KROMONA MINE & MILLSITE

Mount Baker-Snoqualmie National Forest
Snohomish County, Washington

ENGINEERING EVALUATION/ COST ANALYSIS

NOTICE

The comment period for the Kromona Mine & Millsite Engineering Evaluation/Cost Analysis and the Recommended Alternative has been extended to June 20, 2010.

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Mount Baker-Snoqualmie National Forest
Snohomish County, Washington

ENGINEERING EVALUATION/ COST ANALYSIS

November 6, 2009

Prepared For:
U.S. Forest Service, Region 6
10600 NE 51st Circle
Vancouver, Washington 98682

MSE
Millennium Science & Engineering, Inc.

ENGINEERING EVALUATION/COST ANALYSIS

Kromona Mine and Millsite
Mount Baker-Snoqualmie National Forest, Washington

Prepared For:

USDA Forest Service
Gifford Pinchot National Forest
10600 NE 51st Circle
Vancouver, WA 98682

Prepared By:

Millennium Science and Engineering, Inc.
1555 Shoreline Drive, Suite 150
Boise, ID 83702
(208) 345-8292

Principal Author: Michael Puett, P.E., Project Manager

Technical Reviewer: Don Tibbets, E.I.T.

November 2009

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ACRONYMS AND ABBREVIATIONS

μg/L	Microgram per liter
bcy	Bank cubic yard
cfs	Cubic feet per second
gpm	Gallon per minute
lcy	Loose cubic yard
mg/L	Milligram per liter
mg/kg	Milligram per kilogram
sy	Square yard
t $CaCO_3$/kt	Ton calcium carbonate per kiloton of waste
ABA	Acid base accounting
ABP	Acid base potential
ACM	Asbestos containing material
AGP	Acid generating potential
AMSL	Above mean sea level
ANP	Acid neutralizing potential
APA	Abbreviated Preliminary Assessment
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Aboveground storage tank
ATV	All terrain vehicle
BLM	U.S. Bureau of Land Management
BMP	Best management practice
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CES	Cascade Earth Sciences
CFR	Code of Federal Regulations
COI	Contaminant of interest
COPC	Contaminant of potential concern
CPEC	Contaminant of potential ecological concern
CTE	Central tendency exposure
EE/CA	Engineering Evaluation/Cost Analysis
EF	Exposure factor
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
FP S&G	Forest Plan Standards and Guidelines
FR	Forest Road
HDPE	High density polyethylene
HHRA	Human Health Risk Assessment
HI	Hazard index
LRMP	Land and Resource Management Plan
MDC	Maximum detected concentration
MDL	Method detection limit
MFSF	Middle Fork of the South Fork of the Sultan River
MSE	Millennium Science and Engineering, Inc.

ACRONYMS AND ABBREVIATIONS (continued)

MTCA	Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFS	National Forest System
NFSR	North Fork Sultan River
NWFP	Pacific Northwest Forest Plan
NWUE	Northwest Underground Explorations
O&M	Operations and maintenance
PRG	Preliminary Remediation Goal
Q	Risk ratio
RAO	Removal action objective
RCRA	Resource Conservation and Recovery Act
RL	Reporting limit
RME	Reasonable maximum exposure
SFSR	South Fork Sultan River
SHPO	State Historic Preservation Officer
SI	Site Inspection
SPLP	Synthetic precipitation leaching procedure
T&E	Threatened and endangered
TCLP	Toxicity characteristic leaching procedure
TEE	Terrestrial Ecologic Evaluation
TPH	Total petroleum hydrocarbons
UST	Underground storage tank
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology
WDNR	Washington Department of Natural Resources
XRF	X-Ray fluorescence

EXECUTIVE SUMMARY

Millennium Science and Engineering, Inc. (MSE) prepared this Engineering Evaluation/Cost Analysis (EE/CA) for a proposed Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) removal action at the Kromona Mine and Millsite in Western Washington. This inactive copper mine is located on the Mt. Baker-Snoqualmie National Forest, about 10 miles northeast of the town of Sultan (Figure 1). The Site is in a remote area along the Middle Fork of the South Fork (MFSF) of the Sultan River about 3.75 miles upstream of Spada Lake. Accessing the Site is very difficult and requires a 5-mile hike from Olney Pass because of heavy downfall, embankment failures, several washed out culverts, an unstable wooden bridge, and a collapsed bridge across the MFSF.

The scope of removal actions evaluated in this EE/CA focus on:

(1) Eliminating direct contact with high concentrations of hazardous substances, especially arsenic, in the waste rock, soil, and sediment for all receptors;
(2) Reducing or eliminating the migration of contaminants to the environment; and
(3) Improving surface water quality.

As an adjunct to addressing the risks posed by hazardous substance releases through the above removal action objectives (RAO), this EE/CA considers public safety associated with physical hazards at the Site. Cascade Earth Sciences (CES) completed a Site Inspection (SI) of the Kromona Mine in 2005. The Site consists of two separate areas: (1) millsite, and (2) upper workings located on the steep hillside above the millsite about 1,000 feet higher in elevation. The two areas were originally connected via an 1,800-foot-long tramway. The millsite consists of a multi-tiered concrete mill foundation partially covered with partially processed ore, a tailings impoundment, waste rock, an underground storage tank (UST), and petroleum-contaminated soil. The upper workings (or mine) consist of two open adits with water discharge, a large waste rock pile, an aboveground storage tank (AST), and wood and metal debris, including asbestos containing material (ACM). There is also reported to be dynamite inside one of the open adits (Northwest Underground Explorations 2004). Public Site use is moderate and physical hazards at the Site pose a significant public risk.

CES also evaluated potential human health and ecological risks at the Site (CES 2006). The streamlined risk evaluation indicated significant potential risk to both human and ecological receptors at the Site from exposure to high concentrations of metals, particularly arsenic, in the mine waste and soil. Maximum concentrations of arsenic in the mine waste/soil (10,500 milligrams per kilogram [mg/kg]) exceeded human and ecological screening criteria by 525 and 1,500 times, respectively. CES developed a risk-based arsenic cleanup level of 109 mg/kg for soil in the risk evaluation using human health risk equations and site-specific exposure factors to back-calculate values based on acceptable risk levels (CES 2006).

