life-of-mine will indicate whether any adverse impacts to water quality have occurred during operations. Following cessation of mining operations, the approved post-operational water monitoring program will be implemented. This program will be used in conjunction with other reclamation and revegetation monitoring to document post-reclamation conditions at the Project site and in surrounding water resources.

Both short- and long-term water quality monitoring closure programs will be established with DEQ. These programs will be based upon baseline studies and data collected during mining that prescribes surface and groundwater sampling sites, analytes, and frequency of sampling. The selected sites will likely be a subset of the operational water monitoring sites, and will be phased out as closure criteria are met and verified over time.

Results of the water quality monitoring will be provided to DEQ, which will determine whether down-sizing or cessation of the monitoring program is permissible. Provided that additional water quality monitoring is not warranted, the monitoring wells will be decommissioned by sealing the full length of the well with an inert cement grout. The casing will be cut off below ground level as per Montana well abandonment protocols and DNRC regulations.

Post-operational monitoring will occur until such time as the mine is certified as fully reclaimed and all bonding release milestones are met, or as determined in the post-operational monitoring program to be developed in conjunction with DEQ.

6.4.3 Aquatic Resources Monitoring during Closure

Aquatic resource monitoring during the closure period is proposed to follow the plan outlined in Table 6-4. Sampling locations are shown on Figure 2.26. Sampling will be annually during the first 2-years of closure and then every other year through year 6 (6-years, 4 sampling events).

Table 6-4. Post-operational and Closure Aquatic Monitoring Plan

Aquatic Indicator	Frequency	Timeframe	Locations (Figure 2.26)

Fish Populations	Post-closure: 2 consecutive years than every other year for a total of 6 years.	Summer	• 4 representative Sheep Creek reaches downstream from Johnny Lee project (AQ1, AQ4, AQ10, AQ11) • 2 Sheep Creek reaches upstream of the proposed project area. (AQ2, AQ3) • 2 sites in Little Sheep Creek above and below the project access road (AQ7, AQ8) • 2 control stream reaches in Tenderfoot Creek out of the sub-basin (AQ5, AQ6) • 1 Coon Creek impact stream (AQ9)
Macroinvertebrates	Same as fish	Summer	Same locations as fish reaches
Whole Body Fish Metals Analysis	Same as fish and macroinvertebrates	Summer	2 locations below the mine (AQ4 and AQ1) and 2 locations upstream of Coon Creek (AQ3 and AQ2)

6.4.4 Reporting

A report will be submitted annually to DEQ describing post-operational closure water quality monitoring results, discussing reclamation and erosional problems, identifying remedial measures taken, and documenting reclamation / closure success.

7 RECLAMATION AND CLOSURE

7.1 Category Descriptions

The reclamation and closure plan is structured to meet the requirements of the Montana Metal Mine Reclamation Act (MCA § 82-4-301). Three categories (periods) of reclamation and closure have been developed for the Project including:

- Contemporaneous construction reclamation and operational maintenance,
- Short-term temporary closure (less than one year), and
- Permanent closure.

The overall objectives of these categories of reclamation and closure are similar and include:

- Recontouring and revegetation of disturbed areas and landforms that have been modified by the construction of facilities and throughout life-of-mine operations;
- Stabilization of disturbed areas using erosion and sediment control BMPs, and revegetation measures to prevent air and water pollution;
- Surveying and monitoring the pond water elevations and pond volumes (water inflows and outflows) to make certain that none of the ponds exceed their design capacity and at the same time leave additional pond storage capacity for additional possible water inflows from either the probable maximum flood event or the design 1 in 200-year storm event (depending on the facility);
- Confirming and documenting that the volumes of the water and brine in the ponds don't exceed the facility design standards at the time of closure (including monitoring of the various volumes of water and brine generated from the WTP previously described in Section 3.7.3, (construction, operations, and closure).
- Monitoring programs will continue during construction, operations, temporary closure and in permanent closure until closure objectives have been met; and
- Noxious weed control.

7.1.1 Contemporaneous Construction Reclamation and Operational Maintenance

Construction reclamation takes place to stabilize disturbed areas during and shorty after mine facility construction, and is extended to include operational programs to maintain optimum reclamation performance over time. Operational reclamation is focused upon construction disturbances associated with facilities that will remain in place throughout life of mine operations (i.e., cut and fill slopes, downstream embankments, pipe line trenches, access roads and erosion control ditches and berms), or those that occur peripheral to and between constructed mine facilities. Interim reclamation of temporary or construction roads, embankments, soil stockpiles, ditch cuts and fills, trenches, surface water control structures, and other disturbances not inherently stable will occur during the first appropriate seeding season following construction. Reclamation of disturbed areas will be carried on throughout operations to the maximum extent practicable.

The temporary WRS facility (WRS) and most of the northern excess excavation materials stockpile located west of the WRS facility will be reclaimed near the end of the second year of facility construction. Both of these facilities are located immediately west of the portal pad (Figure 1.3). The WRS pad is designed to hold the first two years of development mining waste until the CTF is completed. The WRS pad liner will be removed and shipped off-site for disposal or recycling. Compacted surfaces at the base of the WRS stockpile will be ripped to relieve compaction and allow for future water infiltration, and the excess material stockpile will be used to reclaim the WRS pad to near pre-existing topography.

7.1.2 Short-term Temporary Closure - Less than One Year

Short-term temporary closure reclamation will occur if the mine enters into a period of temporary inactivity for a time period of up to one year. At that time, evidence of intent not to abandon the Project and to resume operations will be submitted to DEQ (in accord with ARM 17.24.150). Tintina will request that deferred implementation of the permanent closure plan be approved by DEQ. Short-term temporary closure reclamation and site protection will include: continued underground mine dewatering, continued treatment of water through the WTP (and properly disposing of the brine), stabilizing site-wide drainage facilities, prevention of unnecessary erosion by stabilization and revegetation of any existing disturbances, maintaining site access, maintaining water quality sampling and monitoring / reporting, maintaining the site weather station, providing site security by maintenance of fencing for all of facilities (including the ponds, ventilation raises, and the mill area), protection of equipment, and preparation and implementation of a facility inspection programs. All infrastructure required to resume mining will remain in place in this scenario.

If this short-term closure scenario occurs during the first year of the life of mine production, no water would have been generated (and therefore no water would need to be treated) from the underground mine development (i.e. the development tunnel workings all lie above the water table). If the short term scenario happens any time after the first complete year of the LOM plan and before year 3.5 when the mine dewatering quantity could approach a volume of 500 gpm (1,893 liters/minute) and before the mill becomes operational (the latest date for mill startup is year 3.5), a certain variable quantity of water from the mine dewatering program up to a maximum of 500 gpm (1,893 liters/minute) will be processed through the water treatment plant and the permeate disposed of into the underground infiltration galleries. The approximate average volume of processed water through the WTP at year 2.5 of the LOM (the same time at year 2.5 when the PWP is scheduled to become operational and can accept brine and treated water) is approximately 300 gpm (1,140 liters/minute).

In addition, there is sufficient storage capacity to store the brine reject in the brine cell (21,000 m^3; 5,547,613 gallons capacity) and contact water (CWP cell capacity; 70,000 m^3 or 18,492,043 gallons) from the WTP early in the mine life (during years 0.5 to 2.5 years in the LOM) in the CWP and later in the mine life (after year 2.5 of the LOM) in the PWP (Figure 7.1). Anytime in the first 2.5 years of the LOM (i.e. from years 0 to 2.5 of the mine production plan), both the CWP and the brine pond cell will always maintain a sufficient storage capacity for a 1:200 year storm event and all brine generated from the WTP respectively. The PWP is planned to be online and operational at the latest by year 2.5 of the LOM which will thereafter be used for all brine storage until the mill becomes operational (latest at year 3.5 of the LOM) which at that time may also utilize the brine material in the paste thickener as a less preferred alternative. Should any excess brine be generated during construction that exceeds the design capacity of the brine pond (and before the PWP becomes operational), it will be hauled off-site for disposal.

In a short term closure scenario that happens after year 3.5 of the LOM, or after the mill has been operational, Tintina will place a high-cement content (~4%) lift on top of the existing surface of the cemented tailings facility to decrease the dust, increase the strength, and create a durable weathering surface to withstand the temporary closure time period. Should Tintina decide to resume operations it will only take approximately 29 days at the modeled average mine dewatering volume of 500 gpm (1,893 liters) to generate the minimum volume of water (21.1 million gallons or 80,000 m^3) necessary to restart and operate the mill (not counting any water already stored in the PWP).

In addition, the following other items will be implemented: gate and lock the mine portal entrance to minimize wildlife and people from entering the underground mine, and removal of all explosives from the site using a licensed contractor.

A temporary closure shall not extend for more than one year, because continued dewatering of the underground working for more than a year without operating the mill is not feasible. When a temporary closure has continued for one year, Tintina will start implementing the permanent closure plan outlined in Section 7.1.3, below. Tintina will continue mine dewatering and the WTP operations (i.e. water treatment and brine generation and proper disposal) as they prepare to close the underground mine, draw down water levels in the PWP and implement the permanent closure plan as described below in Section 7.1.3.

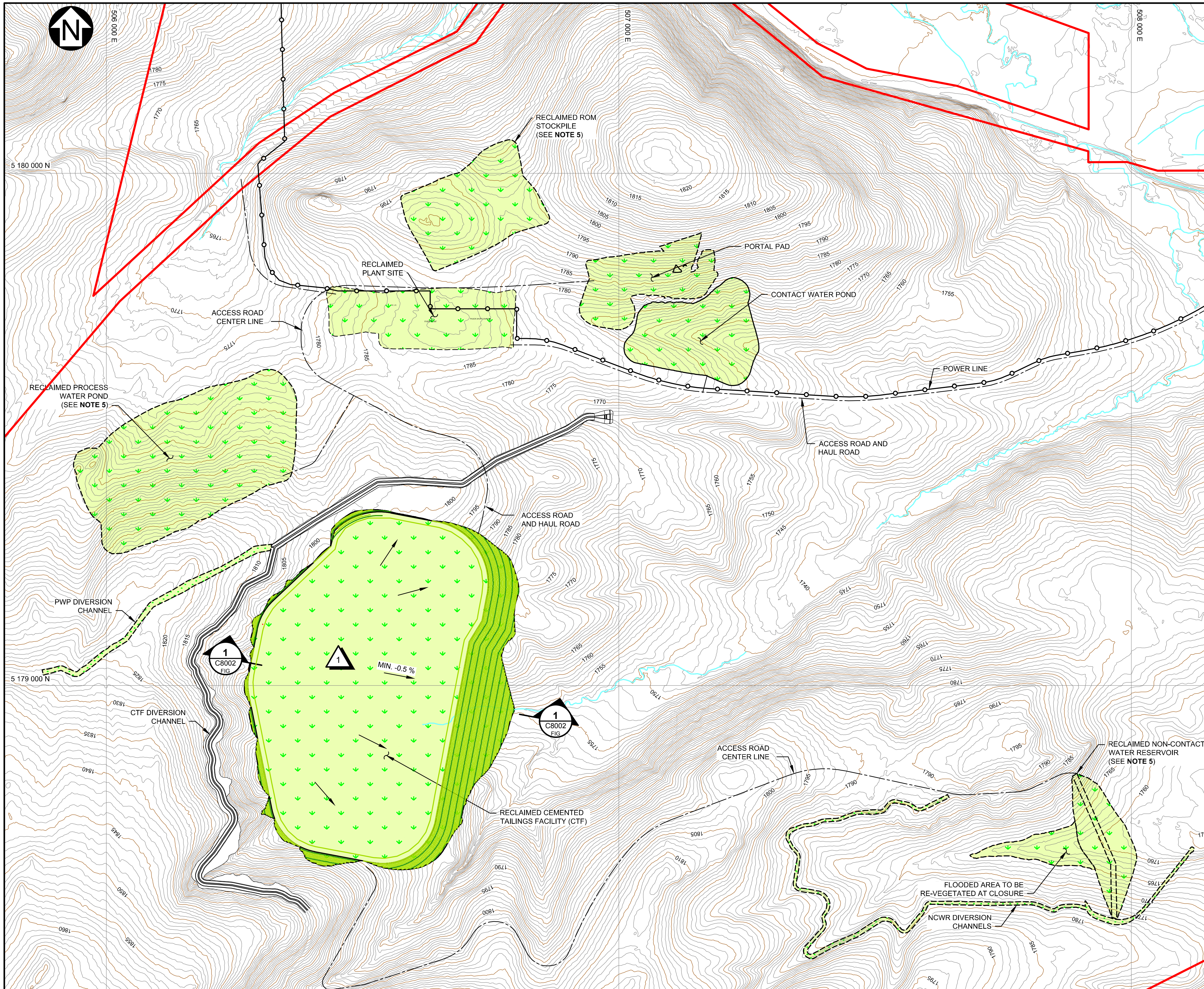
7.1.3 Permanent Reclamation and Closure

Permanent reclamation and closure will occur at the end of mine life and would also be initiated if a temporary closure extends beyond a period of one year. It includes reclamation of all disturbances and removal or closure of facilities. Should permanent closure of the mine operations occur before execution of the full mine plan, it is expected that reclamation objectives and plans will remain the same as those presented below. If revised closure plans are required, they will be prepared in cooperation with DEQ.

Permanent mine closure planning is the most comprehensive type of reclamation planning and considers all disturbed ground across the permit area. Planning activities anticipate treatment of underground mine water and closure of all mine openings, dewatering and treatment of water from all storage facilities, facility reclamation, removal of all buildings, liner disposal, site-wide re-contouring of disturbance areas to near pre-mining topography for most facilities (the only exception is the CTF), drainage stabilization and erosion control, redistribution of soils, establishment of long-term vegetative cover, and site-wide reestablishment of conditions that support pre-mining beneficial land uses.

The long-term closure plan is discussed in greater detail below. The specific closure plan for each facility is described in Section 7.3.3. Prior to initiating permanent closure, Tintina will meet and review the previously approved final long-term closure plan with DEQ. Any proposed revisions to the plan will be submitted to DEQ in writing for its approval.

A site plan map showing the post closure topographic map for the site including portal pad, mill facility, WRS, CWP, CTF, PWP, NCWR, and soil and excess material stockpiles facilities is shown in Figure 7.1.



PLAN
SCALE A

LEGEND:

- RECLAIMED AREA
- MINE PERMIT BOUNDARY

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 12N.
2. PLAN BASED ON INFORMATION PROVIDED BY TINTINA RESOURCES INC., DATED FEB 03, 2011.
3. EXISTING CONTOUR INTERVAL IS 1 METER. BLUE CONTOUR LINES ON CTF SLOPES ARE 5 METER INTERVAL.
4. DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
5. FACILITIES HIGHLIGHTED IN YELLOW (EXCEPT FOR THE CTF) WILL BE CONTOURED AT RECLAMATION TO APPROXIMATE THE ORIGINAL TOPOGRAPHY.
6. THE CTF DIVERSION CHANNEL PERIMETERS AND OUT-SLOPING FILL SLOPES WILL BE REVEGETATED FOLLOWING CONSTRUCTION AND WILL REMAIN IN CLOSURE.

SCALE A 80 40 0 100 200 300 400 m

TINTINA RESOURCES

BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 7.1
POST CLOSURE TOPOGRAPHIC MAP

C8002	CTF RECLAMATION - SECTION

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	29APR'16	MINOR REVISIONS	GIM	RAP		
0	16OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP	KJB	KJB

REVISIONS

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C8001_r1

REVISED DATE:

JULY 2017

SAVED: O:\T-Z\TBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 7.1 Post Closure Topo Map (C8001_r1), PRINTED: 7/6/2017 8:56:55 AM

7.2 Disturbed Lands Reclamation Compliance

The permanent reclamation and closure plan will be compliant with applicable reclamation requirements set forth in MCA 82-4-336 for the reclamation of disturbed lands. These requirements were previously summarized in Table 1-3 (Permit Application Cross-Referenced with Regulatory Compliance). Below are the applicable requirements of MCA 82-4-336 with which the permanent reclamation and closure will comply, taking into account the site-specific conditions and circumstances.

- Reclamation activities, particularly those relating to control of erosion, to the extent feasible, will be conducted simultaneously and will be initiated promptly after completion or abandonment of the operation on those portions of site not subject to further disturbance as discussed in Section 3.4 (Mine Site - General Construction, Erosion Control and Engineering Studies), and Section 3.7.6 (Erosion Control Methods and Best Management Practices, and in accordance with MCA 82-4-336(2).
- In the absence of an order by DEQ providing a longer period for mine-related facilities, reclamation activities will be completed not more than two years after completion or abandonment operations in accordance with MCA 82-4-336(3) unless an alternative timeframe is allowed by DEQ. However, Tintina may request an extention from the DEQ should this two year period not be long enough to complete the reclamation and closure of the site.
- In the absence of emergency or suddenly threatened or existing catastrophe, Tintina will not depart from the approved reclamation and closure plan without previously obtaining written approval for the proposed change from DEQ in accordance with MCA 82-4-336(4).
- Provisions will be made to avoid accumulation of stagnant water in the development area to the extent that it serves as a host or breeding ground for mosquitoes or other disease-bearing or noxious insect life in accordance with MCA 82-4-336(5).
- All final grading will be made with non-noxious, nonflammable, noncombustible solids unless approval has been granted by DEQ for a supervised sanitary fill in accordance with MCA § 82-4-336(6) (which Tintina has not proposed).
- Provisions will be made for vegetative cover, if appropriate, to the future use of the land. Any such reestablished vegetative cover, if appropriate, will meet county standards for noxious weed control in accordance with MCA 82-4-336(8).
- Tintina will reclaim all disturbed land to comparable utility and stability as that of adjacent areas. Tintina will seek DEQ approval for post-mining use of any mine-related facilities that will not be removed or disturbed land associated with the facilities will not be reclaimed. In the absence of a legitimate post-mining use of mine-related facilities upon completion of other approved mine reclamation activities, Tintina will comply with state reclamation requirements and the reclamation and closure plan within the two-year time limit specified above unless a longer period is granted by DEQ. All disturbed land will be reclaimed in accordance with MCA 82-4-336(9a). Tintina will request DEQ’s approval to retain the 2.5/1 exterior slope on the CTF facility, which will however be reclaimed and vegetated both operationally and in closure.
- Tintina will provide sufficient measures to ensure public safety and to prevent the pollution of air or water and the degradation of adjacent lands in accordance with MCA 82-4-336(10).

- Tintina will provide for permanent landscaping and contouring to minimize the amount of precipitation that infiltrates into disturbed areas that are to be graded, covered, or vegetated, including but not limited to tailings impoundments and waste rock dumps. Tintina will provide measures to prevent objectionable post-mining ground water discharges in accordance with MCA 82-4-336(12).

7.3 Detailed Plan for Permanent Reclamation and Closure

7.3.1 Post Mining General Construction Measures

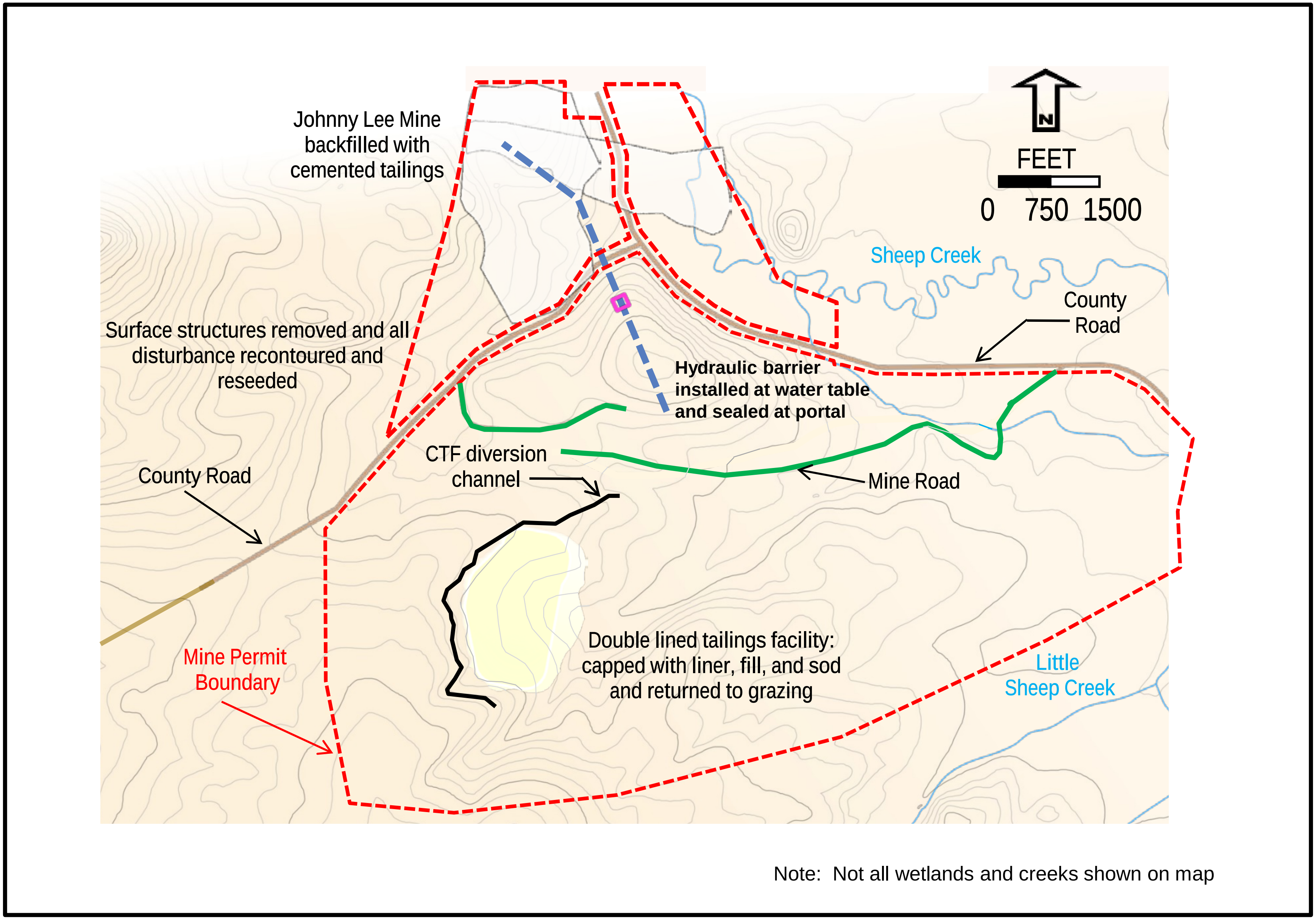
The section and presents construction measures that will be applied site-wide during permanent closure. They include facility removal, landform restoration, surface reclamation, and closure activities. The goals of these post mining construction measures are to achieve long-term stability of each reclaimed facility site and the remaining CTF embankment, to use all of the remaining reclamation material stored in the two designated stockpiles (north and south), to develop a self-sustaining productive vegetative cover, and to ensure long term protection of the environment with respect to water quality and erosion.

Natural drying and evaporation will reduce the moisture content in waste materials and pond levels in water storage facilities. Cement, fly ash, or slag added to the tailings operationally during thickening will stiffen the tailings after deposition and create a stable, non-flowable mass as part of the on-going process of tailings deposition. At closure all remaining water will be pumped from the facilities and their respective sumps and foundation drain ponds, treated to non-degradation standards for groundwater, and discharged to shallow bedrock infiltration galleries. Any sediment present in the PWP after draining, will be mixed with cement to create a hardened, non-flowable mass.

An HDPE cover will be placed on the tailings facility, and welded to the bottom liner, as described below in the CTF closure section (Section 7.3.3.3). Final reclamation of the facilities will include decommissioning of the CTF and PWP foundation drain ponds and removal of their liners prior to reclamation. The liners will be hauled off-site either to a disposal or recycling center. At that time, flow from the CTF foundation drain outlet pipes will be diverted to a downgradient underground infiltration gallery. Flow from the PWP foundation drain pond (if any) will be diverted into an infiltration basin constructed at the same location.

Reclamation of facility areas will include removal and off-site disposal or recycling of liners, filling of excavated basins, and reshaping of the ground surface. This will be done by placing embankment or other appropriate fill materials to create a self-draining surface approximating the pre-mining topography (except for the CTF) that will provide long-term stability after closure. The upper reclaimed surface of each facility will be capped with 27 inches (68.5 cm) of soil and revegetated. Sub-grade bedding material may need to be locally placed above the final (upper) tailings cemented paste layer lens to provide a lower protective layer for HDPE geomembrane placement, depending upon the grade and smoothness of the final upper surface. Surface gradient restoration will be suitable for the post-operation use of rangeland. Grading will minimize the amount of precipitation and run-on that infiltrates into disturbed areas.

Revegetation measures include soil replacement using the stockpiled topsoil and subsoil, seedbed preparation and seeding with approved seed mixes (Table 7-6). In most places, the soil cover will include approximately 14.6 inches (37.1 cm) of topsoil and 12.4 (31.5 cm) inches of subsoil that will be placed over the regraded topography. Inactive borrow areas and stockpiles will also be recontoured, covered with topsoil, and revegetated at closure. All disturbed ground will be recontoured and revegetated. A footprint depicting final surface reclamation of the Project site is illustrated in Figure 7.2.



Prepared by: Tintina Resources, Inc. (2017)

TINTINA RESOURCES

Underground workings (some) projected to surface

Hydraulic barrier installed underground

Figure 7.2
Schematic Site Plan Map with Final Reclamation
Mine Operating Permit Application
Meagher County, Montana

Using the material balance volumes described in Tables 3-14a and 3-14b, there will be an estimated total of 294,948 m^3 of stockpiled excess excavation bedrock materials (sourced from the mine facilities during the construction early in the mine life) available for closing all of the facilities. This excess material will be stored in the two designated reclamation material stockpiles: (1) reclamation material stockpile north that is located west of the WRS pad that will store approximately 133,268 m^3 and (2) reclamation material stockpile south that is located west of the CTF that will store approximately 161,680 m^3. The reclamation material from the northern stockpile will generally be used to reclaim the northern mine facilities including: the WRS pad (to be done after pre-production mining after the CTF is constructed), the CWP/brine pond, the mill pad, the portal pad, and the copper enriched rock stockpile. The reclamation material from the southern stockpile will generally be used to reclaim the southern mine facilities as shown in Table 3-14c including: the CTF (cap), the PWP and NCWR diversion channels, the NCWR spillway, and backfilling of the underground workings (including the ventilation raises, the portal plug, and a 200 foot section of the primary access ramp below Coon Creek). The final reclamation material balance will be optimized in closure.