Mine waste (waste rock, tailings, and partially processed ore) at the Site contains high concentrations of hazardous substances, primarily arsenic, and is the primary contaminant source at the Site. Fine-grained materials (i.e., sediment) that may have been deposited in, or migrated to, the MFSF is considered a secondary contaminant source. Surface and groundwater flowing through the mine waste at the millsite are also considered secondary contaminant sources because impairments to surface water quality at the millsite result from direct contact with the mine waste. Removal of the primary contaminant source (i.e. mine waste) or minimizing contact with surface and groundwater should improve surface water quality and reduce metals loading to the MFSF. Therefore, the scope of this removal action focuses on addressing the mine waste, and treatment of surface water at the millsite was not included in the removal scope. If future water quality monitoring indicates that a significant risk from surface water or sediment in MFSF remains, additional removal actions may be necessary. Groundwater is not used for drinking water at the

Site and future use as a drinking source is not anticipated; therefore, treatment of groundwater is also beyond the scope of this removal action.

The primary contaminant at the upper workings is also mine waste. While water discharging from the two open adits exceeds risk-screening criteria, there does not appear to be a significant threat to human health because of the remoteness of the Site, very difficult access to the upper workings, and the presence of more suitable drinking water sources in the area. The adit discharges also do not have a surface water connection to the MFSF and there is minimal ecological risk. Therefore, active treatment of the two adit discharges was eliminated from the scope of this removal action.

Because of the poor condition of the existing access road and significant cost of improvement, two access options were evaluated: (A) rebuilding the road to provide heavy equipment access to the millsite, and (B) accessing the Site via helicopter and minimally improving the road to provide ground support access via all terrain vehicles (ATV). Building a road to the upper workings is infeasible because of the extreme slope, collateral environmental impact, and high costs. Therefore, removal actions at the upper workings assume helicopter access.

Five removal action alternatives were evaluated for the Kromona Mine:

- **Alternative 1** – No Action
- **Alternative 2** – Excavation and Off-Site Disposal of Mill Waste
- **Alternative 3** – On-Site Disposal of Mill Waste via Road
    - Option A – Excavation and Disposal in Repository at Millsite
    - Option B – Excavation and Disposal in Repository along Access Road
    - Option C – Capping in Place
- **Alternative 4** – On-Site Disposal of Mill Waste via Helicopter
    - Option A – Excavation and Disposal in Repository at Millsite
    - Option B – Capping in Place
- **Alternative 5** – Capping Mine Waste in Place (Upper Workings)
    - Option A – Capping in Place, Main Adit Bench
    - Option B – Capping in Place, Entire Bench/Waste Rock Pile

The recommended alternative is a combination of Access Option A and removal action Alternatives 3C and 5A. The existing access road (FR 6110) would be fully reconstructed to provide heavy equipment access to the millsite. A Chinook helicopter would be used to access the upper workings. At the millsite, the UST, petroleum-contaminated soil, and empty drums and debris would be removed and transported off-Site for disposal. Soil from the sump outfall and partially processed ore on the foundation tiers with arsenic concentrations above the risk-based cleanup level of 109 mg/kg would be placed on the tailings impoundment. The tailings impoundment and nearby areas of arsenic-contaminated (>109 mg/kg) soils would be capped in place with an engineered cover consisting of a geocomposite sheet drain covered with 12 inches of growth medium imported from an off-Site source. Two diversion channels would be constructed above millsite to divert stormwater run on and two geocomposite drain trenches would be constructed to intercept and divert groundwater seepage around the capped waste material.

At the upper workings, a certified asbestos removal team would remove the ACM and transport it to an off-Site disposal facility. Dynamite inside the Main Adit would be disposed of by a certified explosives handler. Discharge from the Main Adit and surface drainage above the bench would be diverted around the waste rock to infiltrate in native soils. A bat gate or culvert would be installed in the Main Adit. The AST would be buried on-Site at one end of the bench and the bench would be covered with 2 feet of soil generated from the hillside and northwest end of the bench.

The engineered cap and all disturbed areas would be seeded with a Forest Service approved seed mix and mulched. Trees, brush, and woody debris cleared and stockpiled during the removal action would be placed back over the seeded areas. The access road and temporary bridges would remain in place for post post-removal monitoring.

The recommended removal action would achieve RAOs and attain applicable or relevant and appropriate requirements (ARAR) to the extent practical by eliminating the surface exposure pathway to the mill waste and hazardous materials, minimizing contaminant transport to surface water, and mitigating physical hazards.

The total estimated cost for the recommended alternative is **$1,521,501.**

1.0 INTRODUCTION

Millennium Science and Engineering, Inc. (MSE) was contracted by the United States Department of Agriculture, Forest Service (Forest Service) to perform an Engineering Evaluation/Cost Analysis (EE/CA) for a contemplated non-time critical removal action at the Kromona Mine and Millsite ("the Site") on the Mt. Baker-Snoqualmie National Forest.

- This EE/CA is being performed by the Forest Service under its cleanup authorities (42 USC 9604(a), 7 Code of Federal Regulations (CFR) 2.60(a)(39) and Federal Executive Order 12580). The purpose of this EE/CA is to select an alternative to minimize or eliminate any release or threat of release of a hazardous substance into the environment or impact on public health and welfare as outlined in 40 CFR 300.415(b)(2)(i)-(viii).
- This EE/CA was prepared utilizing the U.S. Environmental Protection Agency (EPA 1993) *"Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA"* and in accordance with the provisions of National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300.415(b)(4)(i).
- The purpose of a removal action is to "abate, prevent, minimize, stabilize, mitigate or eliminate the release or the threat of a release" (40 CFR 300.415). The EE/CA for a removal action is intended to:
  - Satisfy environmental review requirements for removal actions;
  - Satisfy administrative record requirements for documentation of removal action selection; and
  - Provide a framework for evaluating and selecting alternative technologies.
- To meet those purposes, this EE/CA identifies objectives for the removal action and evaluates the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives.
- The primary sources of data used to evaluate Site conditions and to develop removal action alternatives, are the Site Inspection (SI) report prepared by Cascade Earth Sciences (CES 2005), Human Health and Ecological Risk Assessment prepared by CES (2006), and the Abbreviated Preliminary Assessment (APA) prepared by the Forest Service (2003).

2.0 SITE CHARACTERIZATION

A detailed Site characterization is presented in the SI (CES 2005); please refer to that report for more information. The Kromona Mine is located in Snohomish County, approximately 10 miles northeast of the town of Sultan, Washington. The Site is comprised of two separate areas: (1) millsite, and (2) upper workings. A vicinity map is provided in Figure 1, a map showing primary features at the millsite is provided in Figure 2, and a map showing primary features at the upper workings is provided in Figure 3.