Additional reclamation material available to close the mine facilities will be sourced from the PWP and NCWR embankment fill materials since in closure these facilities will be deconstructed and decommissioned. Using the conceptual material balance volumes listed in Table 3-14c required for closing the southern mine facilities and backfilling of the underground workings, a total of 308,000 m^3 of embankment fill sourced from the NCWR embankment and the PWP embankment will also need to be re-used (i.e. moved). Since the NCWR will be totally decommissioned in closure, 100% of the NCWR embankment fill (approximately 138,000 m^3 based on the volume listed in Table 3-14b and 3-14 c) will be re-used in closure. In order to fully reclaim (cap) the CTF in closure, using the required estimated conceptual reclamation material volumes listed in Table 3-14c for the southern mine facilities will require the re-use of approximately 170,000 m^3 of embankment fill from the PWP.

Based on the available excess reclamation material volume from the southern stockpile (161,680 m^3) and reusing the 308,000 m^3 of embankment fill from the NCWR and the PWP as stated previously, approximately 102,000 m^3 of reclamation materials are required to reclaim the southern mine facilities and backfill the underground workings as specified in Table 3-14c. Knowing this volume of reclamation material required for closure, the total excess volume of reclamation material remaining in the southern reclamation material stockpile after closing all of the mine facilities may be calculated using the *Equation 7.3.1* listed below:

Equation 7.3.1:

161,680 m^3	**-**	***102,000 m^3***	**=**	***X m^3***
(Excess RM in the RM south stockpile)		*Required reclamation material required to reclaim the facilities listed in Table 3-14c*		

where:

X = the net excess reclamation material volume remaining in the reclamation material south stockpile after all of the mine facilities have been reclaimed in closure,

RM = reclamation material,

and the *102,000 m^3* includes placing a minimum 1.0 m thick reclamation material layer as stated in the CTF closure Detail “A” in Figure 7.3.

Using the assumptions and volumes of reclamation material listed in *Equation 7.3.1* above, a total volume (*X*) of 59,680 m^3 of reclamation material is estimated to remain after closure that may be either used for closing other unidentified facilities or more likely added as additional material to the CTF cap. If all of this excess reclamation material is added to the CTF cap, the total thickness of the reclamation material layer as identified in Figure 7.3 (Section 7.3.3.3) is estimated at 1.30 m thick.

7.3.2 Post Mining Building and Solid Waste Disposal

In final closure all buildings, related equipment, and surface infrastructure at the mine site will be dismantled and removed. Salvageable equipment and construction materials will be sold. The buildings will be dismantled and recycled or disposed of at an approved facility, as will all above ground piping and other infrastructure. Concrete foundations will be broken up, exposed rebar cut-off, leveled, and buried on the respective facility sites with a minimum cover of four feet (1.2 m) of fill material. No landfills for waste disposal of any type are proposed by Tintina in the MOP Application.

Following removal and / or salvage of facilities, any remaining solid waste will be disposed of in accordance with laws and regulations of the Montana Waste and Underground Tank Management Bureau, and Meagher County. Valuable inert waste such as steel, concrete, plastic or wood will be sold to scrap dealers for recycling. Some waste may be transported to an approved waste transfer station as authorized by the county solid waste district. Hazardous wastes will be removed from the property by a licensed commercial hazardous waste disposal company.

7.3.3 Site-specific Facility Closure

The closure of specific mine facilities are discussed below in the approximate order in which they are expected to be closed and reclaimed. However, often reclamation of some facilities might be expected to go on simultaneously, and there may be other reasons for altering this proposed order. A site plan map showing the post closure topographic map for the various facilities is shown in Figure 7.1.

7.3.3.1 Copper-Enriched Rock Stockpile

The copper-enriched Rock Stockpile will remain in place until late in the active mining process. Once all copper-enriched rock is removed from the pad, the pre-production waste rock protective layer materials on top of the copper-enriched rock stockpile liner will be placed in the CTF. The bottom liner for the copper-enriched rock stockpile will be cut up, removed and buried in the CTF prior to reclamation, or hauled off site for disposal or recycling (Table 7-1). Compacted surfaces at the base of the copper-enriched rock stockpile will be ripped to relieve compaction and allow future water infiltration. The perimeter of the reclaimed site will be graded to blend with surrounding topography, topsoil placed, and the surface reseeded. Figure 7.1 shows post-mining reclamation topography in the copper-enriched rock stockpile area.

Table 7-1. HDPE Liner and Upper Protective Layer Disposition

Facility	Liner Disposition	Protective Layer Composition	Protective Layer Disposition
CTF	Buried in-place	Screened Waste Rock	Buried In-place Beneath Cemented Tailings
PWP	Buried in-place	None	Pond Sediment, Mixed with Cement, Buried In-place
CWP	Off-site Disposal or Recycling	None	None
WRS	To CTF[1]	Excavated Construction Materials	To CTF[1]
Copper-enriched Rock Stockpile	To CTF[1]	Excavated Construction or Screened Waste Rock	To CTF[1]
NCWR	Upstream Embankment Face Only, To CTF[1]	None	None
[1] Disposed of in CTF prior to placing HDPE cover.			

7.3.3.2 Non-Contact Water Reservoir Closure

The NCWR is proposed to be completely reclaimed. The liner on the upstream embankment of the reservoir will be removed and placed in the CTF during closure (Table 7-1). The embankment, surface water diversion channel, and the spillway will be removed and the land reclaimed to near original topographic contours. The 138,000 m^3 of embankment fill material removed from the NCWR will be placed either on reclamation material stockpiles or more likely placed directly on top of the CTF, overlying the HDPE cover and the over-lying sub-grade bedding material placed on-top of the HDPE cover. Soils will be replaced and the disturbed areas seeded. The area previously flooded by the reservoir, including the central 0.95 acre wetland area, will be revegetated with appropriate Lowland and Altered Grassland and Riparian and reclamation seed mixtures.

7.3.3.3 Cemented Tailings Facility Closure

Permanent closure of the CTF requires considerable effort and will include dewatering (by pumping back any water on the liners or from the water reclaim sump to the PWP or the CWP), water from the foundation drain pond will be pumped to the WTP for treatment, shaping and / or filling of the final upper surface of the tailings to make an even surface prior to installation of the HDPE cover, ground shaping to create a new closure topography, redistribution of soils, and establishment of long-term vegetative cover.

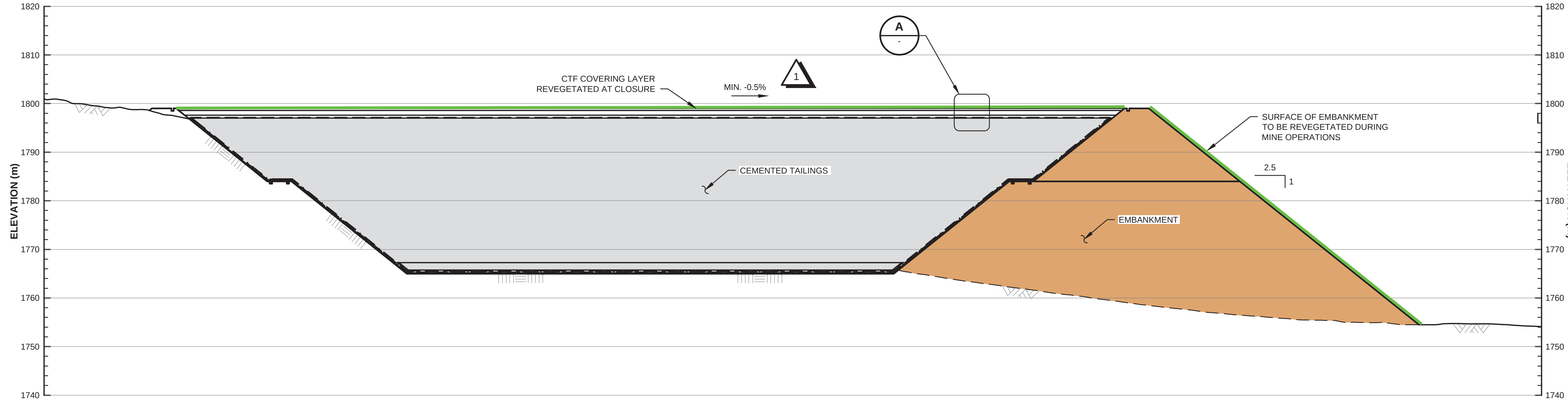
At closure, all water will be pumped out of the CTF (including the water reclaim sump and foundation drain collection pond), and treated in the on-site WTP. Cement, fly ash, or slag added to the tailings during thickening will solidify the tailings shortly after their deposition and create a stable, non-flowable mass. Natural drying and evaporation will further reduce the moisture content in the tailings as it is deposited, and the cementing consolidation process will consume available water with excess seepage mixing with incident precipitation and reporting to the sump. Prior to placing the final layers of the cemented tailings in the CTF, the cement content would be increased to approximately 4% in order to create a hardened surface on which equipment can work, thereby reducing the time required for reclamation and closure of the facility. No tailings are required to cover the exposed CTF ramp in closure as the upper portion of the CTF haul ramp is planned to be constructed of excavated bedrock from the CTF basin excavation, and could be used in preparing an even surface prior to placement of the HDPE cover on the CTF.

An even surface of the materials inside the CTF is required prior to placing the HDPE geomembrane cover. Therefore shaping of the tailings surface may be required for closure. The shaping may be accomplished by selective cemented tailings paste deposition. If additional shaping is required to achieve an even surface, the upper portion of the CTF haul ramp which is proposed to be constructed of excavated fill material could be regraded to fill in low spots. Regardless, sub-grade bedding material may need to be placed above the tailings, along with general rock fill (i.e., reclamation materials) to provide a protective layer for the HDPE geomembrane placement

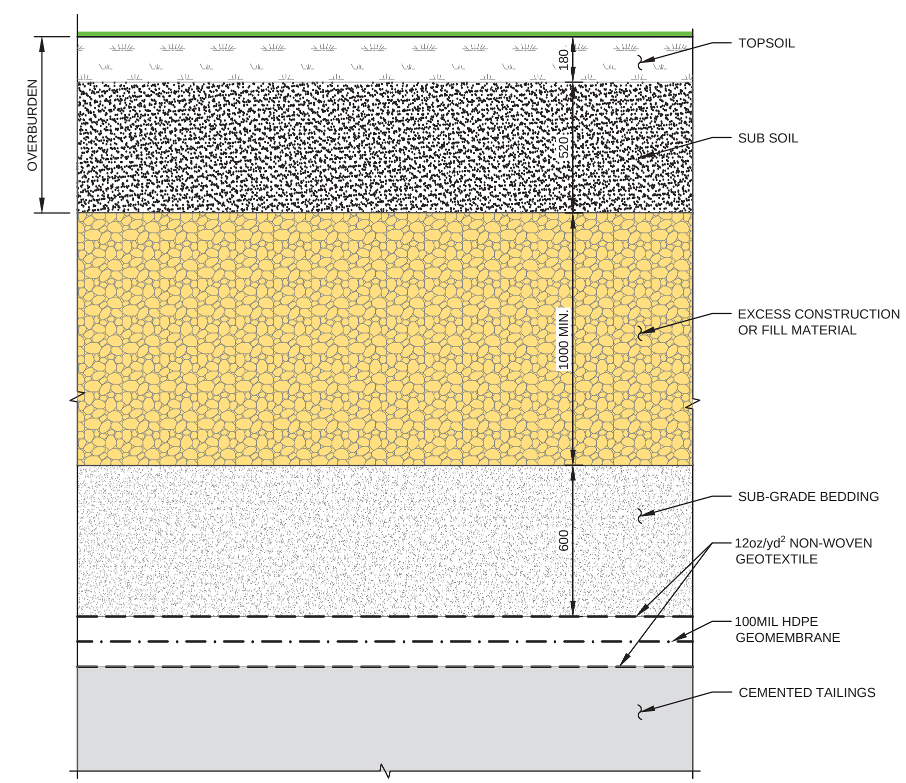
After an even surface of the materials inside the CTF is achieved, the CTF will be covered with a 0.1 inch (100 mil) HDPE geomembrane which will be welded to the existing liner system. The geomembrane cover will be capped with a minimum of 5.2 feet (1.6 m) of non-reactive and geochemically clean fill materials (including the soil cap materials) as shown in Detail “A” (CTF Closure Cover Details) of Figure 7.3. This capping layer thickness exceeds all State and federal guidelines for reclamation and closure and will also serve to provide a stable platform for topsoil / subsoil cover and revegetation. The cover material must be sized so that the geomembrane is not damaged during placement.

The minimum 5.2 feet (1.6 m) of cover materials overlying the HDPE geomembrane consists of (described from the bottom up): 2 feet (60 cm) of granodiorite sub-grade bedding material and a minimum of 3.3 feet (1.0 meter) non-reactive (i.e. geochemically clean) rock fill (i.e. excess reclamation materials), sub soil (20.5 inches; 520 mm) and topsoil (7.1 inches; 180 mm) will be placed and shaped (i.e. graded) to control run-off. As per the CTF cover design shown in Figure 7.1 and Figure 7.3, grading of the non-reactive rock fill to achieve a minimum gradient of -0.5% to the east is required in order to create a self-draining topographic surface suitable for closure of the CTF.

Settlement of drained, cemented, tailings is not anticipated. Tailings are deposited in the CTF as a flowable very fine-grained paste that establishes a 1-2% surface slope angle, before solidifying into a non-flowable mass. The cemented mass of tailings is laterally structurally confined in a double HDPE-lined basin. In temporary and permanent closure the cement content of the upper tailings in the CTF will be increased to 4% to strengthen and increase the durability of the uppermost layer of tailings such that trucks and dozers can work on the surface for construction of the cover as described above.



1 C8001 **SECTION**
HORIZONTAL: SCALE A
VERTICAL: SCALE B



A - **DETAIL**
CTF CLOSURE COVER DETAILS
SCALE C

NOTES:

1. TAILINGS SURFACE WILL BE LEVELED USING SUB-GRADE BEDDING AS NEEDED.
2. DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.

SCALE C: 0.3 0.15 0 0.5 1.0 1.5 m
SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 20 10 0 20 40 60 80 100 m

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BLACK BUTTE COPPER PROJECT
MINE OPERATING PERMIT APPLICATION

MEAGHER COUNTY, MT

FIGURE 7.3
CTF RECLAMATION AND CLOSURE
CROSS-SECTION

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
1	29APR'16	CTF SLOPE ADDED	GIM	RAP		
0	16OCT'15	ISSUED FOR MOP APPLICATION	GIM	PP	KJB	KJB

REVISIONS

REVISED DATE:
MAY 2016

C8001	CTF, PWP, NCWR AND ROM STOCKPILE - POST CLOSURE TOPOGRAPHIC MAP

DRAWING BY KNIGHT PIESOLD: Report No. VA101-460/3-2 Rev 4

SOURCE FIGURE NUMBERS: C8002_r1

SAVED: O:\T-Z\TTBozeman\114-710301A BlackButte 2016\110 2D CAD\SheetFiles\KP Figures\Fig 7.3 CTF Reclamation Section (C8002_r1), PRINTED: 5/27/2016 9:17:24 AM

Should any differential settling be observed (again is not anticipated based on the method of placement) the final tailings surface of the CTF can be graded with excess reclamation and sub-grade bedding fill prior to placement of the upper HDPE cover. In situ investigations, such as Cone Penetration Testing, could be used to confirm material characteristics and bearing capacity of the tailings for closure reclamation and the cover requirements will be adjusted as appropriate, prior to closure construction. Final reclamation contours will be established using a minimum of 5.2 feet (1.6 m) of graded fill and soil over the top of the HDPE cover as described above.

Final reclamation will include decommissioning of the CTF foundation drain collection pond and connecting the buried foundation drain system outlet pipe to an underground infiltration gallery, located immediately downstream to the east of the foundation drain pond on the south side of the creek (Figure 1.3). The foundation drain system is excavated into native bedrock with excavated drainage trenches filled with clean washed drain-rock (i.e. drainage gravel sourced from the CTF excavation) and water transmitted through perforated PVC pipe. Therefore, the water collected from the foundation drain system is expected to be un-impacted groundwater, passed beneath the CTF and can be discharged back to the groundwater system during closure without a discharge permit. Water quality of the foundation drain will be monitored throughout the operation of the CTF as part of the water monitoring program, which is capable of verifying that the foundation drain is un-impacted groundwater prior to closure. The water quality of the foundation drain system will be compared to the baseline water quality from CTF monitoring wells (MW-10 through MW-13) to verify it is un-impacted groundwater. The CTF monitoring wells were installed in March 2016 and have been sampled quarterly since their installation; water quality results are discussed in Section 2.2.4.6 and included in Appendix B-A. Significant impact determinations will be evaluated through an appropriate statistical method for the monitoring data and approved by DEQ prior to construction of the CTF. If the water quality of the foundation drain system shows a significant impact compared to baseline monitoring data from the CTF wells, Tintina will install an established mitigation alternative based on the water quality results. Mitigation alternatives include passive treatment systems or installation of horizontal well(s) up-gradient of the CTF to capture the groundwater prior to it flowing beneath the CTF and discharging it to the underground infiltration gallery designed for the foundation drain in closure. The foundation drain collection pond will have its liner removed and hauled to an off-site disposal or recycling center (Table 7-1). All disturbed ground will be re-contoured and re-vegetated.

Revegetation measures include soil replacement using the stockpiled topsoil and subsoil, seedbed preparation, and seeding with approved seed mixes (Table 7-6). A soil cover as previously described will be placed over the regraded surface, as well as rock placed in irregular mosaic patterns on the lateral embankment slopes. The soil cover will be revegetated with approved seed mixes, with revegetated slopes not exceeding 160 feet (50 m) in length before being interrupted by a mosaic rocky zone. These rocky zones will be placed asymmetrically across the slopes.

A site plan map showing the post closure topographic map for the CTF is shown in Figure 7.1. A cross-section of the reclamation CTF topography and closure cover details are shown in Figure 7.3. Closure of the CTF will maintain the original 2.5:1 slope angle of the east facing embankment. The CTF embankment will be geotechnically stable (operationally and in closure), and long term erosional stability and revegetation success will have been established over the 2 years of construction, 13 years of operations, and four years of closure. The closure goal established for final grading to “blend with existing topography” will not be able to be attained in closure for the east embankment of the CTF, as it will for all other mine-related facilities. Conifers will not be used as part of the productive vegetative cover of the CTFs upper surface that is underlain by the HDPE cover.

CTF Seepage Control and Closure: As described previously in Section 3.6.8.5 above, Tintina's proposed liner system for the CTF uses two 100 mil HDPE liners and an intervening geonet flow layer between the two liners that collects potential seepage through the upper liner. The seepage through the upper liner is estimated at maximum of 16 L/day (4 gallons/day) over the entire 71.91 acre (29.1 ha) facility (Knight Piésold, 2017a). This seepage subsequently reports to the CTF wet well sump via the geonet layer for removal to the PWP during operations. In closure seepage that collects in this sump (if any) will be pumped to the CWP for temporary storage and eventual processing through the WTP. Two separate models, by Knight Piésold (2016b), of potential seepage volume passing through the CTF HDPE liner system are presented in Section 8.2.2 of Appendix K, where that volume is predicted to be negligible. Therefore, Tintina does not anticipate any significant seepage from the CTF to pass through the liner system and enter the underlying foundation drain system. The lack of seepage impact to local groundwater diverted under the facility to the foundation drain pond will be checked by monitoring water quality in the drain operationally and in closure until the DEQ determines that it is no longer necessary. This will presumably occur when significant drain-down of the CTF no longer reports in large enough quantities to the CTF wet well sump for removal by pumping. The time estimate for the CTF sump pumping in closure is expected to be on the order of 30 days since the CTF is designed to contain mostly solids (i.e. cemented tailings paste and waste rock) and only minor aqueous phases. Regardless the pump and piping dewatering the sump will remain in place for pumping to the water treatment plant as necessary until agreement is reached with DEQ that it can be removed.

In addition to the liner system and foundation drain, the case for negligible seepage from the CTF is also supported as Tintina proposes to remove as much water as possible continually from the CTF wet well sump during operations and in early closure. In addition, newly deposited cemented paste consolidation will occur rapidly, within days. Seepage water from paste dewatering will mix with incident precipitation during operation and report quickly to the CTF wet well sump. However; this volume of water flow will be eliminated at closure.

Seepage into the tailings mass will be mitigated by the overlying HDPE geomembrane placed over-top of the tailings, as described in Section 12.1 of Appendix K and clearly shown in Figure 7.3 (design Drawing C8002). Waste rock placement inside the CTF will be completed by year nine in the mining operations (Table 3-5) and all waste rock should be submerged in tailings by the end of the mine life. Furthermore, drain-down from the mass of consolidated cemented tailings is not expected. In closure, the length of time between placement of the composite HDPE / soil cover and the reduction of flow to the wet well sump to a volume that no longer can be pumped, cannot be calculated using the steady state hydrogeochemical model due to the resulting very low water flows.

However, the amount of time is expected to be on the order of a few weeks (30 days). Never the less, Tintina intends to leave the CTF wet well sump pump in place during and following final closure of the facility so that any water collected in the sump could be pumped to the CWP for storage and then treated in the WTP. The flow to the sump will be measured by pumping in closure until the DEQ determines that flow rates are low enough that pumping is no longer necessary. This will presumably occur when significant drain-down of the CTF no longer reports in large enough quantities to the CTF wet well sump for effective removal by pumping. At that time, with DEQ concurrence, and as long as the water meets groundwater non-degradation criteria, the foundation drain pond will be removed and water from the drain will be transferred to the UIG immediately down-gradient of the facility (in a floodplain to the east of the northeast flowing tributary stream of Brush Creek, Figure 1.3) and allowed to mix with regional groundwater as it does today.

7.3.3.4 Process Water Pond Closure

The PWP and its foundation drain pond will remain in place until the milling of all copper-enriched rock is completed. Operationally, the volume of water in the process pond is expected to be maintained at or below 235,400 cubic yards (180,000 m^3) or approximately 45 million gallons. At the operational treatment system rate of approximately 588 gpm (2,226 Lpm), it will take approximately two months to treat all of the water in this pond at closure. More likely as final production and milling draws to a close the PWP would be allowed to fall as low as 80,000 m^3 (approximately 21 million gallons) cutting the treatment time in about half. Water will be treated to meet non-degradation standards for groundwater then discharged to the underground infiltration gallery system. It is anticipated that the permeate generated from treatment of the PWP water will be used to flood the underground workings; however, the underground infiltration gallery system is designed to handle a flow rate greater than about 500 gpm (1,893 Lpm) to dispose of the volume of water without causing a breakthrough to surface water. Down-gradient groundwater and surface water will continue to be monitored.

Once the PWP is dewatered, the accumulated slimes will be mixed with cement and air dried, wrapped in the liner in preparation for burial during final facility regrading (Table 7-1). The PWP's foundation drain pond will subsequently be drained, and the water treated and discharged to the underground infiltration gallery system. The foundation drain pond liner will be cut and placed on top of the PWP liner. The PWP liner will be folded in on top of the cemented sediment and buried in place (Table 7-1). A drainage gravel lined infiltration basin will be constructed in the footprint of the PWP's foundation drain pond, and the PWP's foundation drain's flow (if any) will be directed through a buried pipeline to the infiltration basin (Figure 7.9).

Using the material balances presented in Tables 3-14a, 3-14b, and 3-14c, an estimated total of 280,000 m^3 of embankment fill from the PWP will be used to bury the PWP liner system. Because the PWP was constructed as a cut and fill material balance facility, there will be ample PWP embankment material available to bury the liners during reclamation to a depth of about 30 feet (10 m). Approximately 170,000 m^3 of excess PWP embankment material will be placed on the upper surface of the CTF, above the cover, in closure. The perimeter of both the reclaimed PWP and foundation drain pond areas will be graded to blend with surrounding topography, topsoil / subsoil placed, and the site seeded.

7.3.3.5 Underground Mine Closure

The elevation and location of the mine portal and collars for the four ventilation raises above the pre-mining groundwater table precludes any natural direct surface discharge from these openings or the underground workings. Early during underground mine closure, Tintina plans to install two underground groundwater monitoring wells in mined-out zones: one in the *Ynl B* hydro-stratigraphic unit in the Lower Decline above the *VVF* and another in an access drift within the *USZ* hydro-stratigraphic unit. These wells in conjunction with water pumped from the workings during rinsing will be used to monitor groundwater quality in closure to determine when rinsing has the workings can cease. However, it is expected, based on hydrologic modeling results presented below in this section, that the mined-out areas and the cone of groundwater depression associated with the mine, will be principally recharged by laterally flowing regional groundwater of background water quality.

If the dewatering pumps were to be turned off and removed, the mine will flood to pre-mining groundwater levels over time (estimated at three to four years) (Hydrometrics, 2016a, Appendix M this report) (see Section 4.1.6.2). Post mining hydrologic simulations indicate that the effects from dewatering will show a slight decrease in the groundwater system and surface water resources through the first year of closure. Figure 4.10 shows the recovery over time for wells completed in the hydro-stratigraphic units *Ynl A, USZ*

/ UCZ, *Ynl B*, and *LCZ*. Effects on water resources decrease quickly after the first year. The shallow water table is within 1-2 feet (0.3 to 0.6 m) of pre-mining levels within three to four years after closure, and the reduction in stream flows are limited to the SW-1 watershed ($\leq$0.1 cfs) (Hydrometrics, 2016a; Appendix M this report). There are no measureable effects to stream base flow resulting from mine dewatering either operationally or during closure. There are no model predicted effects to stream base flow 20 years after mining has stopped.

In preparation for underground mine closure, all mobile equipment and all salvageable fixed equipment (pumps, electrical transformers, and hoists) and all economically salvageable utilities (power, air, water, and backfill lines) will be removed from the underground workings for salvage sale. Underground mined-out stopes and some access drifts will have been backfilled with cemented paste tailings. Access drifts developed in sulfide-rich rock are planned to be backfilled operationally, once they are no longer needed to facilitate access required by mine production plans. Prior to backfilling the stopes or access drifts, a shotcrete wall (with wire screening and burlap to hold initial shotcrete in place) will be built at the stope / access drift entrance as a retaining wall against which to pump and confine paste backfill. The wall will remain in place indefinitely, and will eliminate direct exposure of the cemented paste backfill to the open mine workings operationally and to flooded workings in closure. These walls will also prevent direct in situ erosion and degradation of the cemented paste backfill by providing lateral support and a chemical isolation across the wall. Tintina will also backfill as much of the development workings as possible with cemented tailings during operations, (for example the access drift ramps to the lower sulfide zone should it be mined out in advance of the upper sulfide zone) or with other mine facility waste materials (i.e., solid wastes (if any) from the foundation drain ponds, CWP and any possible contaminated materials from the surface of the portal pad). These materials will either be placed underground below the ultimate groundwater level in closure or in the CTF prior to placement of the HDPE cover.

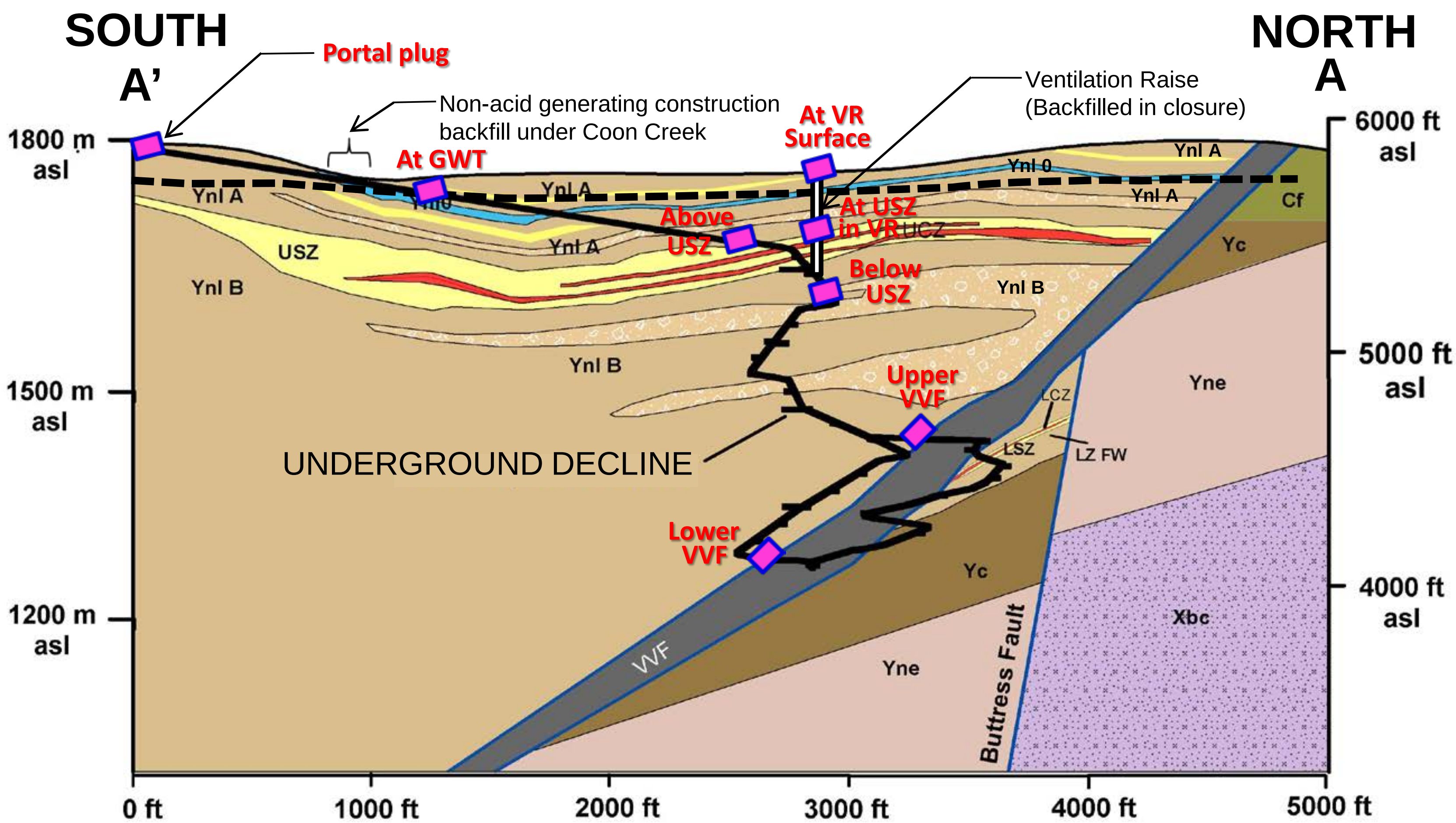
A total of 14 hydraulic barriers are planned to be installed in closure. Tintina plans to use a combination of five hydraulic barriers (Table 7-2) at strategic locations in the main access ramps (Figure 7.4 and Figure 7.5). Eight additional hydraulic barriers will be installed in the four ventilation raises (an upper and lower barrier in each raise). An additional plug will also be installed at the mine portal in closure (see the last two paragraphs of this Section 7.3.3.5 for description). Although hydraulic walls and hydraulic plugs are relatively common in mining operations and closure applications they are designed based on site-specific observable geotechnical and hydraulic conditions, and their construction locations are carefully chosen based on rock quality, and fracture patterns and density. Hydraulic walls and plugs will be designed for long-term stability by mining, geotechnical and hydraulic engineers.

Hydraulic walls and plugs are both hydraulic barriers. Hydraulic plugs are typically comprised of massive blocks of concrete confined by bulkheads at both ends, and completely fill a short segment of the mine workings. Hydraulic plugs commonly are surrounded by both formation grouting out into adjacent rock to minimize groundwater flow in fractures around the plug, and contact grouting of the cement / bedrock contact around the entire perimeter of the plug for a tight seal. Hydraulic plugs are typically used where significant changes in hydrostatic head or pressure might be expected on either end of the plug. Hydraulic walls are constructed as describe above for the shotcrete walls constructed at the ends of backfilled mining stopes. Hydraulic walls are tied into the perimeter back (roof), ribs (walls), and sill (floor) of the mine working in areas to minimize or restrict the flow of groundwater along the adit. Large differences in hydrostatic head or pressure are not typically expected across hydraulic walls.

Table 7-2 depicts the installation of the hydraulic barriers over time (earliest at the bottom of the table). These hydraulic barriers (plugs or walls) serve to separate the development and production workings into segments, coinciding with different hydrostratigraphic units. Table 7-2 also correlates the timing of hydraulic barrier installations, with various flooding, rinsing, treatment and reclamation material backfilling actions in the underground mine closure process.

In the late stages of mining and during the earliest stage of closure of the lower copper zone, the water from the lower mine sumps will continue to be pumped to the water treatment plant. The lower copper zone and the enclosing lower zone footwall sedimentary rocks of the *Ynl* (*LZ FW*) isolated beneath the *VVF* have extremely low flow rates (approximately 1 gpm) and low hydraulic conductivity (average 1.8 x 10^{-7} cm/sec) as do the cemented paste backfilled tailings (1.0 x 10^{-8} cm/sec). These characteristics imply that the lower zone rocks and backfill are not aquifers (see Section 2.2.5, Aquatics Characterization Investigations). Tintina proposes to isolate the *LZ FW* unit, the backfilled mining stopes in the *LSZ* (hydraulic conductivity estimated 5.9 x 10^{-8} cm/sec), and the associated groundwater below the *VVF* by installing hydraulic plugs as described below in closure.

Two hydraulic barriers or plugs (labeled Lower *VVF* and Upper *VVF* on Figure 7.4, Figure 7.5 and Table 7-2) to be constructed up-drift of the Lower Copper Zone and the *VVF* will be installed in stable, competent (higher strength and low fracture density) zones in the Lower Newland Formation. Once mining is completed in the lower zone, treated water will be pumped into the lower zone access drifts and the Lower Decline until it floods to the level of the lowermost penetration of the VVF (elevation approximately 4,100 feet, 1,250 m) (Figure 7.4). Specifically, Tintina will place a concrete hydraulic plug just up-drift of the lower *VVF* in the *Ynl B* at this location and treated water will continue to be pumped into the lower zone until it floods to the level of the upper decline penetration of the upper *VVF* zone (elevation approximately 4,650 feet, 1,417 m) (Figure 7.4 and Figure 7.5), where another hydraulic wall will be installed up-drift of the *VVF* in the *Ynl-B*. This will establish a horizontal and a vertical barrier between the groundwater above and below the *VVF* in closure. This will virtually eliminate the risk of mixing of the shallower and deeper water systems across the fault and minimize the risk of the artesian conditions observed in the *LCZ* (as seen in PW-7) from affecting water quality in the shallower groundwater systems or surface water.



Notes: (1) See Figures 1.5 and 1.6 for rock unit descriptions
(2) See Figure 1.5 for cross-section A-A' line

VVF = Volcano Valley Fault
asl = above sea level
VR = ventilation raise

Lower VVF — Hydraulic barrier (or plug) installation with name corresponding to Table 7-2 in MOP

Top of groundwater table surface estimated in closure

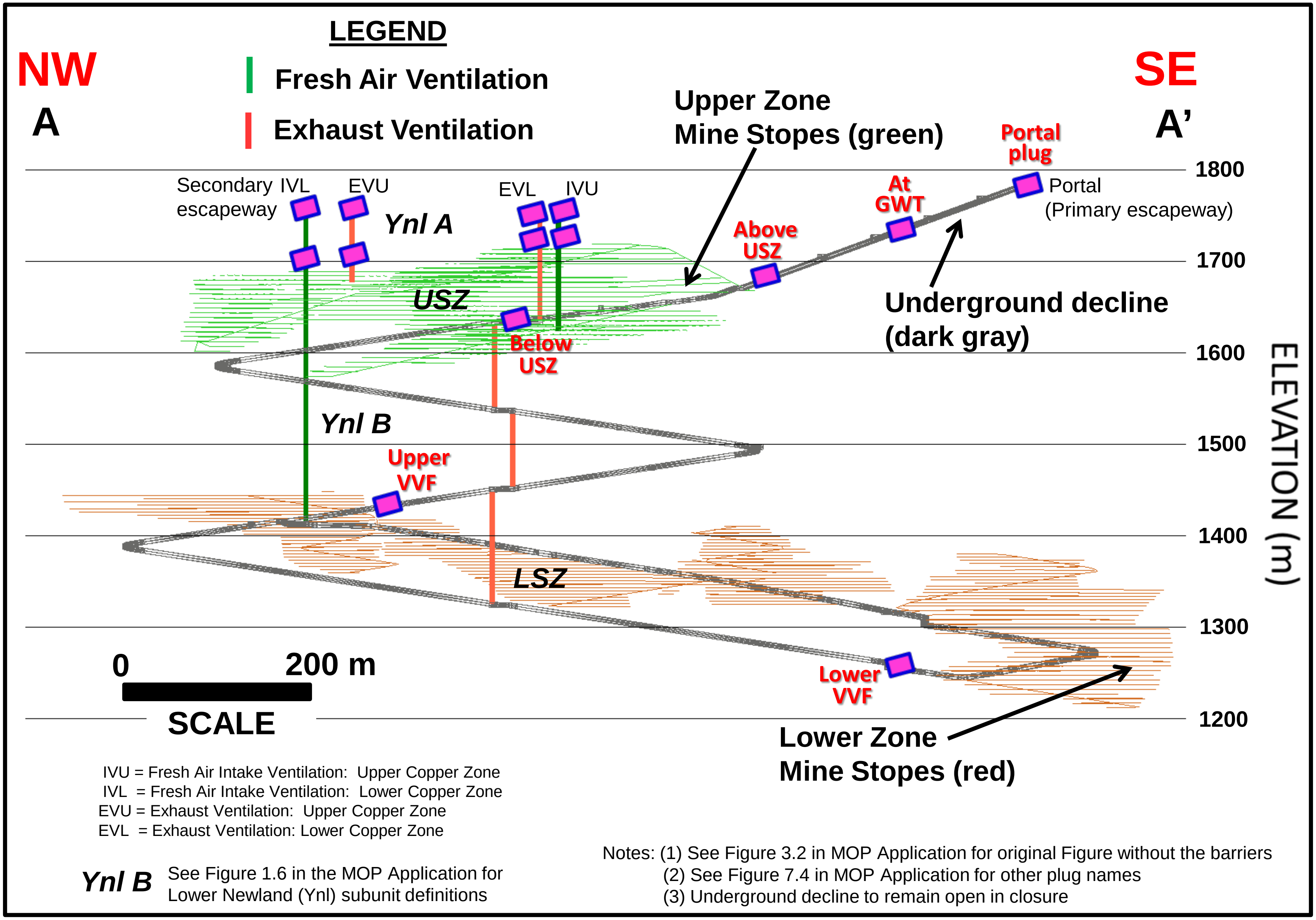
Prepared by Tintina and Hydrometrics (February 2017)

Figure 7.4

Generalized Geologic Cross-Section A-A' Showing the Underground Mining Closure Plan

Mine Operating Permit Application

Meagher County, Montana



Prepared by: AMEC and Tintina Resources (2017)

Figure 7.5 Cross-Section of Underground Workings Showing Hydraulic Barriers Installed in Closure

TINTINA RESOURCES

Upper VVF — Hydraulic barrier (or plug) installation with name corresponding to Table 7-2 in MOP Application

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Table 7-2. Sequence of Plug Installation and Rinsing/Treatment of Zones in Underground Closure

	Hydraulic Barrier[1] Installation Sequence	Flooding, Rinsing and Treatment and Reclamation Material Backfilling Actions
	Portal Plug	
		Backfill portal plug area
		Backfill access drift under Coon Creek
		Backfill all vent raises with Reclamation Materials to surface and reclaim
	At GWT (Groundwater Table)	
	Upper IVU vent raise	
	Upper EVL vent raise	
	Upper EVU vent raise	
	Upper IVL vent raise	
TIME		Backfill all vent raises with Reclamation Materials to bottom of upper vent raise plugs
	Above *USZ*	
		Rinse / Treat[2] *USZ* [3]
		Flood *USZ*
	Lower IVU vent raise	
	Lower EVL vent raise	
	Lower EVU vent raise	
	Lower IVL vent raise	
		Install USZ monitor well
	Below *USZ*	
		Rinse / Treat[2] *Ynl B zone*[3]
		Flood *Ynl B*[3]
		Install *Ynl B* monitor well
	Upper VVF	
		Flood *LSZ* with treated[2] water
	Lower VVF	

Notes: (1) All hydraulic barrier names (and locations) as listed in this table are shown in Figure 7.5
(2) Please see Section 7.3.3.6 (Underground Mine Closure – Initial Rinsing and Water Treatment) for "treating" description.
(3) For abbreviations and "zone" locations see Figure 1.6, Figure 3.3, and Figure 7.5.
(4) Total number of hydraulic barriers to install in closure is 14.
(5) Please see Sections 7.3.3.5 and 7.3.3.6 in the MOP Application for a complete description of the hydraulic barrier installation sequence and associated flooding/rinsing, treatment, and backfill actions.

Tintina plans to place another concrete hydraulic barrier (plug) beneath the upper sulfide zone (Figure 7.4, Figure 7.5; elevation approximately 5,250 feet, 1,600 m; and Table 7-2). The decline between the VVF and this hydraulic wall will have been developed in the *Ynl B* unit below the *USZ*, and this interval will be flooded with treated water and then rinsed by pumping and treating as described in sub-section 7.3.3.6 "Underground Mine Closure – Initial Rinsing and Water Treatment" below. Once this rinsing is completed the hydraulic plug below the *USZ (labeled "Below USZ" on Figure 7.5 and in Table 7-2)* will be installed. This hydraulic wall, located beneath the upper sulfide zone, is intended to provide a sump for use in storing and treating water during flooding of the *USZ*. The *USZ*, once flooded, will undergo a couple of rinsing cycles using treated, but unbuffered RO permeate water, and then will be allowed to fill with regional ground water. The regional ground water will continue to be pumped and treated until ambient pre-mining water quality is reestablished. Geochemical estimates based on HCT test results and the volume of water flowing into the mine relative to the exposed surface area, suggests that the majority of solutes would be removed within the first three to six flushes (open space volume replacements) of flow through the mine. This cycle of treatment could be completed within about three to six months. A detailed discussion of this flooding, and rinsing with both unbuffered and buffered RO permeate and then with regional groundwater is discussed in the following sub-section and in sub-appendix N of Appendix N within the MOP Application.

Tintina plans to place a concrete hydraulic barrier wall (large differences in hydrostatic pressures or heads are not expected on either side of this wall) in the decline immediately above the upper sulfide zone (Figure 7.4) elevation approximately 5,550 feet, 1,692 m) (labeled “Above USZ” on Figure 7.5 and in Table 7-2) to reduce the potential for groundwater communication between the *USZ* and the overlying *Ynl A* aquifer in closure. The highest conductivities within the Lower Newland Formation occur within the *Ynl A,* above the *Upper Sulfide Zone*, which exhibits hydraulic conductivities ranging from 1 to 5 feet per day (0.3 to 1.5 m/day). The permeability of the bedrock decreases by one to two orders of magnitude in the underlying *USZ* with hydraulic conductivities ranging from 0.01 to 1 ft. /day (0.003 to 0.3 m/day). Water level elevations in wells show a large upward gradient between the Upper Sulfide Zone (*USZ*, PW-9) to *Ynl A* and a downward gradient from *USZ* to *Ynl B* bedrock system. The Ynl A hydrostratigraphic unit is described in Section 2.2.4.5 and Section 2.2.5.

Tintina plans to install a fifth hydraulic barrier wall near the upper surface of the groundwater table in closure (labeled “At GWT” on Figure 7.5 and in Table 7-2).

Tintina also plans on using non-acid generating near-surface materials obtained from either of the two reclamation material stockpiles to backfill an approximately 200-foot (60 m) long section of the upper portion of the decline where it passes beneath Coon Creek in order to minimize the long term risk of collapse that could damage the grouted segment of drift installed during initial mine development.

The four ventilation raises will all have surficial structures including hoists and power supply lines removed. In addition, all four ventilation raises will have hydraulic plugs set in two places: one above the upper sulfide zone, and another set of plugs installed near the ground surface (Figure 7.5 and in Table 7-2). A representation of these sets of plugs, in one of these ventilation raises, is schematically shown in Figure 7.4. The deeper set of plugs will serve to isolate the *USZ* from the overlying *Ynl A* aquifer. The upper near surface set of plugs in these four ventilation raises will be closed with concrete plugs set far enough down the raise to be placed in solid bedrock. All vent raises encounter solid bedrock between 8 and 62 feet (2.5 and 19 m) below the ground surface (bgs). Three of the ventilation raises concrete plugs will be installed above the groundwater table and the fourth, the southernmost ventilation raise (IVU raise on Figure 3.2 and Figure 3.3) will have a plug installed that will ultimately reside below the top of the predicted groundwater table elevation in closure. The groundwater table in this southernmost ventilation area occurs at an elevation that is about 22 feet (6.7 m) below the ground surface and the depth to solid bedrock is 62 feet (18.9 m). Although both of these conditions are acceptable from a constructability, ventilation performance, and risk of discharge to surface water in closure, it is possible that a more desirable location can be located in the same general area that allow for shallower depths to solid bedrock and deeper depths to the groundwater table. This ventilation raise may be relocated based on a review of the geotechnical characteristics during the final detailed mine design and future geotechnical drilling of a pilot hole that verifies actual conditions at the site. Once the near surface concrete plugs have cured, the ventilation raises will be backfilled to surface with non-acid generating excess excavation materials. Prior to actual closure of the ventilation raises a site specific engineered design will be prepared for the concrete plugs based on actual conditions observed during the raise construction. Top soil from the ventilation raise construction sites will be stored within the 100 foot (30 m) diameter surface disturbance construction footprint and the site will undergo interim reclamation once the ventilation raise construction is complete, and final reclamation using additions from the soil stockpiles once the raise closures are complete. The access roads will be reclaimed, soil will be placed on the surface and the sites seeded.

The decline immediately inboard of the portal will be closed with a portal plug. This plug will be constructed with non-acid generating rock backfill for at least the first 25 feet (7.6 m) of decline. A concrete wall will be placed at the portal before reclamation of the portal pad.

An estimated total of 3,000 m^3 of reclamation material will be required to backfill and close the four ventilation raises, backfill the 200 foot drift section under Coon Creek, and backfill the decline inboard of the portal for final closure as stated in Table 3-14c of the MOP Application.

7.3.3.6 Underground Mine Closure – Initial Rinsing and Water Treatment

Conditions during the early rinsing stages of closure will be different than those predicted by Enviromin's post-closure model (see Section 4.3.2). Tintina has committed to treating water from the underground mine until water quality meets non-degradation criteria for groundwater with respect to pre-mining background chemistry. Specifically, Tintina plans to flood portions of the workings with an initial rinse of unbuffered reverse osmosis (RO) permeate while pumping to remove the solute-affected water for treatment. This continual loop of injection and withdrawal of unbuffered and then buffered RO permeate will initially rinse the lower (*Ynl B*) decline between the *VVF* (Upper V*VF* plug) and the lower USZ (Below *USZ*, Figure 7.4, Figure 7.5, and Table 7-2). A hydraulic plug will be placed below the *USZ*, to isolate it for rinsing. In subsequent rinses, the RO permeate will be buffered and ultimately the injection rate will be reduced relative to groundwater inflow so that groundwater replaces the injected water as rinsing is completed.

As the mine workings are flooded with unbuffered RO permeate, limiting the availability of oxygen and reducing sulfide oxidation, accumulated oxidation products will be aggressively dissolved and rinsed from exposed surfaces. Salts accumulated on bedrock surfaces, the result of direct reaction of wall rock with oxygen under humid operational conditions as well as the evaporation of water at the wall interface, are expected to include oxide, hydroxide, and sulfate minerals. These minerals are likely to have variable solubility. Sulfates (e.g., alunite, jarosite, gypsum) are likely to be more soluble than iron oxides or barite, for example. Soluble salts will dissolve into the RO permeate that will be pumped through the workings; the most soluble minerals will dissolve rapidly, while others will dissolve more slowly, if at all. Initially, elevated concentrations are thus expected to decline with rinsing, ultimately achieving a steady state concentration based on equilibrium with bedrock. As the closure process continues, RO permeate will be buffered and then pumping rates will be adjusted so that groundwater infiltration will replace flooding with buffered RO permeate. Once the injection of RO permeate has ended, all subsequent inflow will be sub-oxic groundwater, which will react with rinsed bedrock surfaces and exposed paste backfill. The reaction of groundwater with bedrock (as represented by monitored groundwater) and exposed paste backfill under sub-oxic conditions (based on saturated diffusion tests) is the basis for long term post-closure predictions addressed in the water quality model in Section 4.3.2 of Appendix N (Enviromin, 2017c).

Enviromin (2017c) has used humidity cell test (HCT) data for the *USZ* and *Ynl B* to estimate the mass and rate of dissolution of oxidation products, as a basis for predicting the time required to accomplish the removal of the stored minerals during closure. The HCT results for the 2015 *USZ* are shown in Figure 7.6. Using sulfate release as a proxy for mineral dissolution, a steep rinsing curve was observed through week 2 followed by relatively steady release of sulfate due to exposure and oxidation of sulfide minerals during testing. The mass of sulfate released per mass of leached rock subsequently increased late in the HCT test, when this material demonstrated acid production. The steep initial slope of the sulfate release curve reflects the rinsing of stored oxidation products from the crushed rock sample, which has relatively high surface area and which was stored for weeks to months prior to humidity cell testing. Sulfide oxidation occurred during this time. The rinsing curve is defined from the start of the HCT to the point when the sulfate begins to increase in concentration due to oxidation. Other rock types, such as the 2015 *Ynl B* (Figure 7.7), which Tintina proposes to rinse prior to placing a bulkhead to isolate the *USZ*, reached the end of the rinsing phase by the end of week 3. Likewise, the 2012 *USZ* (Figure 7.8) reached the end of the rinsing phase by week 6. Lacking actual rates for the accumulation of oxidation products on unrinsed underground surfaces, Enviromin relied upon the rinsing of oxidation products during the initial phases of HCT testing to predict that three to six rinsings would be necessary.

Enviromin recognizes that the rate of weathering in the underground workings could potentially exceed that observed in the stored samples, due to enhanced exposure to oxygen and water, and that the accumulation of salts over time could be greater. Enviromin has therefore bounded the likely mass generated using the total cumulative solute released during each HCT test. This cumulative solute represents the mass released under optimized oxidation conditions in the HCT, and is thus considered to represent an upper bound of oxidation product formation. Table 7-3, presents a cumulative sulfate release of 6,713 mg/kg during rinsing (weeks 0 through 2 for this HCT), and a total cumulative release of 67,649 mg/kg throughout the 73 week test. Dividing the total mass of sulfate released by the mass removed during rinsing suggests that no more than 10 rinses would be needed to remove the accumulated sulfate at the rate of rinsing observed during the early 2015 USZ HCT. In contrast, the same calculation for the 2012 USZ test was made, which did not develop acid conditions before it was terminated at 24 weeks, and showed that 3 rinses should be sufficient to remove all oxidation products accumulated during that test.

These calculation were repeated for the *2015 Ynl B* HCT, using the data summarized in Table 7-3 and Figure 7.7. A total of 824 mg/kg sulfate was released during the rinsing phase (weeks 0 to 3) of that test. Dividing the total sulfate released during that HCT (4,916 mg/kg) by the sulfate released during rinsing suggests that, for this material, 6 rinses would be sufficient to dissolve the total sulfate released throughout the 36 week test.

These calculations suggest that 6 rinses of the 2015 *USZ* or 2015 *Ynl B* exposed within the underground workings should remove stored oxidation products. If we conservatively estimate that the total solute released during the entire 2015 *USZ* HCT would be rinsed, as many as 10 rinses could be required (Table 7-3). This is a highly conservative estimate because the oxidation rate in the mine will be slower than that observed in the optimized HCT test and water-to-rock surface area ratio used to flush the workings is more than three orders of magnitude greater than was used in the HCTs.

Table 7-3. Cumulative Sulfate Release Calculations, 2015 *USZ* and *Ynl B*

	Week	***Cumulative Sulfate mg/kg***	***Estimated Maximum Rinses***
2015 USZ	0	4,333.9	67649.9 ÷ 6713.8 = **10.0**
	1	5,574.8	
	2	**6,713.8**	
	Total (73)	***67,649.9***	
2012 USZ	0	724.4	2808.0 ÷7735.8 = **2.8**
	1	1,213.3	
	2	1,664.2	
	3	2,035.3	
	4	2,382.7	
	5	2,777.0	
	6	**2,808.0**	
	Total (36)	***7,735.8***	
2015 Ynl B	0	536.8	4916.4 ÷824.4 = **6.0**
	1	713.4	
	2	776.0	
	3	**824.4**	
	Total (36)	***4,916.4***	

Bold text represents the inflection point of the sulfate release curve (from rinsing of stored products to oxidative production).
Bold italicized represent the total sulfate released for entire HCT.