- The millsite is located adjacent to the Middle Fork of the South Fork (MFSF) of the Sultan River about 3.75 miles upstream of Spada Lake at an elevation of 2,390 feet above mean sea level (amsl).
  - The millsite covers about 2.8 acres.
  - Features at the millsite consist of:
    - Multi-tiered concrete mill foundation;
    - Sump drain, outfall, and pond;
    - Tailings impoundment;
    - Partially processed ore;
    - An underground storage tank (UST);
    - Petroleum-contaminated soil; and
    - Soils and waste rock with elevated concentrations of several metals.

- The Main Adit and associated waste-rock bench of the upper workings are found on the hillside above the millsite at an elevation of about 3,390 feet amsl.
  - Access to the upper workings is via an overgrown hiking trail that switchbacks up the steep hillside.
  - The upper workings cover about 1.2 acres.
  - Features at the upper workings consist of:
    - Two open adits (Main Adit and Reservoir Adit),
    - One large waste rock pile,
    - Wood and metal debris from collapsed structures,
    - Asbestos containing material (ACM),
    - An aboveground storage tank (AST), and
    - A wooden platform from an aerial tram that connected the upper workings and millsite.
  - The Main Adit is located in the hillside adjacent to the upper workings, and the Reservoir Adit is located in a gulch approximately 600 feet east of and 300 feet in elevation above the Main Adit.
    - Surface drainage from above the upper workings and water discharges from the Main Adit flows through two culverts beneath the upper workings. Both culverts discharge onto the large waste rock pile where the flow infiltrates within a short distance.
    - Water also discharges from the Reservoir Adit and flows down the gulch that is adjacent to the upper workings.

2.1 Surrounding Land Use and Populations

Land uses in area surrounding the Site include minerals prospecting, timber harvesting, and recreational activities such as hiking, swimming, camping, fishing, and hunting. The Site is promoted in the publication *"Discovering Washington's Historic Mines"* (Northwest Underground Explorations [NWUE] 1997); however, public use is limited because of the difficult access and recent collapse of the bridge crossing the MFSF at the Site. The town of Sultan is about 10 miles southwest of the Site and has approximately 4,183 inhabitants (U.S. Census Bureau 2007). There are no known residences within a 4-mile radius of the Site (CES 2005).

2.2 Data Gap Investigation

MSE conducted a reconnaissance of the Site with the Forest Service staff on September 10, 2008. Selected photographs taken during the Site reconnaissance are provided in Appendix A. The estimated mine waste and contaminated soil quantities are presented in bank cubic yards (bcy). In general, the observed Site features were consistent with descriptions presented in the SI report and APA. Observations from the Site reconnaissance are summarized below along with any noted inconsistencies.

- Site access is via foot from Olney Pass along Forest Road (FR) 6110 and requires a 5-mile hike through dense overgrowth and heavy downed timber in places. The access road has been gated at Olney Pass because of embankment failures and unsafe conditions. FR 6110 occupies Washington Department of Natural Resources (WDNR) land from Olney Pass to the Forest Service boundary near the millsite.
  - Culverts at three stream crossings have washed out and there is a 60-foot-long wooden bridge of questionable integrity that spans a 30-foot-deep gorge.
  - A second wooden bridge that formerly spanned the MFSF at the Site has collapsed.
  - There are unstable conditions in several areas along very steep side slopes where the roadbed is narrow and beginning to crack and slough away.
  - According to a reference cited in the SI, tailings were reportedly used to build the road (Western Mining and Industrial News 1956).

- Three shallow (0 to 0.5 feet) soil samples (KM-S-4, KM-S-5, and KM-S-6) were collected from the roadbed during the SI (CES 2005). The samples contained arsenic concentrations ranging from 11 to 56 milligrams per kilogram (mg/kg), and sample KM-S-6 contained the highest concentration (0.449 mg/kg) of mercury detected at the Site. The source of mercury is unknown, appears to be anomalous relative to the other samples, and may be from an off-Site source.
- MSE inspected the roadbed material for the presence of tailings during the Site reconnaissance.
  - The roadbed is heavily vegetated in most areas.
  - Areas of exposed material consisted of a mix of soil and coarse aggregate with rounded grain morphology and color inconsistent with tailings material.
  - No tailings were identified along the access road and no additional soil samples were collected.

- The millsite is located on a bench about 200 to 300 feet upslope of and 100 to 150 feet in elevation above the MFSF along a steep and heavily forested southwest-facing slope. Based on the interpretation of geographic information system (GIS) data and orthographic photographs of the Site, the millsite appears to be above the 100-year flood elevation but may be within the riparian reserve area as defined by the Forest Plan Standards and Guidelines (FP S&G). Additional field measurements are needed to determine the location of the 100-year flood elevation and riparian reserve boundaries in relation to the millsite.
  - The multi-tiered mill occupied a portion of a large, cut-and-fill bench and the steep hillside above it. The millsite and associated features, including the multi-tiered concrete mill foundation, generator shack foundation, UST, and tailings impoundment, are all largely obscured by vegetative growth.
    - There are several small piles of fine, partially processed ore on the lower foundation tiers, and larger piles of coarser material on the middle tiers. According to the SI, there are approximately 130 bcy of fine ore and 135 bcy of coarse ore (CES 2005).
    - The hillside surrounding the mill foundation is heavily vegetated and there is little evidence of spilled ore or waste rock.
  - The SI describes the millsite bench as soil mixed with waste rock and estimates the volume of waste rock to be approximately 7,500 bcy based on an assumed depth of 10 feet over the entire bench, including the tailings impoundment (CES 2005). While there may be residual waste rock, partially processed ore, or contaminated soil around the mill foundation from milling operations, it's unlikely to extend to a depth of 10 feet. It's also unlikely that the bench was constructed of waste rock from the upper workings. It's probable that the bench consists of native cut and fill material that has been contaminated from milling operations.
    - Only a single shallow (0-0.5 feet) soil sample (KM-S-3) was collected from the bench during the SI. The sample contained arsenic at a concentration of 947 mg/kg.
    - During the Site reconnaissance by MSE in September 2008, two additional shallow soil samples (KM-S-4-MSE and KM-S-5-MSE) were collected from the bench and submitted for analysis of total metals. The sample locations are shown on Figures 2 and 3.
      - Both samples were collected from a depth of 0 to 6 inches.
      - In general, metals concentrations were elevated above background levels but significantly lower than in other soil and mine waste samples collected during the SI.
      - Arsenic concentrations ranged from 98.2 to 140 mg/kg.
      - There is likely to be surficial soil contamination at the millsite from ore processing operations; however, additional soil samples should be collected, including samples at depth, to better characterize the millsite soils.
  - The lower mill foundation was flooded to a depth of about 6 to 12 inches. The water flows into a sump that conveys the flow through a culvert under the generator shack foundation and