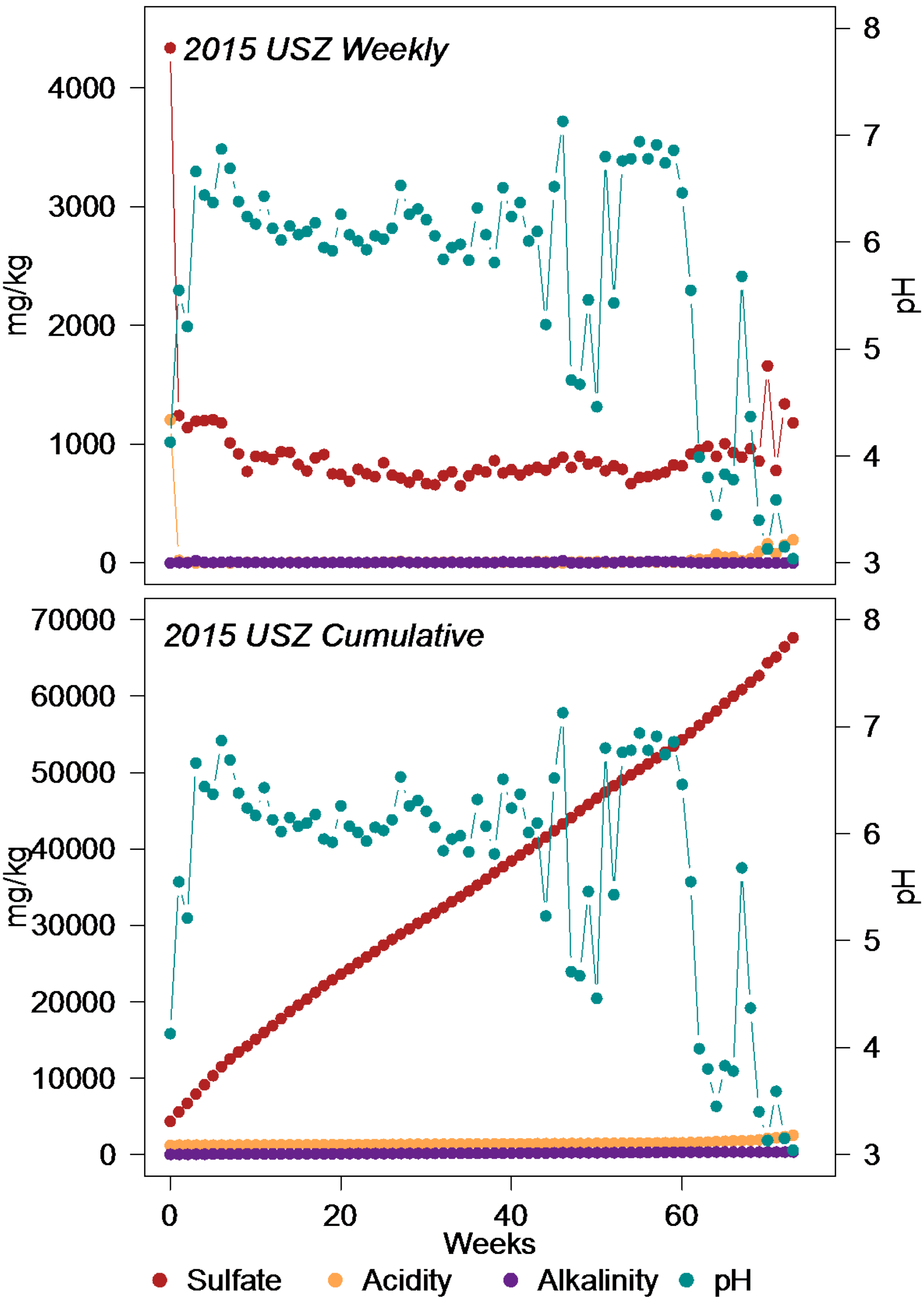


Figure 7.6. **2015 *USZ* HCT Summary**

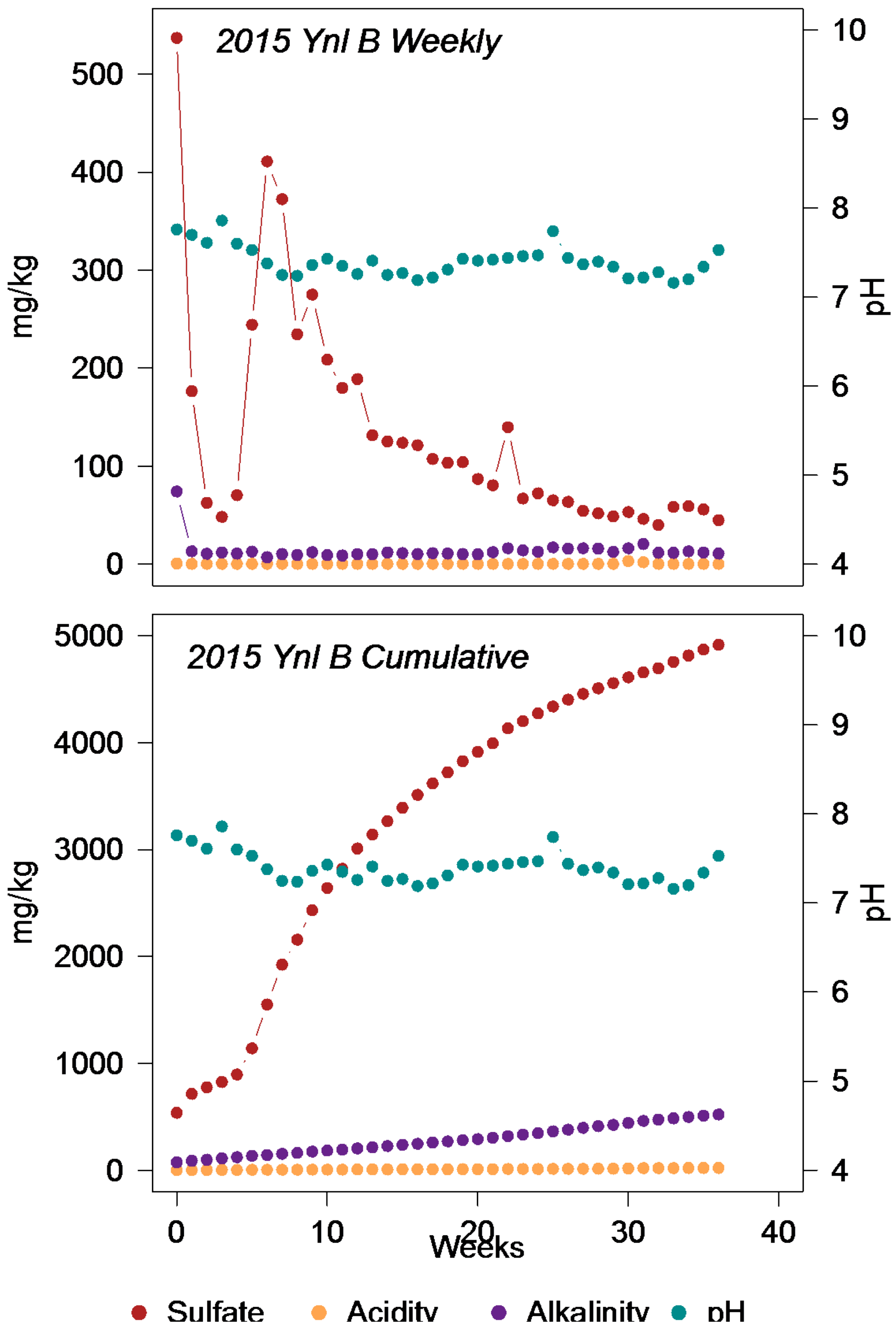


Figure 7.7. 2015 *Ynl B* HCT Summary

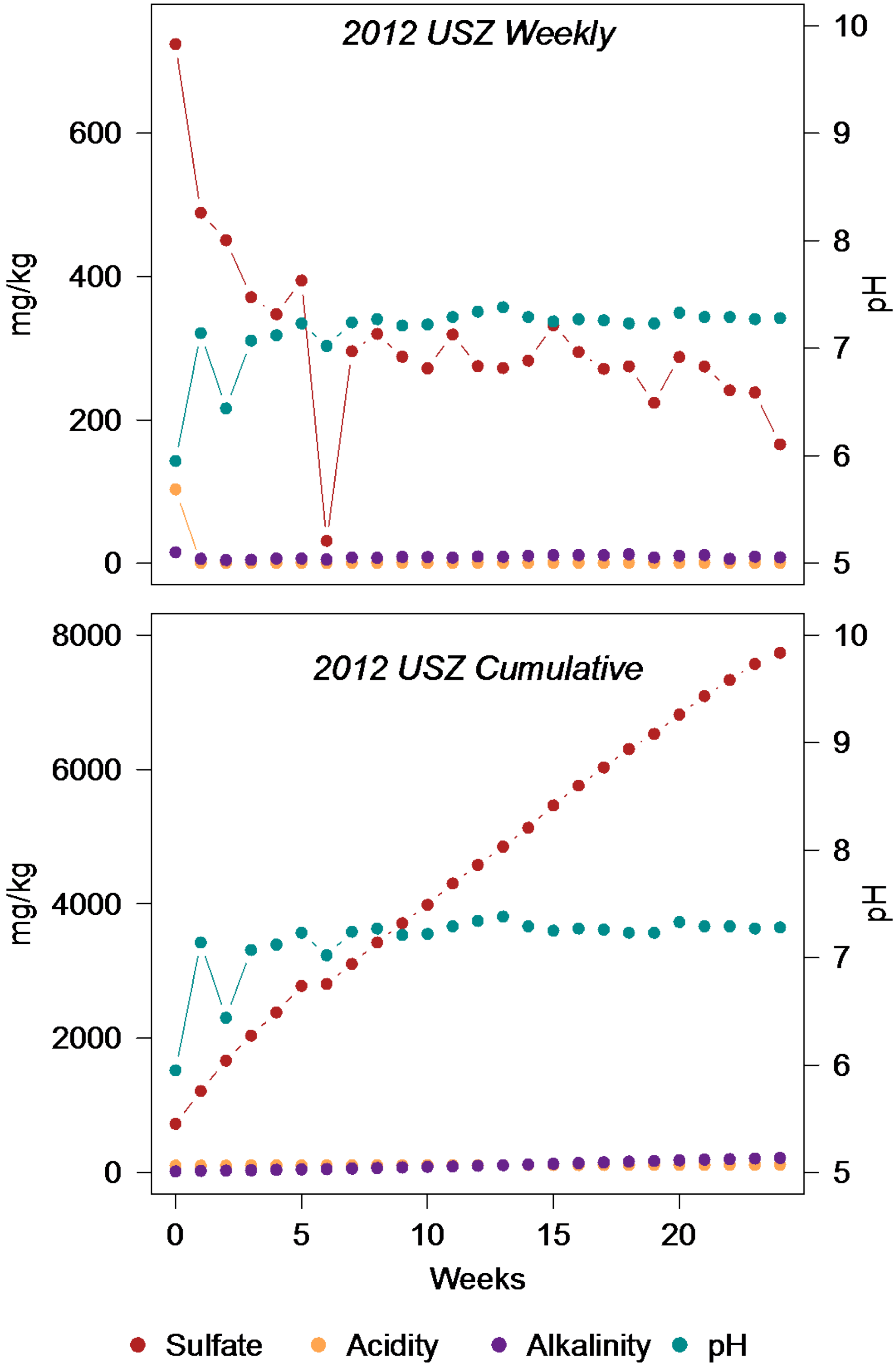


Figure 7.8. **2012 *USZ* HCT Summary**

7.3.3.7 Underground Mine Closure – Predicted Duration of Rinsing Cycles

Tintina has calculated the volume of water required to fill the zones to be rinsed and treated in each cycle. The Lower Decline zone would be mined within the *Ynl B* just above the *VVF* and below the *USZ.* This zone is 1,700 meters in length, including turn-outs and flooded portions of ventilation raises. The cross-section of the Lower Decline is 16.4 by 16.4 feet or 269 ft^2 (5 by 5 meters or 25 m^2) and the total volume of the Lower Decline to be rinsed is thus 1,500,873 ft^3 (42,500 m^3). Therefore, at a pumping rate of 500 gpm (1.89 m^3 / minute) 15.6 days would be required to fully replace the water in the flooded void. If three rinsing cycles are required, as is predicted, to remove stored oxidation products from the *Ynl B* exposed within the Lower Decline workings, it should require 47 days or about 1.6 months (Table 7-4) to complete this work. If the most conservative estimate of six cycles is accurate, as long as 97 days (approximately 3.1 months) could be required.

The exposed section of *USZ* to be rinsed is comprised of 2,110 feet (643 m) of main ramp decline (including turn-outs and flooded portions of ventilation raises), and as much as 8,071 feet (2,460 m) (33%) of development access drifts that may not be backfilled, totaling 10,180 lineal feet (3,103 meters) of open workings. The cross-section of *USZ* workings is 16.4 by 16.4 feet or 269 ft^2 (5 by 5 meters or 25 m^2); the total volume to be rinsed is therefore calculated to be 2,739,641 ft^2 (77,578 m^3). Thus, at a pumping rate of 500 gpm (1.89 m^3 / minute), 28.5 days should be required to complete a rinsing cycle. The rinsing cycle calculations suggest that 6 rinses of the *2015 USZ* will be required to remove stored oxidation products from the workings. That should require 171 days or approximately 5.7 months to complete. While, modeling indicates that more than 6 rinses should not be necessary, the most rinsing that any model indicated may be necessary to remove the maximum estimated mass of soluble oxidation products from the USZ zone was 10 rinses. This could take as long as 285 days or 9.5 months. The final decision on the necessary number of rinses would be based on actual measurement of water quality in the underground workings and documentation and concurrence by the DEQ that closure goals of attainment of non-degradation criteria with respect to pre-mining groundwater quality have been met.

The Ynl B and USZ must be rinsed sequentially; therefore, using the model predicted durations of rinsing for both zones indicates that the total time to treat the upper (*USZ*) and lower (*Ynl B*) workings is estimated to be approximately 7.3 months. Alternatively, using the most conservative approach suggests that the rinsing could take as long as 12.6 months. Treating water for the underground mine closure would likely occur late in the overall two to four-year closure period.

Groundwater quality monitoring for determination of permanent closure will be evaluated through two surface wells completed within the *USZ* and *Ynl B* HSUs. These wells will be completed between the downgradient edge of the mine workings and the *USZ* outcrop (*USZ* monitoring) (Figure 6.1) and the bedrock wells completed in the *Ynl B* below the Sheep Creek Alluvial system (*Ynl B* monitoring) (Figure 6.1). All groundwater wells will meet the groundwater non-degradation criteria for each of the HSUs that the wells are completed in (*USZ* and *Ynl B*, respectively) prior to permanent closure. Estimated non-degradation criteria are included in Table 4-10 for the *USZ* based on the data collected since July 2015. The final non-degradation criteria will be determined based on all water quality data from when the wells are installed to when the mine workings advance below the water table.

7.3.3.8 Underground Mine Closure – Brine Generation

Pumping water from the underground mine at a rate of 500 gpm allows for treatment of approximately 718,900 gallons/day (2,721.6 m^3/day). The RO treatment plant operating at a recovery rate of 81.7% would generate 131,600 gallons of brine or RO reject. However, in the mine closure water treatment scenario, the volume of RO reject would be passed through the VSEP system, which would further reduce the RO reject volume by an additional 85% to approximately 21,570 gallons per day.

Table 7-4 presents the total brine production for the various rinsing scenarios developed in the sub-section above. Rinsing of the *Ynl B* zone must be completed before rinsing of the *USZ* zone can begin.

Table 7-4. Predicted Duration of Early Closure Water Treatment and Brine Generation Volumes

	Predicted Cycles (Cycles / Days)	Predicted Gallons of Brine	Maximum Predicted Cycles (Cycles / Days)	Maximum Gallons of Brine
Ynl B	3 / 47	1,013,790	6 / 94	2,027,580
USZ	6 / 171	3,688,470	10 / 285	6,147,450
Total	218 days (7.3 months)	4,702,260	379 days (12.6 months)	8,175,030

The brine cell has a capacity to store of 5,550,000 (21,000 m^3) of RO / VSEP reject. Once treatment is initiated in closure and the PWP is empty, the CWP will be the only on-site storage facility available. The main cell of the CWP has a capacity to store 18,500,000 gallons (70,000 m^3) of untreated water. Treated water in closure will be discharged to the UIGs, and brine will be transported to a licensed off-site facility for disposal, most likely in Utah. Off-site disposal of brine will begin as soon as the PWP is closed, ensuring that the brine pond always has adequate storage capacity.

7.3.3.9 <u>Underground Mine Closure – Mitigations and Operational Testing</u>

Tintina has considered both high pressure washing of the mine walls to remove stored oxidation products as well as the possibility of shotcreting high sulfide zones in the workings to cover and immobilize oxidation products. These potential mitigation measures could be used prior to rinsing and water treatment described above, and would likely reduce the time required to meet closure goals. However, the best scientific and technically most appropriate approach would be to observe the evolution of water quality with respect to modeled predictions before using shotcrete in sulfide zones, which could change chemistry sufficiently to interfere with changes in predicted geochemistry. It will be possible to test the proposed high pressure washing and shotcrete mitigation strategies in localized individual heading scale once mining has begun in the USZ. The rinsing closure model could also be tested during mining operations on a controlled and smaller scale within a bulkheaded portion of a sulfide-rich heading. Thus, the testing and consideration of mitigation measures to optimize the closure of the underground workings during the operational life of the mine will ensure that any mitigation measures are necessary and effective before they are incorporated into the closure procedures. Such mitigation would only be implemented to further optimize the closure process, as the models indicate that non-degradation standards to groundwater will be achieved without such additional mitigation.

7.3.3.10 <u>CWP Closure</u>

Tintina plans to keep the CWP open well into closure. During this time, it will be used in conjunction with the WTP to treat water (if any is present) that may accumulate in the sump of the closed CTF and to treat the deliberately lowered, minimal remaining volume of water on the PWP. Treated water will discharge to an UIG, and the brine will be stored in the CWP in the brine cell (created when it was first constructed). Brine will ultimately be hauled off-site for disposal. It is not expected that any significant amount of water will accumulate in the CTF sump in closure once the welded HDPE cover is placed on the CTF.

Treatment, however, will continue until monitoring provides sufficient data with regard to water accumulation rates to indicate that final closure objectives have been met. The CWP will then be closed by treating all water stored on the CWP facility with treated water being discharged to the underground infiltration galleries. The remaining brine (in the brine cell) will be hauled off-site for disposal.

During the final water treatment stage of closure of the CWP there should be little risk of dust being generated from either cell of the CWP, as there should be adequate volumes of water in each cell and the embankments should be covered with soil and vegetated. In final closure of the CWP, brine will be disposed of off-site as necessary.

Once these tasks are completed, the water treatment system can be dismantled and the CWP reclaimed. The CWP's liners will be removed and hauled off-site for disposal or recycling (Table 7-1). Embankment material will be tested for contamination, and if clean used to re-shape and reclaim the CWP disturbance footprint. The footprint of the CWP will be ripped to relieve compaction, the site regraded, soil placed, and the site seeded.

7.3.3.11 _Portal Pad Closure_

The portal pad will be regraded and revegetated, to further bar the workings from entry. The portal pad fill slope material will be used to backfill the cut on the north side of the pad, and the fill slope material will be tapered out to achieve a final reclamation slope of 2.5H:1V or less. Any additional fill materials required for closure of the portal pad will be sourced from the reclamation material stockpile(s). Figure 7.1 shows post-mining reclamation topography in the portal area. Material at the perimeter of the reclaimed site will be graded to blend with surrounding topography. A stabilized drainage will be re-established. Stockpiled soil will be placed over the regraded surfaces, and the area seeded.

7.3.3.12 _Post Mining Road and Land Use in Closure_

Post mining land uses in the general area will remain the same as the pre-mining land uses (grazing and hay production) (Section 2.8.2). Property lease agreements include commitments to reestablish these land uses. The post-mining topography has been designed to be erosionally stable. It will be graded to minimize the amount of precipitation and run-on that infiltrates into disturbed areas, thereby, accommodating the pre-mining beneficial uses. To the extent possible, features enhancing wildlife habitat will also be incorporated into the final closure plan. Possible examples include: use of shrubs on grazing lands, willows in riparian areas, and creation of slash or rock piles during final revegetation. Recreational use of the land is limited and only occurs with permission of the landowners.

Reclamation activities would meet fundamental operating permit requirements of site stability, minimizing erosion, and providing a self-sustaining vegetative plant community. Removal of all buildings and earthwork facility reclamation will insure protection of the property owners, livestock, and the public should they gain access to this private property. Grading of final topography will insure that landforms and slopes are suitable for livestock grazing. During final closure activities, temporary fencing will be required to protect newly seeded areas from livestock grazing. Fencing will be removed as revegetation areas meet DEQ reclamation requirements. Meeting these objectives will assure that pre-mining land uses are restored.

The Sheep Creek and Black Butte county roads will remain open to public access throughout the mine-life. The main access road to the mine site (including bridges), construction road access, and service roads access to various facilities (Figure 3.17 and Figure 3.19) on private property will not be open to the public. They will either be completely reclaimed or left open with a reduced footprint at the request of the landowner. Complete closure of roads will consist of obliteration with recontouring of the road surface disturbance, and blending road construction materials with existing topography. Road disturbance areas will receive topsoil placement and reseeding with approved mixes to reestablish a long-term vegetative cover.

Road widths will be narrowed to reduce the footprint of mine roads requested for post-mining use by the landowners. Any reductions will be recontoured, soil placement, and reseeding.

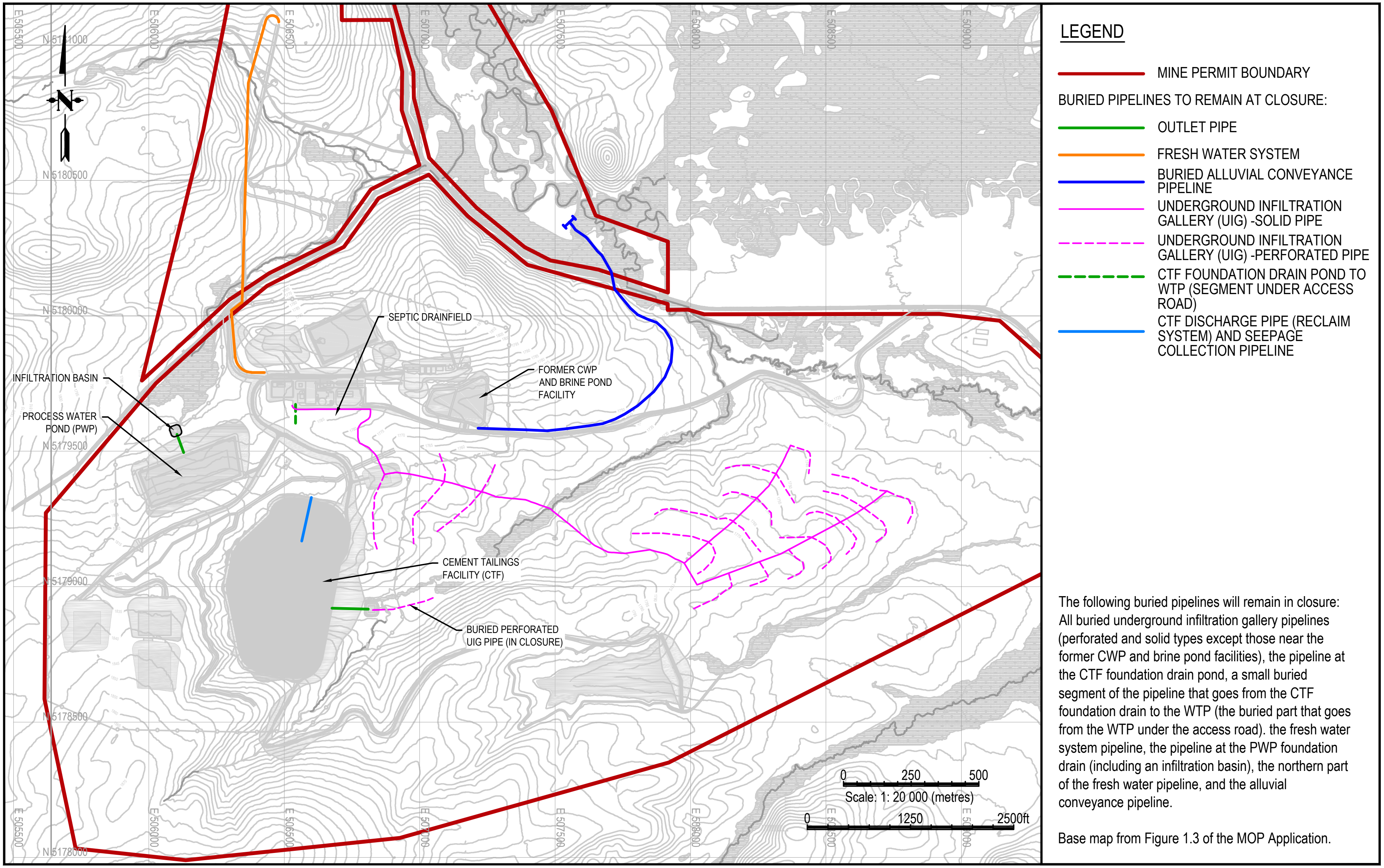
7.3.3.13 Storm Water Diversion Ditches and Sediment Collection Basins

Surface storm water diversion ditches and sediment collection basins will be reclaimed and reseeded following initial construction of the diversion feature. Those not retained for water diversion purposes in post-mining closure will be also be regraded, reclaimed and reseeded at that time. No further alteration or reclamation of the storm water diversion features retained in closure is anticipated.

7.3.3.14 Pipeline, Underground Infiltration Galleries, and Well Closures

Surface disturbances resulting from excavation and trenching of buried water supply / distribution lines, paste backfill lines, and underground infiltration distribution lines will be reclaimed immediately after initial construction by recontouring, soil replacement, and reseeding. During final closure all surface piping will be removed and either disposed of or recycled. Two track access trails along the lines will be ripped and revegetated. Buried underground piping (including those for the UIG's, the alluvial conveyance (MPDES discharge) and septic system) will not be removed (Figure 7.9). However, ends of solid sections of piping will be excavated and the pipe ends capped or plugged with cement. Perforated pipeline sections including those in the UIGs and drain-field piping related to the septic system will remain buried in closure.

Monitoring wells, and water reclaim wells servicing sumps in the CTF that are not scheduled for post-closure monitoring will be plugged and abandoned according to applicable laws including ARM 17.24.106 to prevent aquifer cross contamination, and surface casing cut off below the ground surface. Casing for lysimeters and piezometers will be removed. All areas disturbed by abandonment activities will be scarified and reseeded.



Prepared by Tetra Tech Inc. (Revised July 2017)

FIGURE 7.9

Buried Pipelines Remaining at Closure - Plan Map

Black Butte Copper Project

Mine Operating Permit Application

Meagher County, Montana

TINTINA RESOURCES

7.3.4 Soil Salvage, Handling, and Redistribution

Topsoil and subsoil will be salvaged and stockpiled from most facility construction areas, including the CTF, mill pad, portal pad, Copper-Enriched Stockpile pad, Temporary WRS pad, CWP, PWP and NCWR embankment footprint. Soils will be salvaged, but not stored in the main stockpiles for facilities such as constructed roads, diversion ditches, infiltration galleries, as well as small disturbances such as vent raises and buried pipelines. Areas where soils will be immediately replaced include pipeline trenches, roadside disturbances, diversion ditch perimeters, and buried powerlines. A 10% buffer was added to estimated soil salvage volumes to account for construction buffer zones and a 12% swell factor was used to replicate bulked soil volumes. Estimated soil salvaged depths and soil volumes are provided on Table 7-5. Salvaged soil will be stockpiled for replacement during reclamation activities (Figure 1.3).

7.3.4.1 Vegetation Removal and Disposition

Vegetation will be removed during initial construction. Small shrubs and herbaceous vegetation will be salvaged with topsoil. Merchantable trees will be harvested and removed from the site. Non-commercial trees, slash, tall shrubs and small stumps will be chipped and salvaged with topsoil. Larger stumps will be stored at the toe of soil and reclamation stockpiles to aid in erosion control and ultimately for distribution as part of reclamation.

7.3.4.2 Soil Salvage

The suitability of soil and subsoil proposed for reclamation was determined from physical and chemical data collected during the baseline soil survey (see Section 2.5.3.3 and Table 2-25). The volume of soil suitable for salvage and reclamation use was limited by slope, shallow depth to bedrock, coarse fragment quantity, and exposed bedrock at the construction site. A soils specialist will be present on-site during initial soil salvage activities to provide oversight of soil suitability and establish salvage guidelines for specific soil types or landscape features.

It is expected that soil thickness will vary considerably throughout the proposed disturbance area, although soil volumes are estimated to be sufficient to support the proposed reclamation. However, in the event of a shortage of cover soil, soils containing coarse fragments in excess of 50% by volume will be screened and salvaged for use in reclamation so that no offsite topsoil will be required. Coarse material will be used as fill during reclamation and closure.

All suitable topsoil and subsoil within the recommended salvage depths (Table 7-5) will be removed prior to commencing construction activities. To the extent practicable, salvage activities will be timed to avoid periods of wet or saturated soil in order to limit soil compaction. If possible, soil removed from an area will be hauled directly to, and used to reclaim, another previously disturbed area (thus eliminating the need for prolonged storage). Soils removed during road and diversion ditch construction will be concurrently used to revegetate adjacent cut and fill slopes.

The total volume of salvageable topsoil is about 276,082 cubic yards (211,080 m^3) and salvageable subsoil is about 234,540 cubic yards (179,319 m^3). The following sections detail soil salvage and replacement activities.

Table 7-5. Estimated Soil Salvage Volumes by Disturbance Type (A. Stockpiled and B. Not Stockpiled)

A. Acres of Disturbance and Estimated Salvage Volumes - Soils to be Stockpiled

Soils Map Unit Symbol (MUSYM)	Mine Operations Disturbances (acres)							Pond / Diversion Disturbances (acres)					Soil Salvage Thickness (inches)			Soil Volume (cubic yards)		
	Cemented Tailings Facility (CTF)	Core Shacks and Yard	Mill Pad	Copper-enriched Rock Stockpile	Portal Pad and Conveyor	Temporary Powder Magazine	Temporary Waste Rock Storage (WRS) Pad	Contact Water Pond (CWP)	Foundation Drain Pond	Non-Contact Water Reservoir (NCWR) - Dam	Process Water Pond (PWP)	Total Disturbance per Soil Unit (ac)	1st Lift Volume (Topsoil)	2nd Lift Volume (Subsoil)	Total Salvage (Topsoil + Subsoil)	1st Lift Volume (Topsoil)	2nd Lift Volume (Subsoil)	Total Soil Volume (Topsoil + Subsoil)
Ad-b												**0.0**	12	24	**36**	-	-	**-**
Ch-b	7.6		8.8	0.6	1.2			1.4	0.4	4.3	4.6	**28.9**	12	0	**12**	52,220	-	**52,220**
Cl-a												**0.0**	12	24	**36**	-	-	**-**
Cp-c	4.8			1.0	5.7			3.6				**15.1**	12	0	**12**	27,285	-	**27,285**
Cp-d												**0.0**	0	0	**0**	-	-	**-**
Dc-a												**0.0**	12	24	**36**	-	-	**-**
Fa-b												**0.0**	12	24	**36**	-	-	**-**
Hl-b												**0.0**	12	24	**36**	-	-	**-**
Kp-c	35.3								0.7		16.6	**52.6**	12	24	**36**	95,045	190,090	**285,134**
Kp-d												**0.0**	0	0	**0**	-	-	**-**
Lb-b												**0.0**	12	12	**24**	-	-	**-**
Ml-a												**0.0**	12	24	**36**	-	-	**-**
Ml-b												**0.0**	12	24	**36**	-	-	**-**
Pn-b	24.2		0.2	0.3		0.4	7.9			0.4		**33.4**	12	0	**12**	60,352	-	**60,352**
Rc-b												**0.0**	12	12	**24**	-	-	**-**
Rf-a												**0.0**	12	24	**36**	-	-	**-**
Ry-b												**0.0**	12	24	**36**	-	-	**-**
Se-b												**0.0**	12	24	**36**	-	-	**-**
Wa-b							2.3				2.7	**5.0**	12	12	**24**	9,035	9,035	**18,069**
Wg-b								3.9				**3.9**	12	24	**36**	7,047	14,094	**21,141**
Wu-b												**0.0**	12	12	**24**	-	-	**-**
DL		1.8										**1.8**	0	0	**0**	-	-	**-**
Total Acres	**71.9**	**1.8**	**9.0**	**1.9**	**6.9**	**0.4**	**10.2**	**8.9**	**1.1**	**4.7**	**23.9**	**140.7**			**10% Buffer**	**25,098**	**21,322**	**46,420**
															Total Volumes	**276,082**	**234,540**	**510,622**

B. Acres of Disturbance and Estimated Salvage Volumes - Soils to be Stored and Replaced at Site of Salvage (Not Stockpiled)

Soils Map Unit Symbol (MUSYM)	Road Disturbances (acres)					Mine Operations Disturbances (acres)					Pond / Diversion Disturbances (acres)							Soil Salvage Thickness (inches)			Soil Volume (cubic yards)		
	Access Road	Construction Access Road	CTF Road	Road to Vent Raise	Service Road	Infiltration Pipe - Perforated	Infiltration Pipe - Solid	Powerline and Pipe to Well PW-6	Temporary Construction Stockpile	Vent Raises	Alluvial Conveyance and Pipeline	CTF Diversion Ditching	NCWR Diversion Ditching	NCWR Spillway	NCWR - Open Water	PWP Diversion Ditching	Total Disturbance per Soil Unit (ac)	1st Lift (Topsoil)	2nd Lift (Subsoil)	Total Salvage (Topsoil + Subsoil)	1st Lift Volume (Topsoil)	2nd Lift Volume (Subsoil)	Total Soil Volume (Topsoil + Subsoil)
Ad-b								0.1									**0.1**	12	24	**36**	181	361	**542**
Ch-b	5.1	0.8	4.5		0.4	6.5	3.4				0.6	0.1	1.3	0.5	14.2		**37.4**	12	0	**12**	67,579	0	**67,579**
Cl-a																	**0.0**	12	24	**36**	0	0	**0**
Cp-c			0.2		2.3			0.4				1.7	0.1				**4.7**	12	0	**12**	8,493	0	**8,493**
Cp-d																	**0.0**	0	0	**0**	0	0	**0**
Dc-a	2.9																**2.9**	12	24	**36**	5,240	10,480	**15,720**
Fa-b																	**0.0**	12	24	**36**	0	0	**0**
Hl-b					2.9		0.6										**3.5**	12	24	**36**	6,324	12,649	**18,973**
Kp-c					5.3	0.5						3.6	0.3				**9.7**	12	24	**36**	17,527	35,055	**52,582**
Kp-d											0.2						**0.2**	0	0	**0**	0	0	**0**
Lb-b																	**0.0**	12	12	**24**	0	0	**0**
Ml-a	0.3																**0.3**	12	24	**36**	542	1,084	**1,626**
Ml-b	0.2					0.3	0.1	0.1									**0.7**	12	24	**36**	1,265	2,530	**3,795**
Pn-b		1.4	7.3		7.6	0.4	0.4		2.8			3.7	0.4		1.6	0.9	**26.5**	12	0	**12**	47,884	0	**47,884**
Rc-b																	**0.0**	12	12	**24**	0	0	**0**
Rf-a																	**0.0**	12	24	**36**	0	0	**0**
Ry-b	1.8																**1.8**	12	24	**36**	3,252	6,505	**9,757**
Se-b																	**0.0**	12	24	**36**	0	0	**0**
Wa-b		1.2		0.7	3.6			0.8		0.2						0.4	**6.9**	12	12	**24**	12,468	12,468	**24,936**
Wg-b	4.0					0.2	0.5				1.0						**5.7**	12	24	**36**	10,300	20,599	**30,899**
Wu-b								0.3		0.3							**0.6**	12	12	**24**	1,084	1,084	**2,168**
DL	0.2										0.4						**0.6**	0	0	**0**	0	0	**0**
Total Acres	**14.5**	**3.4**	**12.0**	**0.7**	**22.1**	**7.9**	**5.0**	**1.7**	**2.8**	**0.5**	**2.2**	**9.1**	**2.1**	**0.5**	**15.8**	**1.3**	**101.6**			**10% Buffer**	**18,214**	**10,281**	**28,495**
																				Total Volumes	**200,353**	**113,096**	**313,449**

Disturbance Acreage Summary

Stockpiled Soils	140.7
Non-Stockpiled Soils	101.6
No Soil Salvage[1]	29.6
TOTAL DISTURBANCE	**271.9**

Notes:

[1]Soil will not be salvaged in topsoil (8.0 acres), subsoil (7.0 acres) or reclamation material storage areas (North site = 7.1 acres, South site = 7.5 acres) and thus are not included in soil volume calculations.

7.3.4.3 Soil Storage and Protection

Topsoil and subsoil lifts will be stored in two separate stockpiles in a convenient location for reclamation accessibility (Figure 1.3), and identified with signage. Stockpiles will be constructed with 2.5H:1V side slopes and 3H:1V access ramps that are restricted in area to minimize undue compaction.

The stockpiles will be revegetated using an interim seed mix to prevent water and wind erosion until the soil is needed for use in closure. Broadcast seeding will be conducted during the first appropriate season following stockpiling. The stockpile surface will be scarified to provide a proper seedbed if needed. The estimated life of each stockpile is the life of the mine.

7.3.4.4 Soil Redistribution

Prior to soil redistribution, compacted areas (particularly along access roads and beneath facilities) will be ripped to relieve compaction. This will also eliminate potential slippage along layer contacts, and promote root growth.

Salvaged soils will be redistributed evenly over the disturbed area, allowing an average soil redistribution depth of approximately 27 inches (69 cm) (approximately 14.6 inches, 37 cm of topsoil; 12.4 inches, 31.5 cm of subsoil).

7.3.5 Revegetation

Revegetation will be conducted to stabilize disturbances and restore watershed characteristics, soil productivity and visual resources to be consistent with post operation land use objectives. Revegetation activities will proceed following soil redistribution during interim and / or final closure. Revegetation procedures are described in the following sections.

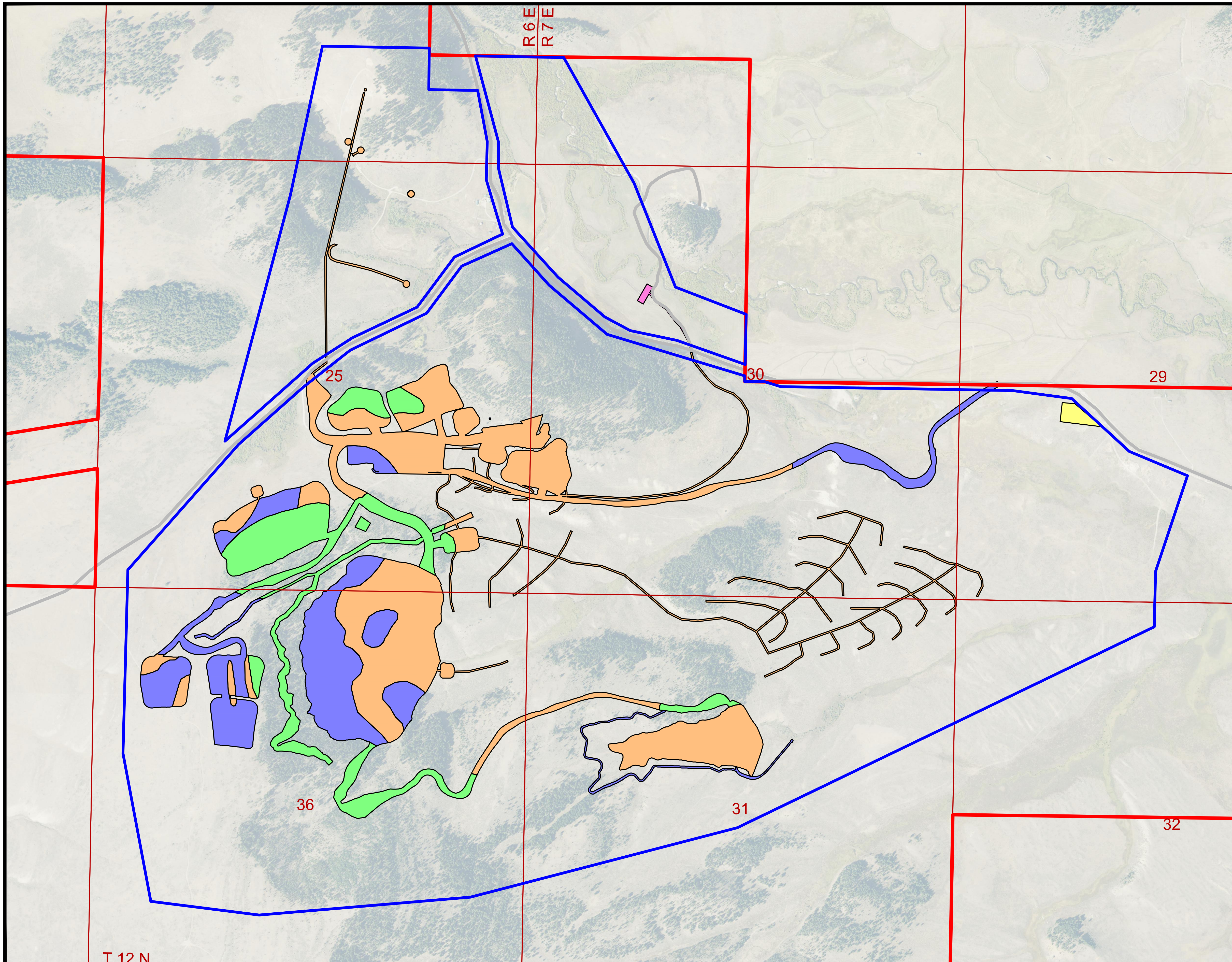
7.3.5.1 Revegetation Mixtures and Rates

Post-mining revegetation is based on an evaluation of baseline vegetation type acreages within the proposed disturbance footprint. Impacted vegetation types primarily include Upland Shrubland; Conifer Forest and Woodland; Upland Grassland; with minor amounts of Lowland and Altered Grassland, Hay Meadow, Riparian and Wetland), and miscellaneous disturbed areas (Section 2.3.6, Appendix H; Westech 2017b). Vegetation types for reclaimed areas are shown on Figure 7.10.

Tintina proposes to use the three permanent native revegetation mixtures presented in Table 7-6, one Hay Meadow revegetation mix presented in Table 7-7, and one interim vegetation seed mix presented in Table 7-8.

These mixtures were formulated based on pre-mining species composition and anticipated post-mining site conditions (soils, topography, slope, etc.). The species are self-regenerating, and are compatible with other plant, wildlife, and livestock species in the vicinity. The seed mixtures will provide a diverse and permanent plant cover that will effectively stabilize the post-mining soil surface.

Seed that is genotypically and phenotypically adapted to the project area and primarily from within the Northern Rocky Mountains or Great Plains will be used when commercially available in sufficient quantity and of acceptable quality. Seeding rates have been calculated on a Pure Live Seed (PLS) basis. All seed will be documented noxious weed-free. Seed that will be utilized to grow tree tublings will be collected on site and grown in an approved nursery.



TINTINA RESOURCES

Black Butte Copper Project

Revegetation Map

WESTECH ENVIRONMENTAL

Figure 7.10

07/05/17 | BBC17_Reclamation_Rev2.dwg

Table 7-6. Reclamation Seed Mixtures

SPECIES		RECOMMENDED VARIETY	DRILL RATE (Pounds PLS/PLS per Sq. Ft.)		
			UPLAND GRASSLAND	UPLAND SHRUBLAND	CONIFER FOREST AND WOODLAND
GRASSES:					
Agropyron smithii	Western wheatgrass	Rosana	5.00 / 10	2.50 / 5	2.50 / 5
Agropyron spicatum	Bluebunch wheatgrass	Goldar	2.00 / 6	1.00 / 3	1.00 / 3
Agropyron trachycaulum	Slender wheatgrass	Pryor	1.50 / 5	0.75 / 3	0.75 / 3
Festuca idahoensis	Idaho fescue	Nezpurs, Winchester	1.50 / 15	0.75 / 8	0.75 / 8
Festuca campestris	Rough fescue	VNS	2.00 / 9	1.00 / 4	1.00 / 4
Koeleria macrantha	Prairie junegrass	VNS	0.10 / 5	0.05 / 2	0.05 / 2
Oryzopsis hymenoides	Indian ricegrass	Rimrock	3.00 / 10	1.50 / 5	1.50 / 5
Poa secunda	Sandberg's bluegrass	High Plains	0.25 / 6	0.10 / 3	0.10 / 3
Stipa nelsonii	Columbia needlegrass	VNS	3.00 / 10	1.50 / 5	1.50 / 5
	Sub-total Grasses		**18.35 / 76**	**9.15 / 38**	**9.15 / 38**
SHRUBS:			**BROADCAST RATE (Pounds PLS/PLS per Sq. Ft.)**		
Artemisia tridentata	Big sagebrush			2.00 / 115	1.00 / 57
Rosa woodsii	Wood's rose				1.00 / 1
Ribes spp.	Currant				1.00 / 8
Shepherdia canadensis	Canada buffaloberry				1.00 / 1
Symphoricarpos albus	Common snowberry				2.00 / 3
	Sub-total Shrubs			**2.00 / 115**	**6.00 / 70**
		GRASSES AND SHRUBS TOTAL	**18.35 / 76**	**11.15 / 153**	**15.15 / 108**
TREES:			**PLANTING RATE (stems / acre)**		
Juniperus scopulorum	Rocky Mountain juniper				6
Picea engelmannii	Engelmann spruce				4
Pinus contorta	Lodgepole pine				20
Pinus ponderosa	Ponderosa pine				10
Pseudotsuga menziesii	Douglas-fir				120
		TREES TOTAL			**160**
Application rates for grasses are based on drill seeding; rates would be doubled for broadcast seeding.					

Table 7-7. Hay Meadow Revegetation Mix

Species		**Recommended Variety**	**Drill rate (Pounds PLS / PLS per Sq. Ft.)**
			All Sites
Grasses			
Agrostis stolonifera	Redtop	-	0.10 / 15
Alopecurus arundinacea	Bluebunch wheatgrass	Garrison	0.50 / 10
Bromus inermis	Smooth brome	Manchar	2.00 / 6
Schedonorus pratensis	Tall fescue	Alta, Fawn	3.00 / 16
Phleum pratense	Timothy	Climax	0.40 / 12
	Total		**6 / 59**

Table 7-8. Interim Reclamation Seed Mix

Species		**Recommended Variety**	**Drill rate (Pounds PLS / PLS per Sq. Ft.)**
			All Sites
Grasses			
Agropyron smithii	Western wheatgrass	Rosana	10.00 / 20
Agropyron spicatum	Bluebunch wheatgrass	Goldar	4.00 / 12
Agropyron trachycaulum	Slender wheatgrass	Pryor	3.00 / 10
	Total		**17 / 42**

An interim seed mix will be used to reclaim temporary features such as soil stockpiles, berms and roadsides. The interim seed mix could be broadcast, drilled or hydroseeded, depending on site conditions.

Grasses and shrubs will be seeded. In the Upland Shrubland and Conifer Forest and Woodland mixtures, the grass seeding rates will be reduced by 50%. Grasses and shrubs may be seeded together using a broadcast drop seeder, however, where grasses are drill-seeded, they will be applied separately from shrubs to alleviate herbaceous competition and promote the establishment of shrubs. Shrubs will generally be broadcast seeded. The Hay meadow will be drill seeded.

A summary of mine-related disturbances to pre-mine vegetation types and the post-mine reclamation types is provided in Table 7-9.

Table 7-9. Pre-mine Vegetation Type Distrubance and Post-Mine Reclamation Type Acreages

Vegetation Type	***Acres of Disturbance***
11 Total	1.37
12 Total	34.75
21 Total	143.37
22 Total	2.02
31 Total	62.54
42 Total	2.11
43 Total	0.36
51 Total	0.06
52 Total	1.43
53 Total	0.54
54 Total	0.66
31R Total	21.24
53/52 Total	0.04
D Total	1.88
Rd Total	0. 57
Grand Total	**271.94**
Reclamation Type	***Acres of Reclamation***
CFW Total	51.24
D Total	1.87
HM Total	0.84
UG Total	72.40
US Total	145.59
Grand Total	**271.94**

7.3.5.2 Seedbed Preparation and Seeding Method

Seedbed preparation will be conducted immediately after grading and soil redistribution. Ripping will be conducted prior to soil application to reduce compaction beneath liner areas, building sites, and the portion of road surface that will be reclaimed. On slopes exceeding 33%, on sites too narrow to negotiate with equipment, or on sites where organic debris has been re-spread, the soil surface will be left in a roughened condition. Seeding will be coordinated with other reclamation activities to occur as soon after seedbed preparation as possible. Fall seeding is preferred; however, seeding could be conducted during spring and summer as long as soil moisture, climatic, and accessibility conditions are appropriate. When soil moisture conditions are suitable, late summer / early fall seeding (mid-August to mid-October) may be employed. Spring seeding (early April through mid-June) will be practiced if areas are ready for revegetation, climatic conditions are acceptable, and access is possible. Interim revegetation will be implemented to stabilize sites prior to permanent revegetation (e.g., sediment control structures or topsoil/subsoil stockpiles) as soon after their construction as possible.

Both broadcast and drill-seeding will be used. Drill-seeding will be used wherever equipment can safely negotiate the terrain, and will be conducted along the contour wherever possible. Seeding depth will generally be 0.25 to 0.5-inch (0.63 to 1.27 cm). A rangeland drill, broadcast drop seeder, or comparable equipment will be used. Broadcast seeding will be conducted for shrubs, for slopes exceeding 33%, and on areas with high coarse fragment content. Seed will be broadcast manually or using mechanically-operated cyclone-type bucket spreaders or a drop-seeder. On small or hard-to-access sites, hand raking will be used to cover seed. Hydro-seeding may be utilized on a limited basis. If hydroseeding is used, seed, mulch, and tackifier will be applied using the manufacturer's recommended rates and procedures. Hydromulch and tackifier will be applied at a rate to produce a uniform mat on the ground at rates recommended by the manufacturer. Fibers will be dyed to facilitate visual metering.

Cultural treatments that will be practiced to ensure successful revegetation include mulching and re-spreading woody debris. Where used, mulch will be certified noxious weed seed-free cereal grain straw. Straw will be crimped on the contour, or will be dozer-tracked with tracked grousers perpendicular to the slope. If the use of fertilizer is indicated, it will be based on cover soil tests. Application rates will be formulated to achieve soil macronutrient levels capable of promoting plant growth and productivity.

If revegetation problem areas are encountered, the cause will be identified. If the cause appears to be related to soil infertility or toxicity, a soil testing program will be implemented. Appropriate remedial actions will be taken to correct any significant problem identified by DEQ.

7.3.5.3 Tree Planting Rates and Methods

Post-mining tree planting rates are based on pre-mine densities of all size classes of trees on a per-acre basis that will be disturbed, adjusted for an anticipated mortality rate of 50% (Table 7-6).

Tree planting stock will consist of tublings. Trees will be planted on 16.5 foot (5.0 m) centers in Conifer Forest and Woodland revegetation areas (Figure 7.10) at rates specified in Table 7-5.

Planting techniques are summarized below:

- Stock will be kept cool and moist prior to planting,
- Holes will be excavated using shovels and dibble bars or mechanical augers and / or excavators,
- Planting hole will be at least 1.5 times the diameter of the container; hole walls will be roughened,
- Any circling or twisted roots will be loosened and uncoiled,
- The top of the soil / root mass will be positioned so that it is planted even with, or slightly higher than, the soil surface. Taproots will not be bent. Suitable backfill material will be firmly compacted around the root mass, leaving no air pockets,
- A trough or low berm may be shaped around the planting hole to retain water, and
- Trees will be watered immediately after planting.

Trees will be planted concurrently with other reclamation activities, preferably in the fall dormant season.

7.4 Reclamation Schedule

Tintina will initiate final closure reclamation activities within one year of reaching a decision to permanently discontinue mining in the Project area. An extension of the one-year time frame could be requested from DEQ if circumstances are warranted. If additional mining in the vicinity of the Project area is still under consideration, temporary closure of the site will follow the procedure outlined in Section 7.1.2.

Long-term closure of the site is expected to take approximately two to three years, excluding successful long-term revegetation establishment and water quality monitoring. All major facilities have reclamation and closure plans associated with them, as described previously in Section 7.3.3, with the exception of the main Project access road (which will be downsized in closure). The property owners may request surface facilities be transferred to the ranch estate by mutual agreement between the ranch, Tintina, and DEQ. Interim reclamation of soil stockpiles, cut and fill slopes, and other construction-related disturbance will occur during the first appropriate seeding season following construction.

7.5 Bond Release

DEQ is responsible for calculating the amount of performance bond for reclamation of the Project. The purpose of the bond is to ensure the fulfillment of obligations under the MMRA and rules implementing MMRA by ensuring the availability of funds sufficient to perform reclamation in the event of default by the operator. The posting of the financial assurance payable to the State of Montana is a precondition to issuance of a Mine Operating Permit. The amount of the financial assurance is based upon the estimated cost to the State to ensure compliance with the Clean Air Act of Montana, the Montana Water Quality Act, and the MMRA (including the reclamation plan set forth in this Mine Operating Permit Application).

Once the Project is further along in the Application approval process and the document reviewed by DEQ, (all necessary facilities and surface disturbances identified, and a reclamation plan agreed upon) DEQ Hard Rock Section staff will prepare a bond calculation assuming site-wide reclamation, and a closure plan will be executed by a third party contractor under DEQ supervision. Bond levels are reviewed annually during operations, and every five years the bond amount is recalculated and the amount held by the State is supplemented if necessary to ensure that adequate funds area available for closure of the site.

Tintina may request incremental bond release in closure and will request a complete bond release from DEQ once all reclamation activities are deemed complete and sufficient data are available to indicate that final closure objectives have been met.