discharges onto the hillside below the bench. The flow continues down the hillside for about 50 feet to a small pond where it infiltrates into the forest soils (CES 2005).
    - The source of water was unclear but appears to be from shallow groundwater seeping from the toe of the slope along the east side of the bench.
    - There is a saturated area along the toe of the slope that appears to drain to and collect in the lower mill foundation.
  - The tailings impoundment is heavily vegetated and flooded in areas up to 6 inches deep.
    - The tailings dam is also heavily vegetated and ranges in height from 2 to 4 feet.
    - There was evidence of water periodically flowing from the tailings impoundment through a buried pipe that discharges onto the hillside about 40 feet north of the impoundment. No tailings were observed at the pipe outlet.
    - The volume of tailings was estimated in the SI to be about 310 bcy (CES 2005); however, that volume equates to less than 2 feet of tailings over the area of the tailings impoundment, not including the tailings impoundment perimeter berm. Assuming a more conservative overall thickness of 4 feet for the tailings and any impacted underlying soils, and including the perimeter impoundment, MSE estimates the volume to be 730 bcy.
  - A UST is located in dense vegetation about 10 feet from the southwest corner of the generator shack foundation and is identified by a short (~12 inches) standpipe protruding from the ground.
    - The UST is relatively shallow and the depth of soil over the tank ranges from about 3 to 12 inches.
    - The cylindrical steel tank appears to be about 4 feet in diameter and 8 feet long.
    - It is unknown whether the tank is empty.
    - Based on a single shallow (0-0.5 feet) soil sample collected during the SI, soil around the tank contained total petroleum hydrocarbons (TPH) as lube oil at a concentration of 19,200 mg/kg (CES 2005); however, the extent and depth of contamination is unknown.
    - Additional characterization is needed to: (1) determine whether the tank still contains any fluid, (2) identify and quantify any contents, and (3) determine the areal and vertical extent of contaminated soil.
- The upper workings are located on the hillside above the millsite, about 2,000 feet east and 1,000 feet in elevation above the millsite.
  - The upper workings are accessed by going south from the millsite on an old heavily overgrown access road for about 500 feet. An overgrown trail leads east from that point and switchbacks up the steep hillside. The trail terminates at a relatively level cut and fill bench constructed on the hillside. The bench is about 30 feet wide and 200 feet long.
  - The upper workings consist of a large waste rock pile, the Main Adit, an AST, remnants of an aerial tram terminal, and wood and metal debris from collapsed structures. A second adit, the Reservoir Adit, is located in a gulch above the upper workings about 600 feet from and 300 feet above the Main Adit (CES 2005).
    - Wood and metal debris from collapsed structures cover much of the bench. The debris includes pipe and insulation material sampled during the SI and determined to be ACM. The quantity of ACM is unknown.
    - There is an AST at the north end of the bench. The cylindrical steel tank is approximately 4 feet in diameter and 6 feet long. The tank appears to be empty and in relatively good condition. The tank likely stored diesel fuel or heating oil. There was no visible soil staining or other signs of leakage or spillage; however, no soil samples were collected from around the base of the tank during the SI.
      - Additional characterization is needed to: (1) determine whether the tank still contains any fluid, (2) identify and quantify any contents, and (3) characterize the underlying soil.

  - According to the SI, the volume of waste rock at the upper workings was estimated to be about 8,250 bcy (CES 2005).
    - The waste rock pile extends along the full length of the bench and down the steep (~70 percent) slope for about 300 feet. One toe of the waste rock pile extends into an unnamed gulch southeast of the upper workings. The gulch conveys surface flow from the slopes above, including drainage from the Reservoir Adit, which is approximately 600 feet up the gulch from the bench.
  - The Main Adit portal is partially blocked by rock and soil that has sloughed around the opening; however, it's still easily accessible and opens to a well-shored tunnel. Dynamite was reportedly observed in Main Adit during an exploration of the underground workings in October 2004 by members of NWUE. According to a Trip Report posted on their website, several sticks of loose dynamite were observed in the No. 12 raise (NWUE 2004).
  - Water discharging from the Main Adit flows through a 12-inch corrugated metal culvert beneath the debris and discharges onto the waste rock slope. The flow infiltrates within a short distance and there was no evidence of significant flow or erosion in the waste rock at the culvert outlet. During the Site reconnaissance by MSE, the flow was estimated to be about 10 gallons per minute (gpm).
  - A 24-inch corrugated metal culvert intercepts surface drainage from the hillside above the bench, conveys the flow beneath the wood and metal debris, and discharges onto the waste rock slope. During the Site reconnaissance by MSE, the estimated flow was about 10 gpm.
- The Reservoir Adit is located about 600 feet east and 300 feet in elevation above the Main Adit in an unnamed gulch (CES 2005). Water flows from the adit portal and down the unnamed gulch. The extremely steep and rocky gulch becomes an avalanche chute that eventually ends in a coarse rock deposit near the toe of the slope. All surface water flow in the gulch infiltrates into the coarse rock deposit and the channel disappears. The Reservoir Adit was not inspected by MSE during the Site reconnaissance in September 2008; however, according to the SI, flow was estimated to be about 5 gpm (CES 2005).

2.3 Source, Nature and Extent of Contamination

Based on information provided in the SI, the primary contaminants of interest (COI) at the Site include: arsenic, cobalt, copper, lead, mercury, selenium, silver, and zinc. Analytical results of samples collected during the SI indicated concentrations of several COIs were above screening levels in the mine waste/soil, sediment, and surface water. The highest concentrations were found in the mine waste. The analytical results are summarized in Tables 1 through 7 and a summary of the estimated volumes of waste rock, tailings and contaminated soil is provided in Table 8.

Surface water features at the Site do not support a viable fish habitat; however, rainbow trout (*Oncorhynchus mykiss*), a Washington State priority species, have been documented in the receiving stream (MFSF), which flows adjacent to the Site.

The following paragraphs briefly describe, by media type, the source, nature and extent of Site contamination. Refer to the SI (CES 2005) for more detailed information.

__Surface Water__

- A total of 10 surface water samples were collected during the SI: 3 from the MFSF, 2 from the South Fork Sultan River (SFSR), 1 from the North Fork Sultan River (NFSR), 1 from the tailings impoundment, 1 from the sump drain in the mill foundation, 1 from the Main Adit, and 1 from the Reservoir Adit.

- The 10 samples include 1 background sample collected from the MFSF upstream of the Site. Another sample intended to represent background was collected from the NFSR in another drainage upstream of the confluence with MFSF, but is not believed to be representative of the background conditions at the Site because of the significant distance from the Site and presence of other potential sources of contamination upstream in the NFSR. Therefore, because only one sample was used to characterize background conditions at the Site, the reported background concentrations should be considered representative of "apparent background" conditions.
- The concentrations of several COIs were elevated above apparent background levels. The highest concentrations of most COIs were in samples from the tailings impoundment and sump discharge.
- Arsenic, cadmium, copper, lead and mercury were reported as not detected in some samples; however, some of the laboratory reporting limits (RL) were above the screening criteria. These constituents could be present at concentrations above the screening criteria but this cannot be verified using standard laboratory techniques.
- The single background sample from the MFSF had a pH value of 6.4 and a hardness value of 2.98 milligrams per liter (mg/L) calcium carbonate ($CaCO_3$). Arsenic and mercury were both reported as non-detect; however, the RLs were above one or more screening criteria. This indicates that arsenic and mercury could be present at concentrations slightly above the screening criteria. No other COIs exceeded human health or ecological screening criteria. The estimated flow in the MFSF upstream of the Site is 22 cubic feet per second (cfs, CES 2005).
- Downstream surface water samples from the MFSF had a pH value of 6.4, and hardness values ranging from 4.36 to 7.22 mg/L $CaCO_3$. Arsenic exceeded state and federal human health screening criteria. Estimated flow in the MFSF downstream of the Site ranged from 25 to 40 cfs.
- The adit samples both had pH values of 7.5, and hardness values ranging from 8.3 to 27.5 mg/L $CaCO_3$. Two COIs in the Main Adit discharge exceeded ecological screening criteria: arsenic V and copper. Only copper in the Reservoir Adit discharge exceeded ecological screening criteria. Arsenic in both adit discharges exceeded state and federal human health screening criteria. The SI report estimated flows from the Main Adit and Reservoir Adit to be 0.017 cfs and 0.012 cfs, respectively (CES 2005).
- The tailings impoundment sample had a pH value of 7 and a hardness value of 6.75 mg/L $CaCO_3$. Three COIs exceeded ecological screening criteria: arsenic V, barium, and copper. Arsenic also exceeded state and federal human health screening criteria.
- The sump drain sample had a pH value of 6.7 and a hardness value of 8.93 mg/L $CaCO_3$. Three COIs exceeded ecological screening criteria: arsenic V, barium, and copper. Arsenic also exceeded state and federal human health screening criteria. Estimated flow from the sump drain was 0.012 cfs (CES 2005).
- With the exception of arsenic, there was no noticeable change in COI concentrations in samples from MFSF upstream and downstream of the Site. Arsenic increased from non-detect (i.e. < 0.43 microgram per liter [μg/L]) upstream of the Site to 0.476 μg/L immediately downstream of the Site.

<u>**Sediment and Pore Water**</u>

- A total of six sediment and six pore water samples were collected from six of the surface water sample locations during the SI. The sampling locations consisted of one location on the NFSR in another drainage, one background location on the MFSF upstream of the Site, two locations on the MFSF downstream of the Site, and two locations on the SFSR. No sediment or pore water samples were collected from the tailings impoundment, sump drain outfall, or open adits. Because only single background samples of each were collected, the reported background concentrations should be considered representative of "apparent background" conditions.

- Sediment samples results:
  - Two COIs exceeded human health screening criteria: arsenic and chromium. All samples exceeded the EPA Region 9 Industrial Soil Preliminary Remediation Goal (PRG) for arsenic (1.6 mg/kg). Four samples exceeded the Region 9 Industrial Soil PRG for chromium (19 mg/kg), including the background sample, which had the highest concentration at 69.1 mg/kg.
  - Seven COIs exceeded one or more ecological screening criteria: arsenic, cadmium, chromium, copper, nickel, antimony, and zinc. The most notable exceedances were arsenic and copper.
  - With the exception of arsenic, copper, and mercury, COI concentrations in the downstream sediment samples from the MFSF were consistent with or considerably lower than apparent background levels.
- Pore water samples results:
  - No COIs in pore water exceeded ecological screening criteria.
  - pH values ranged from 6.2 to 7.0, and hardness values ranged from 1.93 to 8.14 mg/L $CaCO_3$.
  - With the exception of arsenic and barium, most COI concentrations were consistent with apparent background levels.
- Results of the aquatic habitat survey indicated that there were no apparent impacts to the aquatic habitat in the MFSF immediately downstream of the Site (CES 2005).

Groundwater

- Groundwater conditions at the Site are not well documented and no groundwater samples were collected during the SI.
- No water wells are reportedly located within a 4-mile radius of the Site.
- Groundwater pathway is considered incomplete.
- Groundwater will be addressed indirectly in the consideration of the mine waste and contaminated soils.

Air

- Air quality at the Site has not been characterized and no air samples were collected during the SI. The most likely source of air contamination at the Site is windblown dust particulates from the mine waste piles and ACM at the upper workings.
- The ACM at the upper working is mixed in with other wood and metal debris from the collapsed structures. As the material weathers and breaks down, it may become friable which would increase the inhalation hazard.
- Air pathway is considered complete and potentially significant.

Mine Waste and Soil

- Mine waste at the Site includes partially processed ore, tailings, and waste rock. There is also petroleum-contaminated soil around a UST at the millsite.
- The total estimated volume of mine waste and contaminated soil at the Site is about 16,745 bcy.
- Six background soil samples were collected during the SI. This is a relatively small data set for adequately characterizing background conditions at the Site; therefore, the reported background concentrations should be considered representative of “apparent background” conditions. The results indicated:
  - pH values ranged from 2.9 to 4.2.
  - Two COIs exceeded human health screening criteria: arsenic and chromium.