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9 RESPONSES TO COMMENTS (REVISION 3)

Document Reviewed: DEQ Deficiency #3 060817.pdf	Reviewers Name: Montana Dept. of Environmental Quality	MT DEQ
Third Deficiency Review Comments – Pending Operating Permit 00188 (and cover letter from Herb Rolfes - Operating Permit Section Supervisor- received by Tintina on June 8, 2017		

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3DEQ-1	Section 4.1.7.2 Ventilation Raise Post-Closure Analytical Model	**Summary of Major Concerns:** (1) It would appear that the analytical model presented for the raises would only be valid if hydraulic plugs were to be installed near where each drift intersects a raise. (2) On a map of underground workings proposed to be left open (not backfilled with paste tailings) at closure, please identify the locations of the raises, as well as conceptual locations proposed for hydraulic plugs.	Please refer to the response to comment 3DEQ-7.
3DEQ-2	Section 1.7 List of Other Major Requirements Table 1-4 List of Permits Required, Plans Requiring Submission and Acts for Compliance	**Summary of Major Concerns:** To evaluate the full scope of affects in the Environmental Impact Statement DEQ will prepare, DEQ will need information contained in the application materials of several other permits, for which Tintina will need to apply. Tintina will need to apply for an Air Quality permit, a Public Water Supply permit, and a surface water discharge, or MPDES, permit.	The current status of the required permits listed in this comment are briefly discussed below. Tintina will provide information on each of these permits including permit application documents and progress reports as the work is completed early in the EIS process. **Air Quality Permit:** Bison Engineering has been selected a Tintina' subcontractor charged with preparation of the Air Quality Permit application. Documents have been provided to Bison, work was initiated as of 6/27/2017. **Public Water Supply Permit:** Tintina has completed the initial evaluation of a proposed public water supply well to meet the potable water needs of the Black Butte Copper project. The source of the PWS water is proposed to be from well PW-6 (located on Figure 2.3 in the MOP; and discussed in Section 3.7.1.1 - Potable Water Supply) and completed in the Neihart Formation (quartzite). The projected public water supply needs are based on an estimate of 30 gallons / day / employee. The location of the water supply line for the project are

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3DEQ-2		(The need for an underground Injection Control permit (EPA) may not be needed if a MPDES permit is approved.) The DEQ will also need general information related to the wetlands permit (Army Corps of Engineers) and general information related to progress made in working with the DNRC on water rights issues.	illustrated on Figure 3.43 in the MOP application. At 145 employees per day (day and night shifts) the average flow rate from the PWS well would be about 3 gpm or 4.9 acre*feet/year. Sentences 1 and 2, of paragraph 1, Section 3.7.1.1 – Public Water Supply have been modified (italicized and underlined) to say: "Tintina will supply potable water to the Project <u>*at a rate of about 30 gpm for 145 people per day*</u> for drinking water, showers, and restroom facilities. The average potable water needs for the Project are <u>*therefore approximately*</u> <u>*4,350*</u> ~~3,750~~ gallons (<u>*16,467*</u> ~~14,200~~ L/day) per day (~~2.6~~ <u>*3*</u> gpm, 11.4 Lpm) <u>*or about 4.9 acre*feet per year*</u>." However, the PWS permit application requires final design components of not only the supply portion for the system, but also of the distribution system (including the location of all water distribution lines, faucets, sinks showers, toilets, and drinking fountains, etc.). The final design level drawings of the distribution portion of public water supply system will be conducted as part of the final construction level design drawings which will be completed after the record of decision has been finalized. The PWS permit application cannot be completed until the final design has been completed. Additional information on the PWS application will be provided to DEQ, as it becomes available as necessary for the EIS process. **Surface Water Discharge or MPDES Permit:** Hydrometrics has initiated the process of developing a MPDES permit on behalf of Tintina and has met on several occasions informally with the DEQ Water Protection Bureau. Discussions with the Water Protection Bureau have focused on the refinement of the conceptual model for water quality and quantity for the MPDES permit and specific data needs of the MPDES permit to be provided by Tintina. **Underground Injection Control Permit:** An Underground Injection Control (UIC) permit should not be required if an MPDES permit is issued by the Montana DEQ's Water Protection Bureau. **Clean Water Act Section 404 Permit:** Tintina has submitted a 404 Individual Permit application to the U.S. Army Corps of Engineers (USACE) as well as a 401 Certification to the DEQ through a Joint Application. Tintina received 401 Authorization from DEQ on January 19, 2017. The USACE has completed tribal consultation and is in the final phases of permit review to determine if an Individual Permit will be authorized. As part of tribal consultation, Tintina voluntarily realigned the mine access road crossing at Brush Creek, the buried alluvial conveyance pipeline, and the powerline to avoid a cultural site. This revised stream crossing footprint will result in a slight reduction in impacts (0.01 acres) to wetlands at Brush Creek.

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3DEQ-2			**Water Rights (DNRC) issues:** Tintina will apply for a beneficial use permit for groundwater from the underground mine workings for use in the milling process and the production of cemented tailings paste. Additionally, this permit application will be submitted to identify and propose mitigations to offset water use. Hydrometrics has begun assembling the water right beneficial use permits on behalf of Tintina.
3DEQ-3	Section 2.2.6.3 Easter UIG Tracer Test Appendix B-2 Hydrological Investigation of the Proposed Eastern Upland UIG	Page 65, Section 2.2.6.3, and Appendix B-2 and Response to comment #2DEQ-339: Dye tracer tests in the Eastern UIG area are ongoing and as yet are inconclusive (i.e., no dye has yet been detected at any monitoring point). (1) How long is monitoring for dye detection intended to continue? (2) If the tests remain inconclusive, what further testing, if any, does Tintina propose in order to characterize flow paths from the UIG sites? 82.4.335(k), MCA	1) Monitoring is scheduled to continue through October of 2017 and may be continued through December if dye is not detected at any of the monitoring locations. 2) Tintina and its consultant (Hydrometrics Inc.) disagree that the tracer tests are inconclusive. There are numerous conclusions that can be derived from the tracer test. • Groundwater mounding during the infiltration test is direct evidence that there is a hydrological connection between the infiltration trenches and the groundwater system beneath the Eastern UIG; • The hydraulic conductivity of the aquifer near the water table ranges between 7.5 ft/day and 10 ft/day. • It is highly unlikely that either tracer was entirely lost to degradation or adsorption. Five pounds of fluorescein mixture (75% fluorescein equivalent) and 10 pounds of eosine mixture (75% eosine equivalent) were added to the trenches at concentrations of approximately 90,000 mg/L fluorescein and eosine. • With the established hydrological connection and the amount of dye added to each trench, it can be readily assumed that a portion of the dye made it to the groundwater system. • It may be possible for some of the dye to attenuate in the unsaturated zone and/or degrade if exposed to light; however, the attenuation capacity of the rock would likely be minimal and degradation of light would not occur during night nor once the dye had infiltrated to the ground. • Applying a conservative assumption of 5% recovery of the dye, the tracer testing would still be able to detect if 0.03 gallons (0.6%) or more of the tracer solution

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3DEQ-3			was transported and mixed with Little Sheep Creek at average flows measured in the creek. At high flows (highest measured) the tracer test could detect if about 0.14 gallons (<3%) of the dye transported and mixed with Little Sheep Creek. • The volumes of tracer detectable in Brush Creek and the unnamed tributary would be much lower as the flows in these surface water bodies is less than Little Sheep Creek. • The average linear velocity towards Brush Creek and Little Sheep Creek (LSC) can be calculated based on the estimated hydraulic conductivity of the groundwater system (7.5 to 10 ft. /day in bedrock; assumed 100 ft. /day in LSC Alluvium), gradient (0.06 towards Brush Creek; 0.04 bedrock towards LSC, and 0.03 in alluvium towards LSC), and an assumed effective porosity of 0.1 for the bedrock and 0.25 for the alluvial system. Based on these data, the average travel time to Brush Creek from the infiltration trench is about 5 to 7 months, and to LSC is 9 to 12 months. • It is typical for solutes to arrive at a discharge point much faster than the calculated average linear velocity as the solute travels the path of least resistance and mechanical dispersion effects. Based on this data it is likely that the tracer would have been detected by now in the surface water monitoring sites if the groundwater below the Eastern UIG is in direct connection with the monitored surface water bodies. • The absence of dye at all the surface water monitoring sites is evidence that the groundwater system is not in immediate and direct connection to the surface waters being monitored. Tintina is in the process of evaluating the potential for fluorescein and eosine to attenuate when exposed to the bedrock beneath the Eastern UIG. This information will be used to illustrate the effectiveness of the tracer test in the MPDES mixing analysis.
3DEQ-4	Section 2.7.1 Aquatics Study Area and Methods	Page 112, Section 2.7.1: It is noted that the baseline data and monitoring plan in consultation with the FW&P is to be submitted in the near future. DEQ will review that plan upon submittal and any deficiencies would be noted in the subsequent deficiency letter.	The *Baseline Aquatic Survey and Assessment of Streams Report* was reviewed by Montana Fish, Wildlife and Parks, and their proposed revision recommendations dated April 20, 2017 were incorporated into the Baseline report and included in the MOP application (Revision 2) as Appendix G as presented to the DEQ on May 8, 2017. In addition, Montana Fish, Wildlife and Parks has reviewed *the Draft Plan of Study, Aquatic Monitoring Plan for the Black Butte Copper Project in Upper Sheep Creek Basin in Meagher County Montana* dated April 2017, and provided comments on May 17, 2017. This document

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3DEQ-4		ARM 17.24.116(3)(a)	has been revised and is included in Revision 3 of the MOP Application, as a draft report in Appendix G-1.
3DEQ-5	Section 3.6.1.4 CTF Road	Page 216, Section 3.6.1.4, second paragraph, second sentence, and Response to 2DEQ-155: The response states that waste rock moved to the temporary WRS pad, and later from there to the CTF, is coarse rock. (1) DEQ agrees that coarse waste rock would be transferred from underground to the WRS pad; however, this material would be crushed before being placed in the CTF.	(1) All waste rock mined from underground (including the excavation of the ventilation raise shafts) during the pre-production development mining time period (the first 2 to 3 years of the mine life) and prior to the final construction of the CTF will be transported to and stored on the temporary WRS pad as run-of-mine material (i.e. not crushed or screened). All of the waste rock sourced from the temporary WRS pad will ultimately be transported to and placed into the finished (i.e. HDPE double-lined) CTF as run-of-mine material or crushed sub-grade bedding product. As stated in Table 3-14b sub-grade bedding material placed above the liner (44,000 m^3) in the basin drain of the CTF has been identified as *Tgd*; however, Tintina may alternatively use *Ynl Ex* or preproduction waste rock (these alternatives have been added as a new note under Table 3-14b). The sub-grade bedding layers underlying the CTF HDPE liner and underlying the PWP liner will consist of crushed and screened granodiorite bedrock excavated from the CTF and PWP excavation footprints as shown in Table 3-14b. There could be a short time period from year 2.0 to year 3.0 during the development mining when the waste rock could be directly hauled from the underground mine to the finished CTF again as run-of mine material. All waste rock mined during production mining will be transported from the underground mine and stored as run-of-mine material in the CTF. As stated in the material balance Table 3-14b, only a small quantity of waste rock will be used for the sub-grade bedding layer overlying the HDPE liners for the temporary WRS pad and the copper-enriched rock stockpile that will require screening and crushing. As part of final closure of the temporary WRS pad and the copper-enriched rock stockpile facilities, any waste rock utilized in the construction of these facilities would be transported to the CTF (see the second paragraph of Section 3.6.5.3 (Reclamation of the WRS).

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3DEQ-5			Several places in the revised MOP text as listed below have been edited to emphasize that the waste rock generated from the underground mine (including the ventilation raise shafts) will consist of run-of-mine (ROM) material (not crushed or screened). The fourth sentence in Section 3.6.5.1 (Design Characteristics) has been revised to state (newly added text is underlined and italicized): "Waste rock will be placed on the temporary WRS facility *<u>as run-of-mine material</u>* prior to construction of the CTF, and will require a disturbance footprint of 10.2 acres (4.1 ha) for construction." In addition, the first sentence of the first paragraph in Section 3.6.5.2 (Liner and Seepage Reclaim Water Systems) has been revised to state (newly added text is underlined and italicized): "The waste rock generated during the first two years of mining (453,642 tons or 411,537 tonnes) will be temporarily stockpiled on an HDPE-lined WRS pad *<u>as run-of-mine material</u>*, located west of the mine adit portal pad and north of the mill pad (Figure 1.3 and Figure 3.23)." In addition, the first sentence of the first paragraph in Section 3.6.8.13 (CTF Waste Rock Co-disposal during Operations) has been revised to state (newly added text is underlined and italicized): "Waste rock *<u>(as run-of mine material)</u>* generated from the underground mining operations during the production mining period will be delivered to and stored within the CTF during operations (i.e. occur simultaneously with cemented tailings paste deposition)."
		(2) Depending on the crushing location, the material may be reduced to fine particle size before being transported on the CTF road, potentially making spill clean-up more difficult. Please discuss.	(2) As stated above, waste rock transported from the temporary WRS pad and placed into the CTF will not require crushing; the waste rock placed into the CTF will all be run-of-mine material. As stated in Table 3-14b, sub-grade bedding materials utilized above the HDPE liners in both the temporary WRS pad (20,000 m^3) and the copper-enriched rock stockpile (4,000 m^3) will be sourced from waste rock materials from the temporary WRS pad and will require crushing and screening. The location of the crusher and screen plant will be finalized later during the detailed design stage prior to construction, but would likely be placed on the temporary WRS pad (and/or the copper-enriched rock stockpile pad). If the crusher and screening plant is placed on the WRS pad and/or the copper-enriched rock stockpile, which are the ultimate destinations for the crushed and screened waste rock materials, the hauling distance of the of crushed materials will be significantly short and will therefore minimize any

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3DEQ-5			potential "uncontrolled" release of "fine" waste rock materials onto mine facility roads. Hauling of this crushed and screened material during closure of the WRS pad in years 2 to 3 of the mine operation to the CTF would also include hauling of some amount of fine-grained waste rock generated during initial blasting of the rock and rock that disaggregated during normal weathering of the rock during storage on the waste rock pad or copper-enriched rock stockpile. Transporting of this fine-grained rock would use under-loaded trucks (and possibly truck covers or wetted rock if necessary) to minimize the risk of spreading unwanted fine-grained waste along roadways, and would implement BMPs for roadway maintenance as described elsewhere in the MOP. The same would be true for fine-grained materials on the copper-enriched rock stockpile following the end of production mining and milling.
3DEQ-6	Section 3.6.8.10 CTF Water Reclaim System and Construction Sequence	Page 260, Section 3.6.8.10, ninth and tenth paragraphs, and Response to 2DEQ-236: The response states that it is not necessary to extend the foundation drain system beneath the CTF sump. Therefore, groundwater that collects beneath the lined sump, which is the lowest point in the CTF footprint excavation, would rise to the level at which it can flow out through the foundation drain. (1) If groundwater inflow is encountered during the excavation of this sump, how will this water be extracted in order to install the sump liner system? (2) A similar question can be posed with regard to the PWP sump, although the PWP excavation is not projected to intercept the groundwater table. 82.4.335(k) and (l), MCA	(1) Water encountered during construction will be removed from the sump excavation by digging out a temporary sump adjacent to the reclaim sump, and pumping the water from there. (2) As stated, the groundwater table is not expected to intercept the sump excavation. However in the event that there is some flow into the excavation, the same comments apply as listed above for the CTF.

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3DEQ-7	Section 4.1.7.2 Ventilation Raise Post-Closure Analytical Model	Page 362, Section 4.1.7.2; Figure 4-15, and Response to Comment 2DEQ-77: The analytical model for ventilation raises depicts a vertical shaft only. The ventilation raises would be connected at depth to drifts which, if extensive, would alter the hydrologic effects of the raises. (1) It would appear that the analytical model presented for the raises would only be valid if hydraulic plugs were to be installed near where each drift intersects a raise. (2) On a map of underground workings proposed to be left open (not backfilled with paste tailings) at closure, please identify the locations of the raises, as well as conceptual locations proposed for hydraulic plugs. 82.4.335(m), MCA	(1) The comment is correct in that the analysis is only valid if hydraulic barrier were installed where the drift intersects a raise. However, the closure plan (see Section 7.3.3.5) proposes to plug all four ventilation raises just above where they intersect the *USZ*. The following text has been added to Section 4.1.7.2 as new paragraph 3. *"The ventilation raise analysis assumes that the simulated raise is isolated from the access ramps and is open between the USZ and Ynl A. However, the closure plan proposes to plug all four ventilation raises to separate the USZ and Ynl A as described in Section 7.3.3.5. The hydraulic barriers (plugs or walls) will limit flow through the ventilation raises as simulated in this analysis and the flow of groundwater between the USZ and Ynl A will be similar to pre-mining conditions."* (2) New Figure 7.5 shows all 8 of the hydraulic barriers that will be installed in the 4 ventilation raises. Each ventilation raise will have two hydraulic barriers installed: one near the surface and one just above the top of the UCZ.
3DEQ-8	Section 3.6.10 Soil, Reclamation and Construction	Pages 370 and 557, Section 3.6.10, and Response to Comment 2DEQ-121, Response to Comment 2DEQ-121:	

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3DEQ-8	Material Stockpiles	(1) The response describes two excess reclamation material stockpiles. The "southern" one would store excess material from the CTF and/or the PWP excavation footprints, as well as minor amounts from UIG trench excavations, diversion ditches, and ventilation raise shaft excavations. DEQ notes that the ventilation raises would penetrate the upper sulfide zone. (2) Please clarify what material, if any, from the ventilation raises, would be placed in the reclamation material stockpile, and what procedures would be followed to ensure that no sulfide material or other unsuitable waste is placed into reclamation material stockpiles. ARM 17.24.116(3)(i)	(1) The response to comment 2DEQ-121 was partially in error. The materials excavated from the ventilation raise shafts will either be transported to and stored on the temporary WRS pad (and ultimately placed into the CTF) or directly hauled to the CTF. No underground mined waste rock materials will be placed or stored on any of the reclamation material stockpiles as all underground mine wastes are considered to be potentially acid generating (PAG) rock for purposes of material handling. The rock materials excavated from the ventilation raise shafts are included in the underground mine waste rock tonnages production schedule as described in Tables 3-5 and 3-6 of the MOP Application. The vent raises are excavated in the LOM production schedule (see Tables 3-5 and 3-6 in the MOP Application) as follows: IVL (Year 3), EVU (Year 3), EVL (mostly Year 2; the lowermost raise segment is in Year 3), and IVU (Year 3) – see Figures 3.2 and 3.3 for the names and locations of the 4 vent raises. (2) No excavated materials from the ventilation raise shafts will be placed on the reclamation material stockpiles. The excavated materials from the ventilation raise shafts will either be placed on the temporary WRS pad or directly hauled and stored in the finished CTF depending on the state of completion of the CTF facility. Since all underground mine waste rock is considered to be PAG, no procedures are needed to segregate sulfide-rich mine waste rock prior to placement on the temporary waste rock storage pad or directly into the CTF. All material placed in the reclamation material stockpiles will be sourced from near-surface materials excavated within the mine facility footprint (i.e. *Ynl Ex and Tgd*). These rock units have been significantly sampled and characterized using static multi-element analysis, acid-base accounting (ABA), net acid generation (NAG) potential, and kinetic methods (see Section 2.4.4 – Near-Surface Materials - of the revised MOP and Appendix D-1 – Baseline Environmental Geochemistry Evaluation of Near-Surface Materials). These characterization results indicate that all excavation materials from the proposed mine facility excavation footprints are non-acid generating and have very little potential to release metals. They are thus suitable for use in reclamation and closure of the mine facilities. See Figure 2.19, 2.20 and 2.21. The only sample with anomalous sulfide minerals that plots in the area of uncertainty occurs in bedrock beneath the NCWR (see Figure 2.20 and Figure 2.21) which will not be excavated. There is no need to segregate these materials prior to placement on the reclamation stockpiles, however, a supply of *Tgd* would

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3DEQ-8			likely be retained at the Temporary Construction Stockpile area during operations to be selectively used in closure.
3DEQ-9	Section 4.2.3.3 CTF Facility (Model Calculations and Results)	Page 374, Section 4.2.3.3, second paragraph, first sentence, and Response to Comment 2DEQ-168: The application originally indicated that, immediately prior to cessation of milling, the cement content of paste tailings reporting to the CTF would be increased to 4%, resulting in a "several foot thick" layer of more resistant tailings at the surface. DEQ requested that Tintina state the minimum acceptable thickness of 4% cemented tailings. The text was revised to state that this layer would be "thick enough to support trucks and dozers." This does not clarify what volume of tailings is to be placed in the CTF with 4% cement.	**<u>Closure procedure:</u>** Tintina has stated that the 4% cemented tailings is used for longer-term dust suppression and to assist in the supporting of equipment for closure on top of the cemented paste in order to create a self-draining surface that slopes to the east prior to installation of the HDPE cover. The process of closing the CTF facility would begin by placing 0.5 to 2% cemented tailing on the top of the tailings facility using selective spigot placement for rough leveling of the upper surface. This would be followed by placement of 4% cement cemented tailings on the upper surface to control dust from the tailing facility in closure, and to provide basic support for reclamation vehicle traffic. This surface should be essentially dry and hard. Appropriate equipment will be selected for placement of the reclamation materials prior to closure that might range from high floatation tracked equipment to conventional dozers and trucks. The reclamation materials are typically spread from the perimeter of the facility towards the center in one- to two-foot lifts that also significantly aids in supporting the equipment. Grading and shaping of the upper surface would continue by placement of reclamation materials on top of this 4% cemented surface to create the self-draining surface. Once shaping and grading is complete the sub-grade bedding layer of granodiorite would be placed and the HDPE cover would be welded to the bottom liner system. This would be followed by placement and shaping of the final reclamation cover materials, including soils and revegetation of the facility. Again this surface would be constructed as a self-draining surface that slopes gently (minimum of 0.5%) to the east. Mine plans are typically laid out in multiple years periods with progressively greater detail added to the plan for the current year. So during the last year of the production schedule and prior to closure of the CTF, Tintina would schedule when to start implementing the final cover construction for the CTF. The shape and volume requirements of the 0.5 to 2% cemented paste basin would initially be evaluated, and selective spigotting of tailings would be initiated in advance to acquire a roughly leveled surface. Once this was completed the tailings paste containing 4% cement would be introduced. The following new sentences 2 through 4 (italicized and underlined), have been added to paragraph 2, of Section 4.2.3.3 (CTF Facility). "The CTF facility will be finished with a final lift of 4% cemented paste tailings thick enough to support trucks and dozers to place and spread any required *<u>reclamation fill or</u>* sub-grade bedding material. *<u>Engineers would determine the type of equipment to be used for placement of the reclamation materials on top of the 4%</u>*

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3DEQ-9		How would Tintina know when to increase the cement content in the tailings as final closure approaches in order to achieve the required thickness of 4% cemented tailings? ARM 17.24.116(3)(g)	*cemented tailing, and use this information to determine the thickness of the 4% cement layer required. If they determined that a 1-foot (0.3 m) thick layer of 4% cemented tailings was required to minimize dust from the exposed tailings surface and support the proposed equipment (particularly as this will be overlain by a layer of reclamation materials), this would require approximately 87,291 m^3 of material to be deposited (1-foot, thick layer over 71.9 acres). At an approximate cemented tailings paste dry settled density of 2.0 tonnes per m^3, the total amount of cemented tailings paste material required to construct a one-foot cap layer is estimated at 174,582 tonnes of cemented tailings (or about 3% of the total cemented tailings paste estimated to be placed in the CTF over the LOM). At a production rate of 3,300 tonnes per day through the mill, 88% of which (2,904 tonnes per day) would be tailings (the remaining being concentrate), it would require about 60 days (2 months) of cemented tailings paste production to produce and deposit the 1-foot thick 4% cemented paste tailing layer.*"
3DEQ-10	Section 7.3.3.5 Underground Mine Closure	Page 418, Section 7.3.3.5, first paragraph, second sentence: Prior to initiating underground mine closure, Tintina plans to install two monitoring wells into the underground workings. (1) Please clarify whether these wells would be installed before or after the initiation of mine flooding.	Text in Section 7.3.3.5, first paragraph, second sentence has been (italicized and underlined) to say: ~~Prior to initiating~~ *Early during* underground mine closure, Tintina plans to install two underground groundwater monitoring wells in mined-out zones: one in the *Ynl B* hydro-stratigraphic unit in the Lower Decline above the *VVF* and another in an access drift within the USZ hydro-stratigraphic unit. A new Table 7-2 has been created and placed near Section 7.3.3.5 in the MOP that describes the sequencing of hydraulic barriers (plug or walls) installation; monitor well installation; underground mine flooding, rinsing and treating, and placement of mine reclamation materials as backfill. (1) The monitor well in the *Ynl B* hydrostratigraphic unit would be constructed following placement of the Upper and Lower VVF adit plugs and flooding of the *LSZ*, and prior to flooding, rinsing and treatment of the *Ynl B* hydrostratigraphic unit. See Table 7-2. The monitor well in the *USZ* hydrostratigraphic unit would be constructed in an *USZ* access drift following placement of the lower *USZ* adit plug (labeled "Below U*SZ*" in

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3DEQ-10		(2) Also, please commit to reviewing the distribution of un-backfilled workings at the time of closure and to siting these wells in locations where hydraulic head that develops in these tunnels after water level recovery will not result in mine water rising to surface via the well. 82.4.335(5)(m) and 82.4.226(10), MCA	Table 7-2) and the lower of the four ventilation raise plugs, and prior to flooding, rinsing and treatment of the *USZ* hydrostratigraphic unit. See Table 7-2. (2) Tintina commits to reviewing the distribution of actual un-backfilled workings at the time of closure and to siting these wells in locations where the final hydraulic head that develops in these tunnels after water level recovery will not result in mine water rising to the surface via these wells.
3DEQ-11	Section 7.3.3.5 Underground Mine Closure	Page 419-422, Section 7.3.3.5, paragraphs 4 through 13: (1) The fourth paragraph states that Tintina plans to install five "hydraulic barriers or walls" in the underground workings at closure, as shown on Figure 7.4. (2) The text goes on to describe the locations of four of these. The location of the fifth one is not clear, unless this refers to the lower plug in the southernmost ventilation raise. (3) Figure 7.4 indicates the locations of six barriers, including two within a ventilation raise. (4) Elsewhere (thirteenth paragraph) the text indicates that each ventilation raise will receive "hydraulic plugs or walls set in two places: one above the upper	(1) Yes, Tintina plans to install 5 hydraulic barriers in the underground workings (excluding those installed in the ventilation raises) at closure as shown in revised Figure 7.4 and new Figure 7.5 in the MOP Application document. In addition, there will be one more plug installed at the portal in closure. See comment response to 3DEQ-12 (1) below. (2) The fifth barrier installed in the underground workings will be placed near the interface with the groundwater table and is labeled on the figure as "At GWT". This hydraulic barrier has been added to the revised Figure 7.4 and is also shown in the new Figure 7.5. (3) Figure 7.4 has been revised in the MOP Application (Revision 3) to include 5 hydraulic barriers (plugs) in the underground workings (excluding the eight additional plugs to be installed in the 4 vent raises). This now includes the "At GWT" hydraulic barrier to be installed in the underground workings near the groundwater table interface. (4) New Figure 7.5 shows all 8 of the hydraulic barriers that will be installed in the 4 ventilation raises. Each ventilation raise will have two hydraulic barriers installed: one near the surface and one just above the top of the UCZ.