- 12 COIs exceeded one or more ecological screening criteria: aluminum, arsenic, cadmium, chromium, copper, manganese, mercury, lead, antimony, selenium, vanadium, and zinc. The most notable exceedances were aluminum, copper, and vanadium.
- A total of 26 mine waste and soil samples were collected during the SI:
  - Three soil samples from different locations on the access road;
  - Three soil samples from the location at the sump drain outfall and two locations at the outfall pond;
  - One soil sample from near the UST;
  - One soil sample from the millsite bench surface about 50 feet south of the lower mill foundation;
  - Five tailings samples from three locations in the tailings impoundment;
  - Nine partially processed ore samples from five locations on the multi-tiered mill foundation; and
  - Four waste rock samples from four locations at the upper workings.
- The results indicated:
  - pH values ranged from 4.6 to 7.8.
  - Five COIs exceeded human health screening criteria: arsenic, cadmium, chromium, copper and iron.
  - Seventeen COIs exceeded one or more ecological screening criteria: silver, aluminum, arsenic, barium, cadmium, cobalt, chromium, copper, mercury, manganese, nickel, lead, antimony, selenium, thallium, vanadium, and zinc. The most notable exceedances were silver, aluminum, arsenic, copper, lead, selenium, vanadium and zinc.
  - The soil sample from near the UST contained TPH at 19,200 mg/kg, which is above Washington human health and ecological screening criteria.
- Acid-base accounting (ABA), toxicity characterization leaching procedure (TCLP), and synthetic precipitation leaching procedure (SPLP) tests were conducted on mine waste/soil samples from nine locations: three soil sample locations around the millsite, two tailings sample locations in the tailings impoundment, three partially processed ore sample locations on the mill foundation, and one waste rock sample location at the upper workings. The results indicated the following:
  - Acid generating potential (AGP) values ranged from 0.63 to 75.6 tons of $CaCO_3$ per kiloton of waste (t $CaCO_3$/Kt), and acid neutralization potential (ANP) values ranged from 0.15 to 56.6. Acid-base potential (ABP) values ranged from –71 to 54.
  - The fine partially processed ore on the lower foundation tiers and the soil in the sump outfall pond have minor potential to generate acid; however, the coarse partially processed ore on the middle foundation tiers, and the waste rock and tailings are unlikely to generate acid.
  - None of the samples had TCLP or SPLP results exceeding the Resource Conservation and Recovery Act (RCRA) TCLP disposal limits.

<u>Hazardous Material and Debris</u>

- There are no framed structures at the millsite and only the concrete foundations of the mill and generator shack remain.
  - There is a cylindrical UST (about 4-feet in diameter and 8 feet long) located about 10 feet south of the southwest corner of the generator shack foundation.
    - The tank is believed to have stored diesel fuel or lube oil. The tank is sealed and it unknown whether it still contains any fluid.
    - As discussed above, a soil sample from near the tank contained TPH above Washington screening levels. The sample was collected from near the ground surface (0 to 6 inches); attempts at collecting a sample at depth were unsuccessful (CES 2005).
    - The area is heavily vegetated and the areal extent of contaminated soil appears to be limited to around the tank. The depth of contamination is unknown.

- According to the SI report, there are scattered drums and debris on the hillside below the millsite and around the tram terminal (CES 2005). This was not confirmed during the Site reconnaissance by MSE.
- At the upper workings, the Main Adit bench is covered with wood and metal debris from collapsed structures. The only standing structure is the aerial tram terminal, which consists of a wooden platform that extends out over the waste rock pile.
  - There is a cylindrical AST (about 4-feet in diameter and 8 feet long) located in the northwest corner of the bench. No soil samples were collected from the area around the tank during the SI. The tank was likely used to store diesel fuel for mining operations and is believed to now be empty.
  - Two samples of pipe and insulation were collected during the SI and analyzed for asbestos content.
    - The red insulation tiles were determined to contain 2 percent chrysotile asbestos. The material is scattered in with the wood and metal debris near the north end of the bench.
    - The volume of material and areal extent is unknown and difficult to estimate because the tiles are mixed in with and partially covered by the wood and metal structural debris.

2.4 Risk Assessment Conclusion

CES completed a streamlined human health and ecological risk assessment of the Site in 2006 to evaluate risks associated with exposure to mining-related contaminants at the Site (CES 2006). Results of the streamlined risk assessment indicated significant potential risks to both human and ecological receptors at the Site from exposure to high concentrations of metals in the mine waste and soil. The streamlined risk assessment did not assess human health or ecological risks associated with exposure to petroleum-contaminated soil or asbestos.

2.4.1 Human Health Risk Assessment

The streamlined human health risk assessment (HHRA) concluded there is a carcinogenic risk from exposure to mine waste and surface soils at the Site.

- Two human health contaminants of potential concern (COPC) were identified: arsenic and lead.
  - Arsenic was identified as a COPC in mine waste/surface soils and sediment.
  - Lead was identified as a COPC in surface water.
- Lead was determined not to pose a significant human health risk at the Site because the maximum detected lead concentration (0.0005 mg/L) in surface water is well below EPA's action limit for lead in drinking water (0.015 mg/L).
- The HHRA assessed both non-carcinogenic and carcinogenic health risks at the Site based on recreational use by adult and child receptors for both central tendency exposure (CTE) and reasonable maximum exposure (RME) scenarios.
- The HHRA determined that there were no unacceptable non-carcinogenic risks at the Site.
  - Total non-carcinogenic hazard indices (HI) ranged from 0.05 to 0.4.
- Carcinogenic risks were above Washington Department of Ecology's (WDOE) regulatory standard (WDOE 2001a) of 1E-06, but within EPA's acceptable risk range of 1E-04 to 1E-06 (EPA 1991).
  - Total carcinogenic risk ranged from 2E-06 to 3E-05.
  - Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA generally considers carcinogenic risks to an individual ranging from 1.E-06 to 1.E-04 to be acceptable depending on specific Site and exposure characteristics (EPA 1991).