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3DEQ-11		sulfide zone, and another set of plugs installed near the ground surface." (5) Therefore the total number of proposed "plugs or walls" appears to be 12, including 5 to 8 which may serve as hydraulic barriers, and 4 near-surface plugs intended to support backfill of the upper portions of vent raises. (6) Please clarify the total number of these structures that is proposed and location of each. 82.4.336(10), MCA	(5) and (6) The total number of hydraulic barriers (plugs) to be installed in closure is equal to 14 (see new Figure 7.5 that shows all of them and new Table 7-2 that also lists all of them). Please see response to comment 3DEQ-12 (1) below.
3DEQ-12	Section 7.3.3.5 Underground Mine Closure Appendix M-3 Evaluation of Open Access Ramps and Ventilation Raises in Closure	Page 419-422, Section 7.3.3.5, paragraphs 4 through 13, and Appendix M-3: (1) Please discuss the timing of the installation of "hydraulic barriers or walls" compared with the proposed rinsing of the mine workings during closure.	(1) The timing of the installation of hydraulic barriers (walls or plugs) required for rinsing and treatment of hydrostratigraphic units in the mine workings during closure is discussed in revised text in Section 7.3.3.5 of the MOP. Table 7-2 is a new table listing the sequence of installation of hydraulic barriers, and rinsing treatment and backfilling of the mine workings in closure; Figure 7.4 is a geologic cross-section that illustrates the representative hydraulic barrier locations and has been modified slightly in the MOP application (Revision 3); and Figure 7.5 is a newly added figure in the MOP Application of a cross-section of underground workings (similar to Figure 3.3 in the MOP Application) showing all 14 hydraulic barriers proposed for installation in closure. Sentences 1 through 4 of paragraph 4, Section 7.3.3.5 (Underground Mine Closure) have been modified (added text is italicized and underlined) to say the following): "A total of 14 hydraulic barriers are planned to be installed in closure. Tintina plans to use a combination of five hydraulic barriers *<u>(Table 7-2)</u>* at strategic locations in the main access ramps (Figure 7.4 and Figure 7.5). *<u>Eight additional hydraulic barriers will be installed in the four ventilation raises (an upper and lower barrier in each raise).</u>*

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3DEQ-12		(2) DEQ understands that the Lower VVF plug, the Upper VVF plug, and the "Below USZ plug" would be installed prior to the commencement of rinsing of the underground workings. (3) If any plugs are to be installed in mine workings within the USZ (for example, if plug(s) are determined necessary to control head distribution within lengthy sections of access ramps, as suggested in Appendix M-3, pages 5-6 (Model Limitations), it would appear that any such plugs would need to be installed after rinsing in order that rinsing effectively occurs throughout all voids within the USZ. Please clarify. 82.4.336(10), MCA	<u>*An additional plug will also be installed at the mine portal in closure (see the last two paragraphs of this Section 7.3.3.5 for description)."*</u> *(2)* The Lower VVF plug and the Upper VVF plug, would be installed and the *LSZ* zone flooded before rinsing and treating of water in an overlying flooded *Ynl B* section of the lowered access ramp. However, the plug installed below the *USZ (*"Below USZ plug"), would likely be installed after rinsing and treatment of the *Ynl B* zone (including its segments of ventilation raises), as it will act as the plug retaining water at a sump level for rinsing and treatment of the *USZ. See new Table 7-2.* (3) Tintina does not anticipate that additional hydraulic plugs will be necessary to control head distribution within "lengthy sections of access ramps". The analytical element model illustrates that the increase in head within the access ramp will dissipate in the HSU the ramp is located in and in the overlying HSUs. Although the analytical analysis does have some limitations, the analysis was conducted using conservative assumptions that likely have a greater effect on the modeling analysis than the limitations of the model. The results of the analysis indicate the largest mound at the top of the water table would be less than 0.5 feet. If the limitations of the model result in the mound being an order of magnitude greater (which is a conservative assumption) the water table would still be 25 to 45 feet below the ground surface. Sections 7.3.3.5 (Underground Mine Closure) and Section 7.3.3.6 Underground Mine Closure – Initial Rinsing and Water Treatment) have been modified to describe the placement of hydraulic plugs or walls, and their sequence of installation with respect to rinsing and treatment cycles of the *Ynl B* and *USZ* hydrostratigraphic units in closure (Table 7-2). Hydraulic barrier locations are provided on revised Figures 7.4 and 7.5. If DEQ determines additional plugs are necessary, it would alter how rinsing would be conducted. One possible alternative is to install additional plugs after rinsing as suggested in this comment. Another alternative could be to establish extraction and injection wells within areas that are isolated by the plugs. In addition, Tintina proposes to optimize the effectiveness of the rinsing and resulting removal of sulfide oxidation products early in the mining operations (i.e. trial rinsing runs) which might slightly alter the underground closure plan.

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3DEQ-13	Section 7.3.3.5 Underground Mine Closure	Page 422, Section 7.3.3.5, thirteenth paragraph, ninth sentence, and response to Comment 2DEQ-199: The text indicates that the southernmost ventilation raise "may be relocated based on future geotechnical drilling." (1) When would this drilling be anticipated to occur? (2) Has an alternate location been selected? (3) What geotechnical conditions are preferred for siting the raise?	(1) Ventilation raise pilot hole drilling will be completed once construction financing is in place, a detailed underground mine production schedule has been prepared, and a review of the ventilation plan and precise raise locations has taken place. (2) No, the location is acceptable, and the final location of the currently selected site for the southernmost ventilation raise is likely very close to the area in which it will ultimately be constructed. (3) Ventilation raises are sited to meet the ventilation requirement of the overall mine plan supplying fresh air and exhausting spent air from all of the working levels of the mine. Collar locations are typically sited in areas where the depth to solid bedrock are shallow, minimizing the surface structural and shallow ground support required in the collar area, and where ground water is deep enough to eliminate the risk of future surface discharges from the ventilation raise in closure. Three of the four ventilation raise easily meet all of these requirements. The southeastern most ventilation raise (IVU) as currently located has a depth to solid bedrock of about 62 feet and a depth to groundwater of about 22 feet. Although both of these conditions are acceptable from a constructability, ventilation performance, and risk of discharge to surface water in closure, it is possible that a more desirable location can be located in the same general area that allow for shallower depths to solid bedrock and deeper depths to the groundwater table. Sentences 8 through 10 of paragraph 13, Section 7.3.3.5 (Underground Mine Closure) have been modified (added text is italicized and underlined) to say the following: "The groundwater table in this southernmost ventilation area occurs at an elevation that is about 22 feet *(6.7 m)* below the ground surface *and the depth to solid bedrock is 62 feet (18.9 m). Although both of these conditions are acceptable from a*

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3DEQ-13		(4) What would trigger a decision to relocate? ARM 17.24.116(3)(d)	*constructability, ventilation performance, and risk of discharge to surface water in closure, it is possible that a more desirable location can be located in the same general area that allow for shallower depths to solid bedrock and deeper depths to the groundwater table. This ventilation raise may be relocated based on* a review of the geotechnical characteristics during the final detailed mine design and future geotechnical drilling *of a pilot hole that verifies actual conditions at the site.*" (4) A detailed final review of geotechnical characteristics and ventilation requirements as defined in item 3 above, for the selected ventilation raise site, and a pilot hole that verifies actual conditions at the site.
3DEQ-14	Comment Response 2DEQ-101 Section 3.6.8.2 CTF Foundation Drain System Section 3.6.8.15 Hydrologic Assessment of the CTF	Page 544, Comment Response to #2DEQ-101: The reply states that the proposed CTF foundation drain diversion has the potential to indirectly impact the Brush Creek wetlands downgradient of the CTF. This should be considered as a direct impact if 24,000+/-3,000 gallons of groundwater in a 24 hr cycle is collected through the CTF foundation drain system and sent for treatment. Please address. 82.4.336(10), MCA	The removal of 15 to 19 gpm (24,000 +/- 3,000 gal/day) from the area beneath the CTF does not directly equate to impacts to wetlands downgradient of the CTF. There will still be groundwater flowing in the bedrock beneath the CTF foundation drain; which is available to support the wetlands downgradient of the proposed CTF. Therefore the wetland monitoring plan will evaluate the potential indirect impacts to these wetlands from the CTF foundation drain, and supplemental water will be provided to these downgradient wetlands should a negative effect be observed. Response identical to 3DEQ -20. Please also see response to comments 3DEQ-15.
3DEQ-15	Comment Response 2DEQ-101 Section 3.6.8.2 CTF Foundation Drain System Section 3.6.8.15	Page 544, Comment Response to #2DEQ-101: The comment response states "If the upper reaches of the Brush Creek wetlands are impacted from the CTF foundation drainage being re-routed to collection systems, then water from the NCWR would make up the waters lost from the CTF foundation drain through an infiltration gallery located at the toe of the CTF Foundation Drain Collection Pond.	

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3DEQ-15	Hydrologic Assessment of the CTF	(1) As the foundation drain waters should not be impacted, nor would those waters be used in the mill circuit, please consider routing the CTF foundation drainage system directly to the infiltration gallery.	(1) The foundation drain system is engineered to capture all groundwater beneath the CTF (and PWP) and route this water to the foundation drain ponds. The system serves multiple purposes, the most important of which are: a) to prevent the build-up of hydrostatic head against the bottom liners of these facilities, b) to remove groundwater from beneath the facilities, and c) to capture seepage (if any) from the liner system of these facilities (which is predicted to be negligible). Although it is true that the foundation drain waters are highly unlikely to be geochemically impacted, and redirection of this water directly into the down gradient infiltration gallery below the CTF would eliminate any potential for dewatering of downgradient wetlands and replenishment of these wetland waters by water sourced from the NCWR, it is possible that these waters may contain some limited seepage from the CTF. Because of this possibility, Tintina has taken a conservative approach to the handling of water from the foundation drains and the foundation drain pond. The groundwater from the foundation drain system is proposed under the current mine plan to be collected in the foundation drain pond and pumped from there directly to the water treatment plant (or the PWP if the water plant is down) for treatment and subsequent discharge to the UIGs. Tintina looked at the possibility of acquiring relevant analytical data for the foundation drain ponds to determine the absence of any potential contaminants in a timely enough fashion to allow discharge either directly or in stages into the downgradient CTF UIG, but decided that this action could not consistently be guaranteed to receive these results in time to make decisions as to the routing of these waters. Hence the decision was made to pump water collected in the foundation drain ponds to the water treatment plant. Tintina is open to the DEQ evaluating the water disposal option proposed in their comment here, either during the permitting process or operationally based on actual results of water quality in the foundation drain should Tintina be meeting all discharge requirements. Tintina feels that the monitoring will not show any impact from the facilities but realizes it needs to be proven with a 2 – 4 year monitoring program. At the end on an extended monitoring program approved by the DEQ the water collected should be directed into the upper reaches of Brush creek and not the infiltration gallery. This will return the flow as it was prior to the CTF.

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3DEQ-15		(2) Referencing the MOP (page 398, Section 6.3.6 – Wetlands Monitoring: first paragraph, fifth sentence) please submit the referred to transects. ARM 17.24.115(1)(b)	(2) The location of wetland monitoring plots within and adjacent to the Project are shown in Figure 6.2. Vegetation data was recently collected at these sites. Following collection of vegetation and piezometer well water level data from these sites again in fall, the entire 2017 data set will be compiled and provided to DEQ.
3DEQ-16	Section 6.3.1.1 Proposed New Operational Monitoring of Facility Sites Figure 6.2 Wetland Monitoring Sites	Page 392, Figure 6.2: Sites BB WM3 and BB WM4 in Figure 6.2 (Project Area Monitoring Sites), are shown as two wetland monitoring sites located toward the head of the Brush Creek wetlands area. As there were no other references found for these sites, it is assumed these have not been installed. Please install the monitoring sites and start collecting static water levels in BB WM3 and BB WM4 as soon as possible. 82.4.335(5)(k), MCA	All wetland monitoring sites shown on Figure 6.2, including the sites referenced in this comment, have been established. Four additional reference sites (BB-WMR5 through BB-WMR8) were established in June 2017. With the exception of the new reference sites, all wetland monitoring sites have piezometers installed at the location and are instrumented with transducer data loggers. Piezometers and transducer data loggers will be installed at the four new wetland reference sites in the summer of 2017. The following changes have been made to paragraph 1, Section 6.3.6 of the MOP Application text to clarify the wetland monitoring. *"Wetland monitoring ~~will~~ identif<u>ies</u> indirect impacts, should they occur, and ~~will~~ consist<u>s</u> of monitoring shallow groundwater levels and vegetation conditions at four project area wetlands and ~~two~~ four reference wetlands (Figure 6.2).<u> Baseline wetland monitoring began in 2016. At each of the eight wetlands, vegetation monitoring plots were placed in drier and wetter portions of the wetland to record any changes that could occur under either hydrologic condition. In total, there are eight plots monitored at four wetlands within the project area, and eight plots monitored at four wetlands within the reference area. As of June 2017, all monitoring plots have been established and vegetation has been monitored; piezometers have been installed at all sites except BB-WMR5 through BB-WMR8. Piezometers and transducer data loggers will be installed at these remaining four sites in the summer of 2017 to provide continuous water level data in the wetland areas. </u>Existing wetland piezometers will continue to be monitored <u>throughout the life of the mine</u>. ~~Five new piezometers (included in Table 6-1) will also be installed to monitor groundwater levels in the wetland areas;~~* <u>W</u>ater level changes in the project area will be compared to other wetland water levels in the area and the water level changes at the reference sites to determine if impacts to groundwater are associated with mine dewatering or other seasonal or regional trends."

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3DEQ-17	Response to 2DEQ-127	Page 560, Response to Comment #2DEQ-127, last bullet: Please see the comment on page 544 2DEQ-101 above. The last bullet in the Response to Comment #2DEQ-127 relates to the generalized site water management plan and states: "Water from the CTF foundation drain pond will be pumped directly to the water treatment plant, unless the plant is down in which case it will be directed to the PWP."	Please see response to comment 3DEQ-15 above.
3DEQ-18	Response to 2DEQ-143 (3) Section 3.7.3.6 Water Treatment for the Operational Phase	Page 572, Response to Comment #2DEQ-143 (3): "More clarification is needed about the proposed dilution of the brine in the mill, how much of the brine could actually be used in the cement, and whether the resulting salt load going into the cement will have any adverse effect on backfill strength and stability (see related comments)." The reply states that when brine is disposed in the Tailings Paste Plant thickener, the ratio of brine to tailings would be small and that the salt load in the cemented tailings would have negligible impacts on both tailings processing and the backfill strength/stability. To the extent possible, please quantify or be more specific on salt impacts in the cemented tailings and backfill strength/stability. ARM 17.24.115(1)(i)	The total dissolved salt (TDS) concentration of the feed water to the water treatment plant is about 990 mg/L and the flow is estimated to be 588 gpm. This represents a total solids load of about 3.49 dry tons per day. The discharge of treated water to the UIG system is 402 gpm and estimated to contain 163 mg/L of TDS, which equates to 0.39 dry tons/day of solids. Assuming that the difference between the total solids going to the water treatment plant and that which gets discharged (3.49 tons/day minus 0.39 tons/day = 3.1 tons/day) remains in the RO brine and ultimately ends up in the Paste Thickener, this mass of solids would represent only a small fraction (about 1%) of the total tonnage of tailings (with no added cement) going to the paste plant (3,197 tons per day). Consequently, this amount of additional salt will have negligible impact on the tailings process. In addition, there will be no significant issues related to cemented paste backfill strength and stability with less than 1% salt solid mass (TDS) added to the mix. Strength and stability are major concerns for the underground mining method, should any issues be identified they can be compensated for by adjusting the amount of cement added to the paste production process.

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3DEQ-19	Response to 2DEQ-151 Section 3.7.4.1 Upland Underground Infiltration Galleries	Page 577, Response to Comment 2DEQ-151: The reply states that. "The RO effluent will be buffered and be very similar to rain water; therefore any leaching from the UIGs should be similar to existing leachate as precipitation infiltrates through the unsaturated zone." While it is noted a MPDES permit would be applied for, given the volume of RO treated water when compared to rain precipitation, would these large amounts of buffered water alter the ground chemistry? 82.4.336(10), MCA	If any effect on groundwater were observed at all, it would be local dilution of groundwater. RO effluent will be buffered via reaction with calcium carbonate in a trickling filter prior to discharge. The resulting pH would be approximately 8 in water open to the atmosphere. This water will also contain dissolved calcium and carbonate, with some resulting alkalinity that reduces its capacity to scavenge solutes from the bedrock below the drain. The chemistry of RO treated water was predicted by AMEC, 2017 (see Appendix V). This water would react with bedrock minerals as it equilibrates during infiltration. In contrast, rainwater is a weak acid (pH 5.5) which contains no solutes; as it infiltrates into the confined groundwater, it would also equilibrate with minerals in bedrock, achieving a measured pH ranging from approximately 6.2 - 7.3, as is reported for monitored groundwater in Appendix B. The introduction of larger amounts of buffered water would not be expected to change the equilibrium groundwater chemistry associated with rain water infiltration, apart from locally diluting the more acidic, confined groundwater. Any infiltrating water, whether natural rainwater or buffered RO permeate, will react with minerals in bedrock where it is disturbed by construction of the UIG. Both groundwater and rainwater would contain some oxygen, which would be depleted via reaction with sulfides, organic carbon, and aerobic microbial metabolism during infiltration. The influence of any infiltrated oxygen on leaching can be conservatively represented by the aerobic leaching of rock with deionized water in the humidity cell tests. Enviromin has HCT tested the oxidized, sulfide- and metal-depleted, surface-exposed *Ynl Ex* and *Tgd* rock. These data were used to predict groundwater chemistry below the UIG in an analytical model presented by Enviromin in Appendix N-3 (Enviromin, 2017e). Although the deionized water used to leach rock is chemically more similar to rainwater than it is to the buffered RO effluent that will be discharged, as it has a greater capacity to scavenge solutes, HCT data were scaled to the lower reactive mass of rock exposed in the floor and lower walls of the UIG and the relatively higher volume of water discharged to the UIG. Much like rainwater, with its low solute content, the buffered RO permeate will equilibrate with bedrock, acquiring a small mass of solutes as it transits the disturbed and oxidized infiltration gallery. Given the relatively low reactive mass, and the greater volume of discharged water, the predicted solution concentrations are low, and predictably, meet both surface and groundwater non-degradation standards under all cases and in all sensitivity scenarios (See Table 1 in Appendix N-3 in the MOP Application).

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3DEQ-19			Additional information on the Upland UIG discharge will be provided in the MPDES for the MEPA cumulative impacts analysis. A new summary Section 4.2.4 (Underground Infiltration Galleries) has been added to the MOP and a new Appendix N-3 has been added to the MOP Appendices (Enviromin, 2017e) describing these relations.
3DEQ-20	Response to 2DEQ-157 Section 4.1.6.1 Introduction (Summary of Groundwater Numerical Modeling Assessment)	Page 583, Response to Comment #2DEQ-157: Please see comments above (#3DEQ-14 and #3DEQ-15) on page 544 that refers to the Response to Comment #2DEQ-101 above.	The removal of 15 to 19 gpm (24,000 +/- 3,000 gal/day) from the area beneath the CTF does not directly equate to impacts to wetlands downgradient of the CTF. There will still be groundwater flowing in the bedrock beneath the CTF foundation drain; which is available to support the wetlands downgradient of the proposed CTF. Therefore the wetland monitoring plan will evaluate the potential indirect impacts to these wetlands from the CTF foundation drain, and supplemental water will be provided to these downgradient wetlands should a negative effect be observed. Please also see response to comments 3DEQ-14 and 3DEQ-15.
3DEQ-21	Response to 2DEQ-248 Section 3.4.1 Overview and Disturbance Areas	Page 655, Response to Comment #2DEQ-248: DEQ requested "Please commit to post or mark all disturbance boundaries." Tintina responded that proposed surface disturbances have not been "marked" on the design drawings…" This is a misunderstanding of DEQ's request, which was intended to recommend that proposed disturbance boundaries be physically marked in the field prior to construction in order to prevent inadvertent disturbance of lands that do not need to be disturbed for project implementation. Please address. ARM 17.24.116(3)(u)	Marking of disturbance area boundaries or limits is standard industry practice on most construction sites to prevent inadvertent disturbance of land surfaces that should not be impacted during project implementation. The following sentences have been added as a new fourth-to-last paragraph (text italicized and underlined below) in Section 3.7.6.1 (Specific Construction BMPs) that states "*Tintina commits to marking by flagging and / or staking all disturbance boundary limits for construction of surface facilities to prevent inadvertent disturbance of land surfaces that should not be impacted during project implementation. In addition, silt fencing could be installed around most disturbance area boundaries during the earliest phase of construction to eliminate sediment transport off of disturbed sites and would serve as an additional marker of disturbance area boundaries*." The following text is also added as a new 4th sentence, in paragraph 1, of Section 3.4.1 (General Construction: Overview and Disturbance Acres) that states:

<table>
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<tr><td>3DEQ-21</td><td></td><td></td><td>"In addition, Tintina commits to marking by flagging and / or staking all disturbance boundary limits for construction of surface facilities to prevent inadvertent disturbance of land surfaces that should not be impacted during project implementation."</td></tr>
<tr><td>3DEQ-22</td><td>Appendix N Water Quality Modeling Report: Section 4.6: Water Quality at Closure</td><td>Page 734, Section 9.0, Response to Comment #2DEQ-350:

Clarifying DEQ's initial comment about water quality at closure in Appendix N: The cited section was just one instance in the document where the carbonaceous Ynl shale is proposed to act as a potential oxygen sink, thus limiting sulfide oxidation.

However, the data provided in the response are related to measured carbonate content, which is already oxidized, and would not serve the same function.

Are there any organic carbon data available to support this assumption?

82.4.335(5)(k), MCA</td><td>Enviromin Inc, has recently analyzed the total organic carbon (TOC) content of several waste rock composites from Tintina Montana's Black Butte Copper deposit, to support observations of organic carbon made in hand specimen (See new Appendix N-2). Organic carbon was identified in Appendix N (Section 4.6) as one of three possible sinks of oxygen from infiltrating groundwater, which is likely consumed via (1) aerobic microbial metabolism, (2) oxidation of sulfide minerals and (3) reaction with available organic carbon (DEQ, 2017). Further, in situ measurements of dissolved oxygen in site groundwater support its depletion with depth (see Appendix B).

Results of LECO analyses of TOC in waste rock analyzed by Enviromin are compared with values from published literature (Lyons et al., 2000) in the table below.

<table>
<tr><th>SAMPLE ID</th><th>TOC (weight %)</th></tr>
<tr><td>2012 Ynl A</td><td>0.81</td></tr>
<tr><td>2015 USZ</td><td>0.41</td></tr>
<tr><td>2015 Ynl B</td><td>0.5</td></tr>
<tr><td>2015 LZ FW</td><td>0.39</td></tr>
<tr><td>2016 Ynl Ex</td><td>0.3</td></tr>
<tr><td>Lyons et al. (2000)*</td><td>0.13-3.39</td></tr>
</table>

* Range of values for samples collected at Tintina's Black Butte Copper Project site, averaging 1.30 % as reported by Lyons et al. (2000).

The results reported by Lyons et. al. are comparable to the values measured in the Enviromin composites and support the hand specimen observations of organic carbon in these sediments. A new memo describing these test results has been added as Appendix N-2.