- The most significant exposure pathway is ingestion of and dermal contact with arsenic in the mine waste.
- Inhalation of particulates from the mine waste/surface soils contributes minimal risk and is considered an insignificant pathway. Ingestion of and dermal contact with sediment and surface water also contribute minimal risk and are considered insignificant pathways.
- The HHRA calculated a risk-based cleanup level of 109 mg/kg and a hot spot concentration of 16,400 mg/kg for arsenic in the mine waste/surface soils.
    - No human health hot spots were identified at the Site.

2.4.2 Ecological Risk Assessment

Results of the streamlined ecological risk assessment (ERA) indicated significant potential risk to ecological receptors at the Site.

- Several contaminants of potential ecological concern (CPEC) were identified at the Site, including aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, zinc, and heavy oil.
- Most CPECS in mine waste/surface soils at the Site exceeded the acceptable risk level (i.e. risk ratio > 1).
    - Terrestrial plants were the most sensitive receptor with a total receptor group risk ratio (Q_{tot}) of 7,960.
    - There was also significant risk to terrestrial invertebrates (Q_{tot} = 821), mammals (Q_{tot} = 547), and birds (Q_{tot} = 227).
    - The most significant risk contributors were iron, arsenic, copper, and aluminum.
- Copper was the only CPEC in surface water that exceeded acceptable risk levels.
    - Copper posed a significant risk (Q = 16) to aquatic life.
    - No CPECs in surface water posed an unacceptable risk to birds (Q_{tot} = 0.003), or mammals (Q_{tot} = 0.02).
- No CPECs exceeded acceptable risk levels in pore water.
- Five CPECs exceeded acceptable risk levels in sediment: arsenic, chromium, copper, nickel, and selenium.
    - Birds and mammals were the most sensitive receptor group with a Q_{tot} of 41. The largest contributors were copper (Q = 14) and selenium (Q = 12).
    - Benthic invertebrates had a Q_{tot} of 18. The largest contributors were arsenic (Q = 5) and copper (Q = 4).
- Several ecological hot spots were identified in mine waste/soil and surface water at the Site. The ERA defined these hot spots as areas where CPEC concentrations exceed both background concentrations and ecological risk screening criteria by a factor of 10 or more (CES 2006).
    - Mine waste/soil ecological hot spots at the Site included:
        - Soil around the sump drain at KM-DS-SS-1,
        - Soil in and around the sump outfall pond (KM-S-1 and KM-S-2),
        - Millsite waste rock and soil (KM-S-3 and KM-S-7),
        - Tailings impoundment (KM-TP-1, KM-TP-2, and KM-TP1-SS1),
        - Partially processed ore (KM-WR-1 through KM-WR-5),
        - Waste rock at the upper workings (KM-WR-2-1 through KM-WR-2-3, KM-TH-1), and
        - Soil at one off-Site location on the access road (KM-S-5).
    - Surface water ecological hot spots at the Site included:
        - Sump drain discharge (KM-DS-SW1),
        - Tailings impoundment (KM-TP1-SW1), and
        - Reservoir Adit discharge (KM-AS2).

- The majority of ecological risk is to localized plants and invertebrates. There is also localized risk to aquatic life at the millsite and near the Reservoir Adit. Birds and mammals are less likely to be impacted because of their broad home range and small area of the waste piles in comparison to more suitable habitat around the Site.
- Results of the aquatic habitat survey by CES during the SI indicated slight differences in invertebrate assemblages at NFSF-01, MFSF-03, and possibly SFRS-02; however, there were no apparent impacts to the MFSF immediately downstream of the Site (CES 2005).
- According to the ERA, no threatened or endangered (T&E) species were observed during the SI (CES 2006); however, Townsend's big-eared bats (*Coryhorhinus townsendii*), which are a state candidate species and a federal species of concern, may inhabit the open adits. A biological survey should be conducted to determine whether those species inhabit the open adits and a Forest Service Biologist should be consulted to determine whether protective measures need to be taken if these sensitive species are present on-Site.
    - Red-legged frogs (*Rana aurora*), which are a Forest Service sensitive species, were observed in pooled water at the millsite.
    - Rainbow trout (*Oncorhynchus mykiss*), which are a state priority species, are expected to inhabit the MFSF.
    - While no other T&E species are expected to inhabit the Site, federal species of concern may be found in the region, including the western toad (*Bufo boreas*), northern goshawk (*Accipiter gentilis*), and pileated woodpecker (*Dryocopus pileatus*).

2.4.3 Physical Hazards

Physical hazards at the Site include:

- Two open adits;
- Washed out culverts, unstable and collapsed bridges, and embankment failures along the access road;
- Miscellaneous debris.

<u>Adits</u>

- The Main Adit is located at the upper workings (Figure 3).
    - Sloughed rock and soil partially block the adit portal; however, the approximately 5.5 feet wide by 6.5 feet high, shored adit portal is easily entered.
    - NWUE members compiled a detailed description of the underground workings, including photographs, that is available online at: http://nwue.org/archives/2004/10/kromona_mine_tr_3.html.
        - NWUE members identified several sticks of loose dynamite in the No. 12 raise (NWUE 2004).
- The Reservoir Adit is located about 600 feet east and 300 feet above the upper workings in an unnamed gulch.
    - Based on a photograph of the adit portal in the SI report (CES 2005), the portal appears to be in sound condition and large enough for entry (approximately 5-feet wide by 7-feet high).
    - A Bureau of Land Management (BLM) mineral survey for the Kromona Mine (BLM 1952) shows the Reservoir Adit to be only about 50 feet in length with one short (~20 feet) lateral.

<u>Access Road</u>

- The access road is gated at Olney Pass because of embankment failures and unsafe conditions. Heavy timber windfall, washed out culverts, an unstable wooden bridge, and a collapsed bridge also prevent vehicular access.

- There are unstable conditions in areas along very steep side slopes where the roadbed is narrow and beginning to crack and slough away.

Miscellaneous Debris

- There is miscellaneous debris scattered at the millsite and upper workings.
  - The millsite reportedly has scattered drums and debris on the hillside below the millsite bench and around the tram terminal (CES 2005).
  - At the upper workings, the bench is covered with wood and metal debris from collapsed structures. The debris includes hazardous red insulation tiles that contain asbestos. There is also an unstable wooden platform that served as the upper terminal of the aerial tram. The platform extends out from the bench and over the steep waste rock pile, and is at risk of collapsing down the steep slope.