This information was added to the MOP Application as a new Section 2.4.2.3 (Total Organic Carbon Analyses of Waste Rock Composites).</td></tr>
</table>

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3DEQ-23	Section 9.0: Response to Comment 2DEQ-351	Page 734, Section 9.0, Response to Comment #2DEQ-351: "Two additional samples from PW-10 show similar water quality compared to the initial results from this well. Where there are deviations, the trace constituents were greater in the initial sampling than the subsequent quarterly monitoring samples." DEQ notes that there are many similarities between the PW-10 samples (now N=3), but some constituents were measured at equal or greater concentrations in the 2016 samples (As, Ni, Sr, Zn). The lower HSUs are estimated to produce >20% of the flow during year 6, but the groundwater input data for those HSUs are based on the one Ynl B-UA sample from 2015 (Appendix N, Table 4-1 and sub-Appendix E). The concentrations of Al, Mo, Sb, and Zn measured in PW-7 (2014 and 2015) appear to be higher than those from PW-10, which were often below detection. Would inclusion of more recent background concentrations from PW-10 (or potentially PW-7) significantly change the model results or calculations for non-degradation criteria? 82.4.335(5)(k), MCA	The water quality from the additional samples would not significantly affect the calculations for the non-degradation criteria or the modeling results as the differences in water quality are minor.
3DEQ-24	Appendix B-2 Hydrological Investigation of the Proposed	Appendix B-2, Page 2-5, Section 2.4, paragraph 1, last sentence: (1) Tracer monitoring is ongoing, but considering the conductivity values	1) Tintina agrees that it is unlikely that the dyes would be detected at the closest surface water sites (Brush Creek and the Unnamed tributary) in the future. Average potential velocity toward Brush Creek is estimated at 6 ft. /day. However, solutes will travel at varying rates that are both greater than and less than the average flow rate due to heterogeneities with the aquifer (piping) and mechanical dispersion. It is

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3DEQ-24	Eastern Upland UIG: Section 2.5: Water Quality Sampling and Analyses	reported for the upper aquifer zone (7.5 – 10 feet/day), it seems unlikely that the dyes would be detected at the closest surface water sites (1,000 – 2,500 feet away) in the future, if they have not yet been detected. (2) Have other tracer tests been considered to investigate the potential connection between the UIGs and nearby surface water (i.e. other infiltration points or other chemical tracers)? 82.4.335(5)(k), MCA	not uncommon for heterogeneities and mechanical dispersion to cause the solute to arrive 10 times faster than predicted by the average linear velocity. Based on this information the dye would have reached Brush Creek within 1 to 6 months. 2) The dyes used in the tracer test (fluorescein-color index Acid Yellow 73 and eosine-Acid Red 87) were selected as they are relatively conservative dyes and can be detected at 1.5×10^{-5} to 2.0×10^{-6} mg/L, respectively in water and assuming an accumulation factor of 400 in the carbon packets (typical accumulation factor, per personal communications with Tom Aley with Ozark Underground Laboratory) the detection limit ranges between 1.3×10^{-7} to 6.3×10^{-8} mg/L, respectively. As discussed in response to 3DEQ-3, the amount of dye added to the infiltration trenches was sufficient to detect if 0.03 gallons or more of dye discharges to Little Sheep Creek at average flows even if only 5% of the dye injected was recovered in the samples. It is unlikely that any other tracers could be detected at lower concentrations. Therefore no other tracer tests are planned at this time; however Tintina is in the process of evaluating the potential percent attenuation of fluorescein and eosine when exposed to the bedrock beneath the Eastern UIG. The attenuation potential and final tracer study results will be used in conjunction with other hydrological data in development of the MPDES permit.
3DEQ-25	Appendix B-2 Hydrological Investigation of the Proposed Eastern Upland UIG: Section 3.5: Tracer Monitoring	Appendix B-2, Page 3-7, Section 3.5, paragraph 2, general comment: It seems likely that the eosine and fluorescein tracers traveled past the monitoring wells, prior to mixing with deeper groundwater at the depths of the screened intervals. However, it seems that the rhodamine injected in the screened intervals in MW-14 and MW-15 (56-66 and 70-80 bgs) is also unlikely to appear at any of the surface monitoring sites, if conductivity decreases with depth. Are there any groundwater monitoring points or piezometers in the estimated flowpaths, or further to the north (e.g. near core shack), that could be utilized to confirm that the tracers have	There are multiple possible explanations for why the dye was not detected in the monitoring wells. The explanation provided in the comment is one possible flow path of the tracer that was infiltrated in the two trenches. It is also possible that the dye was transported through a preferential flow path that was not in line with the monitoring wells. It is true that the permeability of the bedrock within the screen interval of the wells is likely too low for the tracer to transport a significant distance from the wells in a reasonable timeframe. There are not any groundwater monitoring points in the estimated flow paths that could be used to sample for the tracers. However, it is highly unlikely that either tracer was entirely lost to degradation or adsorption as suggested in the comment. Five pounds of fluorescein mixture (75% fluorescein equivalent) and 10 pounds of eosine mixture (75% eosine equivalent) were added to the trenches at concentrations of approximately 90,000 mg/L fluorescein and eosine. Although there is a potential for fluorescein and eosine to attenuate, the amount of dye added to the trenches was based on the potential for adsorption and/or

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3DEQ-25		not been entirely lost to degradation or adsorption? 82.4.335(5)(k), MCA	degradation. Degradation of dyes can occur when exposed to light; however the potential discharge of dye to surface water would likely take days if not longer. This would result in the dye discharging during periods of low to no light and would be adsorbed by the activated carbon sample packets prior to light exposure. Based on the concentrations added to the trenches and knowing that some of the discharge to surface water would occur in night hours and the dye would not degrade during that time, it is not a reasonable assumption that the tracers were entirely lost to degradation or adsorption.
3DEQ-26	Appendix B-2 Hydrological Investigation of the Proposed Eastern Upland UIG: Section 4.0: Summary of Results	Appendix B-2, Page 4-1, Section 4.0, paragraph 2, last sentence: (1) "The lack of tracer at any of the sites suggests that water infiltrated in the vicinity of the eastern UIG is not in immediate and direct connection to adjacent surface water." This is one possible interpretation for the absence of tracers at any of the monitoring sites. Besides the mounding noted in MW-14 and MW-15 (dissipated within 1 month) there is little indication that the infiltrated water or tracers migrated a significant distance from the infiltration points. (2) Another explanation for the absence of tracers in surface water could be the adsorption of the dyes to mineral surfaces, such as the iron oxides that are abundant in the area.	(1) The mounding in MW-14 and MW-15 is direct evidence that there is a hydrologic connection between the trenches and groundwater system beneath the Eastern UIG. The concentration of dye discharged to the infiltration trench and low potential for adsorption of both fluorescein and eosine make it highly likely that sufficient dye reached the groundwater table to be detected in adjacent surface water. Once the dye is discharged to the groundwater system, the transport of the dye can be estimated by basic hydrogeological principals. The average velocity of the shallow bedrock groundwater system beneath the Eastern UIG is estimated at 4 to 6 ft/day (see response to comment 3DEQ-3). These principals should not be ignored in evaluating the results of the tracer test. (2) The article referenced in this 3DEQ comment is based on an optimized treatment technology for removing dyes from textile effluents. Although the dye referenced in the article is called fluorescein it is a different fluorescein than what was used in the tracer test. Please see the attached letter from Tom Aely with Ozark Underground Laboratory for an explanation of the differences in the dye used in the tracer test compared to that used in the article (see new Addendum Letter that has been added as sub-appendix E in Appendix B-2 of the MOP Application – Revision 3, dated July 11, 2017 from Ozark Underground Laboratory). In general, the dye used in the article adheres to fabric whereas the dye used in the tracer test is much more conservative and does not adhere to textiles. Therefore the article referenced in this comment is not relevant to the tracer test.

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3DEQ-26		(3) Some laboratory investigations indicate that while fluorescein adsorption may be slow compared to other dyes, a 30% removal was observed over the scale of a few hours ("Adsorption of Alizarin, Eriochrome Blue Black R, and Fluorescein Using Different Iron Oxides as Adsorbents," Pirillo et al., 2007). (4) Could other conservative chemical species be used for tracers to investigate the potential connection to surface water, aiding in the development of the UIGs and the associated MPDES permit? 82.4.335(5)(k), MCA	In addition, the iron oxides in the referenced article were synthetically derived to provide the largest surface area and activation of the iron compound. It is almost certain that any available iron oxides in the rock matrix would have less surface area available and likely have limited activated areas to attenuate the quantity of fluorescein and eocine that was added to the trenches. 3) Although it is unlikely that iron oxides were capable of 30% adsorption of the fluorescein-Acid Yellow 73, a general mixing analysis can show that very small quantities of dye could be detected in surface water if only 5% of the dye was recovered. With 5% dye recovery the tracer test could detect about 0.03 gallons of dye added to the trenches was discharged to Little Sheep Creek at average flow rates. This is equivalent to 0.6% of the dye added to the system. Please see response to comment #3DEQ-3 for more details. Based on this information the lack of tracer at any of the sites illustrates that the water infiltrated into the trenches has not discharged to surface water. Which is evidence that the groundwater beneath the Eastern UIG is not in immediate and direct connection to adjacent surface water. (4) Although there are other tracers that could be used (e.g., bromide) Tintina does not plan on doing additional tracer tests at this time. Tintina does plan on continuing the tracer monitoring (past December of 2017) and also is looking into conducting tests to evaluate the potential for fluorescein and eosine to adsorb to the bedrock material beneath the Eastern UIG.
3DEQ-27	Section 7.3.5.3 Tree planting Rates and Methods	Editorial Comment: Page 441, Section 7.3.5.3, first paragraph, first sentence: The reference to Table 7-2 appears to be a remnant from the previous application revision. Table 7-2 now displays the cumulative rates of	

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3DEQ-27		sulfate release from HCTs and does not address tree planting or anticipated mortality rates. Should Table 7-5 be referenced here instead?	The commenter is correct, and the table reference (Table 7-2) currently in the text (Revision 2) is incorrect and is revised to Table 7-5 in Revision 3 of this MOP Application.
3DEQ-28	Response to Comment 2DEQ156 Section 3.8.10 Hazardous Materials Disposal	Editorial Comment: Page 583, Response to Comment #DEQ-156 (also page 337, Section 3.8.10, third sentence): Please remove "….inspections by the Montana Department DEQ Waste Management and Remediation Division." Please re-write to state: "inspections by agencies with regulatory authority."	As per DEQ recommendation, sentence 3, paragraph 1, Section 3.8.10 (Hazardous Material Disposal) of the MOP has been revised to state (new words are underlined and italicized): "A Spill Prevention, Control and Countermeasures (SPCC) plan for the Project will be prepared as required for the final operating permit and a copy will be kept onsite and maintained in accordance with applicable EPA requirements prior to initiation of construction at the project site, and made available during regulatory inspections <u>*by agencies with regulatory authority*</u> ~~the Montana DEQ Waste Management and Remediation Division.~~"
3DEQ-29	Response to 2DEQ-167 Appendix N Final Water Quality Modeling Report: Section 8: Conclusions and Recommendations	Editorial Comment: Page 593, Section 9.0, Response to Comment 2DEQ-167: It is noted the typo concerning water quality contributions and flow from the LCZ was corrected in the Application, but not in Appendix N, page 52, Section 8, "UG" bullet point, second sentence. Please confirm that the LCZ has the highest contribution of metals and acidity and not the UCZ (in Section 8 of Appendix N).	This typographical error has been fixed in appendix N and a replacement page number 52 has been provided.
3DEQ-30	See response to Comment 3DEQ-30 continued	Response to Comment #2DEQ-34: Tintina has responded to this and other questions concerning the UIG system by committing to apply for coverage of all proposed mine water	

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3DEQ-30		discharges under an MPDES permit rather than permitting these discharges via the Metal Mine Reclamation Act. Tintina proposes to submit the MPDES permit application shortly after DEQ determines that the MOP application is complete and compliant. Tintina notes that this will "allow for the two permits to be evaluated in the project EIS." While this is true, Tintina will still need to respond to these deficiency questions and provide the DEQ with the information. This can be done by responding to the questions directly.	Tintina has identified a number of responses to comments in Revision 2 of the MOP Application that the DEQ did not believe fully addressed the comments, and for which they stated that the information would be provided at a later date in an application for a MPDES permit rather than under the Metal Mines Reclamation Act. These responses pertained to the following comments: #2DEQ-34, -139, -140, -151, -152, -153, -175, -177, -179, -219, -220, -253, -254, -259, -340, and -341. In addition to the original comment responses provided, these comment responses have been edited to provide additional information (below), where additional information is available.
	See response to Comment 3DEQ-30 continued See response to Comment 3DEQ-30 continued	2DEQ-34, Response item (5): (5) Without more information about the UIGs, regarding flow paths, transit times, and potential connection to surface water, it cannot be assumed that surface water would not be impacted by Ynl Ex leachate, sourced from the UIG.	(5) Hydrometrics has prepared a document entitled Black Butte Copper – Non-degradation Analysis for MPDES Outfalls. This document contains Non-degradation criteria for the Central UIG, Sheep Creek Alluvial Aquifer, and Sheep Creek surface water. In addition this document contains a mixing analysis and calculates Maximum Effluent Concentrations allowable under non-degradation for receiving waters including: Alluvium, Bedrock, Alluvium/Surface Water, and Bedrock/Alluvium/Surface water. This mixing analysis for the different outfalls is reported in a Technical Memorandum (Hydrometrics, 2017d) which is included as new Appendix V-1 in the MOP. The memorandum provides a summary of the general mixing analysis conducted for the MOP; a finalized mixing analysis will be included as part of the MPDES permit following review by the DEQ-WPB. In addition, in response to questions regarding the potential for mobilization of constituents along potential flow paths to surface water following discharge of reverse osmosis treated water into the underground infiltration galleries (UIG), Enviromin has modeled and predicted the chemistry of infiltrated water below the UIG where it encounters groundwater. The conceptual model, relevant test data, various sensitivity scenarios, and results of this modeling are presented in a new

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			Technical Letter to Tintina data dated July 7, 2017 and entitled "*Prediction of Groundwater Quality below Underground Infiltration Galleries, Tintina Black Butte Copper Project*" (Enviromin, 2017e) that is included in Revision 3 of the MOP Application as a new Appendix N-3, and is summarized as a new Section 4.2.4 of the MOP. The study concludes that: Much like rainwater, with its low solute and metal content, the buffered RO permeate will equilibrate with bedrock, acquiring a small mass of solutes as it transits the disturbed and oxidized infiltration gallery. Given the relatively low reactive mass, and the larger volume of discharged high quality water, the predicted solute concentrations are low and, not surprisingly, meet both surface and groundwater non-degradation standards under all cases and in all sensitivity scenarios modeled. The only anticipated impacts to groundwater in the vicinity of the UIGs is dilution resulting in somewhat improved water quality (please see the comment response to 3DEQ-19 above).
	See response to Comment 3DEQ-30 continued	2DEQ-139: Since the polished water would be free of organic matter and nutrients, what affect would long term discharge into the LAD system have on the ground water chemistry?	In addition to the responses to comments previously prepared for comment 2DEQ-139 and presented in Revision 2 of the MOP Application Comment response tables, the following additional comment is added: The only anticipated impacts to groundwater in the vicinity of the UIGs is dilution resulting in somewhat improved water quality. See also response to comment 3DEQ-19. In addition, Enviromin has modeled and predicted the chemistry of infiltrated water below the UIG where it encounters groundwater. The conceptual model, relevant test data, various sensitivity scenarios, and results of this modeling are presented in a new Technical Letter to Tintina data dated July 7, 2017 and entitled "*Prediction of Groundwater Quality below Underground Infiltration Galleries, Tintina Black Butte Copper Project*" (Enviromin, 2017e) that is included in Revision 3 of the MOP Application as a new Appendix N-3, and is summarized as a new Section 4.2.4 of the MOP.
	See response to Comment 3DEQ-30 continued	2DEQ-151: Please consider more tests in the UIG areas to document leaching of existing parameters of concern using deionized water (RO Water and using RO water mixed with buffering compounds (calcium) as proposed. 2DEQ-219:	In addition to the responses to comments previously prepared for comment 2DEQ-151, 2DEQ-219 and 2DEQ-254, and presented in Revision 2 of the MOP Application Comment response tables, the following additional comment is added: Enviromin has modeled and predicted the chemistry of infiltrated water below the UIG where it encounters groundwater. The conceptual model, relevant test data, various sensitivity scenarios, and results of this modeling are presented in a new Technical Letter to Tintina data dated July 7, 2017 and entitled "*Prediction of Groundwater Quality below Underground*

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		Please discuss the potential for parameters to increase over time in the infiltration gallery area with long-term discharge over mine life. With surface applications DEQ has seen increases in salinity; with groundwater percolation there is potential increases in nitrogen compounds, electrical conductivity, SAR, etc. 2DEQ-254: Please discuss the potential for leaching metals from the naturally occurring soils in the UIG. It appears the shallow bedrock may contain some contaminants that could be mobilized by the treated water discharged in the UIG system.	*Infiltration Galleries, Tintina Black Butte Copper Project*" (Enviromin, 2017e) that is included in Revision 3 of the MOP Application as a new Appendix N-3, and is summarized as a new Section 4.2.4 in the MOP. The study concludes that: Much like rainwater, with its low solute and metal content, the buffered RO permeate will equilibrate with bedrock, acquiring a small mass of solutes as it transits the disturbed and oxidized infiltration gallery. Given the relatively low reactive mass, and the larger volume of discharged high quality water, the predicted solute concentrations are low and, not surprisingly, meet both surface and groundwater non-degradation standards under all cases and in all sensitivity scenarios modeled. The only anticipated impacts to groundwater in the vicinity of the UIGs is dilution resulting in somewhat improved water quality.
	See response to Comment 3DEQ-30 continued	2DEQ-152: Given the connection between the alluvium and Sheep Creek, is Tintina proposing to meet non-degradation criteria for groundwater or surface water, for the water discharged into the alluvial infiltration gallery? 2DEQ-259: Please consider a mixing zone below the UIGs to address concerns for groundwater changes over time.	In addition to the responses to comments previously prepared for comment 2DEQ-152 and 2DEQ-259, and presented in Revision 2 of the MOP Application Comment response tables, the following additional comment is added: Hydrometrics has prepared a document entitled Black Butte Copper – Non-degradation Analysis for MPDES Outfalls. This document contains Non-degradation criteria for the Central UIG, Sheep Creek Alluvial Aquifer, and Sheep Creek surface water. In addition this document contains a mixing analysis and calculates Maximum Effluent Concentrations allowable under non-degradation for receiving waters including: Alluvium, Bedrock, Alluvium/Surface Water, and Bedrock/Alluvium/Surface water. This mixing analysis for the different outfalls is reported in a Technical Memorandum (Hydrometrics, 2017d) which is included as new appendix V-1 in the MOP. The memorandum provides a summary of the general mixing analysis conducted for the MOP; a finalized mixing analysis will be included as part of the MPDES permit following review by the DEQ-WPB.
	See response to Comment 3DEQ-30 continued	2DEQ-153: The alluvial infiltration gallery is a new feature in the September 2016 response.	

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	See response to Comment 3DEQ-30 continued	(1) What is the distance from the alluvial infiltration gallery to Sheep Creek? (2) Based upon the reported infiltration rate and groundwater flux through the alluvium, at what distance from the infiltration gallery would water reach Sheep Creek? (3) Does that correspond with the proposed mixing zone length (3,500 feet), and if not how was that figure estimated? (4) Please discuss the components of that mixing analysis, i.e. estimated WTP permeate quality, and baseline data for the receiving alluvial groundwater and nearby surface water.	(1) The proposed alluvial infiltration gallery is located approximately 180 feet from Sheep Creek at its closest distance; however that location is up-gradient of the alluvial system. Sheep Creek is approximately 600 feet north (perpendicular to groundwater flow) of the infiltration gallery. (2) The proposed alluvial infiltration gallery is approximately 3,500 feet from where it is estimated to discharge to Sheep Creek. (3) Yes the 3,500 feet mixing zone is related to the distance between the proposed infiltration gallery and where it is estimated to discharge to Sheep Creek. (4) A preliminary analysis of the proposed MPDES mixing zone analysis was conducted to establish treatment criteria. This analysis has been added as Appendix V-1 and is referenced in Section 3.7.3.3 (second paragraph) as follows: *The estimated non-degradation criteria for the proposed MPDES permit is summarized in Appendix V-1 of the MOP.* Hydrometrics has prepared a document entitled Black Butte Copper – Non-degradation Analysis for MPDES Outfalls. This document contains Non-degradation criteria for the Central UIG, Sheep Creek Alluvial Aquifer, and Sheep Creek surface water. In addition this document contains a mixing analysis and calculates Maximum Effluent Concentrations allowable under non-degradation for receiving waters including: Alluvium, Bedrock, Alluvium/Surface Water, and Bedrock/Alluvium/Surface water. This mixing analysis for the different outfalls is reported in a Technical Memorandum (Hydrometrics, 2017d) which is included as new Appendix V-1 in the MOP. The memorandum provides a summary of the general mixing analysis conducted for the MOP; a finalized mixing analysis will be included as part of the MPDES permit following review by the DEQ-WPB.
	See response to Comment	2DEQ-177: Page 355, first paragraph, last sentence:	

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	3DEQ-30 continued	Please commit to monitor piezometers in the UIG for increases in nitrates, EC, SAR, etc.	In addition to the responses to comments previously prepared for comment 2DEQ-177 and presented in Revision 2 of the MOP Application Comment response tables, the following additional comment is added: Groundwater quality will be monitored from only monitoring wells to determine nitrate concentration in groundwater beneath the UIGs. Please note that the anticipated nitrate concentration from the WTP effluent is well below the groundwater non-degradation level. Piezometers will only be used to monitor water levels as there is not any reasonable expectation that the nitrates, EC, SAR, etc. will exceed groundwater non-degradation criteria.
	See response to Comment 3DEQ-30 continued	2DEQ-179: (1) Without more information about flow paths, infiltration rates, and groundwater transit time, it is difficult to make any conclusions about whether groundwater or surface water quality would be impacted by the UIGs. (2) Even though water treatment discharge would likely meet non-degradation criteria, there is still potential to leach contaminants from the host rock, particularly selenium.	In addition to the responses to comments previously prepared for comment 2DEQ-179 and presented in Revision 2 of the MOP Application Comment response tables, the following additional comment is added: (1) and (2). A preliminary analysis of the proposed MPDES mixing zone analysis (Hydrometrics, 2017d) was conducted to establish treatment criteria. This analysis has been added as Appendix V-1 and is referenced in Section 3.7.3.3 (see previous comment response above to 2DEQ-153). Please also see response to comment #2DEQ-153. *(2)* See also response to comment 3DEQ-19. In addition, Enviromin has modeled and predicted the chemistry of infiltrated water below the UIG where it encounters groundwater. The conceptual model, relevant test data, various sensitivity scenarios, and results of this modeling are presented in a new Technical Letter to Tintina data dated July 7, 2017 and entitled "*Prediction of Groundwater Quality below Underground Infiltration Galleries, Tintina Black Butte Copper Project*" (Enviromin, 2017e) that is included in Revision 3 of the MOP Application as a new Appendix N-3, and is summarized as a new Section 4.2.4 of the MOP.
	See response to Comment 3DEQ-30 continued	2DEQ-220: Please discuss the need for a groundwater mixing zone, the need for additional pump back systems, etc., to prevent exceedances over time in the UIG soils and groundwater.	In addition to the responses to comments previously prepared for comment 2DEQ-219 and presented in Revision 2 of the MOP Application Comment response tables, the following additional comment is added: See also response to comment 3DEQ-19. In addition, Enviromin has modeled and predicted the chemistry of infiltrated water below the UIG where it encounters groundwater. The conceptual model, relevant test data, various sensitivity scenarios, and results of this

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			modeling are presented in a new Technical Letter to Tintina data dated July 7, 2017 and entitled "*Prediction of Groundwater Quality Below Underground Infiltration Galleries, Tintina Black Butte Copper Project*" (Enviromin, 2017e) that is included in Revision 3 of the MOP Application as a new Appendix N-3, and is summarized as a new Section 4.2.4 of the MOP. Hydrometrics has prepared a document entitled Black Butte Copper – Non-degradation Analysis for MPDES Outfalls. This document contains Non-degradation criteria for the Central UIG, Sheep Creek Alluvial Aquifer, and Sheep Creek surface water. In addition this document contains a mixing zone analysis and calculates Maximum Effluent Concentrations allowable under non-degradation for receiving waters including: Alluvium, Bedrock, Alluvium/Surface Water, and Bedrock/Alluvium/Surface water. This mixing analysis for the different outfalls is reported in a Technical Memorandum (Hydrometrics, 2017d) which is included as new Appendix V-1 in the MOP. The memorandum provides a summary of the general mixing analysis conducted for the MOP; a finalized mixing analysis will be included as part of the MPDES permit following review by the DEQ-WPB.
	See response to Comment 3DEQ-30 continued	2DEQ-140, 2DEQ-175, 2DEQ-340, and 2DEQ-341:	The comment responses previously presented for these numbered comments in Revision 2 of the MOP Application are thought to be complete, in spite of citing reliance on the MPDES permitting process for permitting mine discharges. No additional response is provided.
From Geomin	Access road, powerline, stream crossing and buried alluvial MPDES pipeline alignments have been changed	The base map for Figures 1.3 and MAP SHEET 1 (and other underlying MOP figures), and all base maps associated with the MOP appendix figures showing the previously listed features have been revised.	The following MOP Application figures have been revised to include revisions to mine access road over Brush Creek: Figure 1.3 (Facilities site plan), 2.10 (Wetlands delineation and functional assessment map), 2.27 (Cultural resources), 2.28 (Baseline ambient noise measurement locations), 3.1 (Mine permit boundary survey coordinates), 3.18 (Stream crossing culvert plan), 3.43 (Pipeline plan), 3.53 (Plan Map showing viewpoint locations), 3.55 (Viewpoint VP-6 looking southwest from the Sheep Creek county road), 3.58 (Noise contours: construction phase), 3.59 (Noise contours: operational phase), 6.1 (Baseline and proposed new monitoring sites), 7.1 (Post closure topographic map), 7.10 (Revegetation map), all Map Sheets (1 through 6). The following text (underlined and italicized) has been added to sentences 1 through 5 of Section 3.6.1.2 (Main Access Road, and Stream Crossings): "There are two planned creek crossings on the private *<u>mine</u>* access road (Figure 1.3). *<u>The access road crossing on Brush Creek has been relocated for this revision (Revision 3) of the MOP document. As a result of the USACE tribal consultation process and various site visits, Tintina voluntarily moved the access road crossing location on Brush Creek, the nearby buried alluvial conveyance pipeline,</u>*

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From Geomin			*and the nearby proposed powerline to avoid a cultural site (Site 24ME1108; Figure 2.27). This revised crossing location slightly decreased the amount of fill within wetlands (<0.01 acres; <0.004 ha) at the Brush Creek crossing. Tintina Resources has subsequently realigned the proposed access road which now passes 100 feet south of Site 24ME1108 (see Figure 1.3 for new location)."* The following figures in the listed MOP appendices have been revised to include the mine access road re-alignment revision: (1) Appendix D (Baseline Environmental Geochemistry Evaluation of Waste Rock and Tailings) – Figure 1-2 (BBC Project Facility Map – replacement page 4); (2) Appendix D-1 (Near Surface construction materials) - Figure 1-1 (Facility map showing geotechnical drill holes and test pits - replacement page 2); (3) Appendix I (Cultural Resource Inventory) Table of Contents Replacement page I; also need to add NEW Sub-appendix B (added before the SHPO response letters); (4) Appendix J (Baseline Noise Survey Memo) Figure 1 (Project facilities and noise measurement locations - replacement page "10" of the .pdf document); (5) Appendix N (Water Quality Modeling): Figures 1-2 (Project Site Facilities - replacement page 3); (6) Appendix N (Water Quality Modeling): Figures 2-3 (Location of ground water monitoring wells - replacement page 13); (7) Appendix N (Water Quality Modeling): changed the words UCZ in Section 8 ("UG" bullet) with the words LCZ in two places - replacement text report page 52; (8) Appendix O (Weed Mitigation): Figure 2 (Location of Weed populations – replacement page 6); (9) Appendix P (Emergency Response Plan) Figure 2 (Facilities Site Plan - replacement page 3); (10) Appendix P (Emergency Response Plan) Plate 1: (Site Drainage Controls - replacement page 38); and (11) Appendix Q (Tailings Management Alternatives): Figure 3 (Geotechnical Site Investigation Drill hole and Test pit location map - replacement page 12). The following MOP Application figures have been revised to include revisions to the mine access road over Brush Creek: Figure 1.3 (Facilities site plan), 2.10 (Wetlands delineation and functional assessment map), 2.27 (Cultural resources), 2.28 (Baseline ambient noise measurement locations), 3.1 (Mine permit boundary survey coordinates), 3.18 (Stream crossing culvert plan), 3.43 (Pipeline plan), 3.53 (Plan Map showing viewpoint locations), 3.55 (Viewpoint VP-6 looking southwest from the Sheep Creek county road), 3.58 (Noise contours: construction phase), 3.59 (Noise contours: operational phase), 6.1 (Baseline and proposed new monitoring sites), 7.1 (Post closure topographic map), 7.10 (Revegetation map), and all Map Sheets (1 through 6).