2.5 Sensitive Environments

Sensitive environments at or in close proximity to the Site include wetlands along the North and South Forks of the Sultan River (CES 2005). Potential wetlands may also be present along the MFSF and near the Reservoir Adit discharge. Sensitive animal species that may inhabit the Site include numerous federal and state rare, threatened, or endangered (RTE) mammals, birds, and herpetiles that have potential habitat in vicinity of the Site. Rainbow trout, a Washington priority species, may also inhabit the MFSF. Sensitive species observed at the Site by CES during the SI include the Columbia blacktailed deer and red-legged frog. A complete list of the observed, expected, or possible RTE species at the Site is available in the SI (CES 2005).

3.0 SITE CLEANUP CRITERIA

There are two general types of cleanup criteria:

(1) Applicable or Relevant and Appropriate Requirements (ARAR), and
(2) Risk-based cleanup criteria developed from human health risk equations using acceptable risk levels and site-specific factors.

ARARs are “applicable” or “relevant and appropriate” federal and state environmental requirements. Applicable requirements include cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal or state laws that apply to hazardous substances and removal actions at the Site. Relevant and appropriate requirements are not applicable to the Site but may be suitable for use because they address issues or problems sufficiently similar to those at present at the Site. In addition to ARARs, federal and state environmental and public health guidance and proposed standards that are not legally binding but may prove useful are “to be considered” standards.

Risk-based cleanup criteria are site-specific levels determined to be protective of human health based on acceptable risk levels, and site-specific contaminant concentrations, land uses, and exposure pathways. A risk-based cleanup level was developed for arsenic in mine waste and soil at the Kromona Mine and Millsite as part of the streamlined HHRA (CES 2006).

- Mine waste and soil arsenic cleanup level = 109 mg/kg

The ARARs and proposed cleanup criteria for each media at the Site are discussed below and summarized in Tables 9, 10 and 11.

3.1 Applicable or Relevant and Appropriate Requirements

ARARs are "applicable" or "relevant and appropriate" federal and state environmental requirements used to:

(1) Evaluate the extent of site cleanup needed;
(2) Scope and develop removal action alternatives; and
(3) Guide the implementation and operation of the preferred alternative.

The NCP (40CFR 300.415(j)) establishes that a removal action shall "to the extent practical, considering the exigencies of the situation, attain ARARs under federal environmental or state environmental facility siting laws."

To determine whether compliance with ARARs is practicable, two factors are specified in 40 CFR 415(j):

- Urgency, and
- Scope of the removal action.
  - The scope of the removal action is often directed at minimizing and mitigating potential hazard rather than totally eliminating the hazard; even though a particular standard may be an ARAR for a particular medium, it may be outside the scope of the immediate problem the removal action is addressing.

A comprehensive list of potential ARARs generated and evaluated for the Site is presented in Appendix B. A request for any additional Washington State-specific ARARs was submitted to the WDOE during preparation of this EE/CA; however, no response was received. The ARARs were used to determine the design specifications and performance standards for the project. They are grouped as federal or State of Washington ARARs, and are identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR, and whether the ARAR is applicable, or relevant and appropriate.

- Administrative requirements are not ARARs and thus do not apply to actions conducted entirely on-Site. Administrative requirements are those that involve consultation, issuance of permits, documentation, reporting, record keeping, and enforcement.
- The CERCLA program has its own set of administrative procedures, which assure proper implementation of CERCLA. The preamble to the final NCP states that the application of additional or conflicting administrative requirements could result in delay or confusion.
- Provisions of statutes or regulations that contain general goals that merely express legislative intent about desired outcomes or conditions, but are non-binding, are not ARARs. In accordance with Section 121(e) of CERCLA, no permits are required for removal actions conducted on-Site.

Potential key chemical-, action-, and location-specific ARARs for a removal action at the Kromona Mine and Millsite include, respectively:

- **Chemical-specific Water, Soil, and Sediment Quality Standards:**
  - Washington State Water Quality Standards for Surface Water (Washington Administrative Code [WAC] Chapter 173-201A)
  - Washington State Drinking Water Standards (WAC Chapter 246-290)
  - Federal Water Quality Criteria for Surface Water (40 CFR 131.26)

- 2007 Aquatic Life Ambient Freshwater Quality for Copper[1] (40 CFR 131.26)
  - National Toxics Rule Water Quality Standards (40 CFR 131.26)
  - Washington Model Toxics Control Act (MTCA) Industrial Soil Cleanup Levels – Human Receptors (WAC Chapter 173-340)
  - EPA PRGs for Industrial Soil (EPA 2004)
  - Washington Freshwater Sediment Management Standards (WAC Chapter 173-204)
- **Solid/Dangerous Waste (Solids) Disposal Requirements:**
  - Washington MTCA Terrestrial Ecologic Evaluation (TEE) Criteria (WAC Chapter 173-340)
  - Washington State Hazardous Waste Management Act and Dangerous Waste Regulations (WAC Chapter 173-303)
  - RCRA Hazardous Waste Management Subtitle C (40 CFR Part 261 to 279)
- **Forest Plan Standard and Guidelines (FP S&G):**
  - Mt. Baker Snoqualmie National Forest Land and Resource Management Plan as amended by the Pacific Northwest Forest Plan (i.e. PacFish Riparian Standards and Guidelines)

3.1.1 Water, Soil, Sediment and Pore Water Quality Standards

The potential surface water ARARs are based on Washington State and federal standards for the protection of aquatic life and human health and are summarized in Table 9. The values for hardness dependent metals were adjusted based on an apparent background value of 3 in the single background sample from the receiving stream. Only a few COIs in surface water at the Site exceeded the surface water quality ARARs:

- The results for several analytes in surface water were reported as not detected including arsenic, cadmium, copper, nickel, lead, selenium, and zinc; however, some of the laboratory RLs were above the empirically- or calculation-derived ARAR criteria. These constituents could be present at concentrations above the ARARs, but this cannot be verified using standard laboratory techniques.
- The single background sample from the MFSF had no detected results above ARARs.
- The two samples from the MFSF downstream of the Site both had arsenic concentrations above the human health ARARs.
- Samples from the tailings impoundment and the sump drain at the millsite both had concentrations of arsenic above human health ARARs and concentrations of barium, copper, and lead above ecological ARARs.
- Samples from the two adits both had concentrations of arsenic above human health ARARs, and concentrations of copper above ecological ARARs.
- There is no apparent effect to the benthic community immediately downstream of the Site in the MFSF.
- Future sampling will be required to confirm background concentrations.

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[1] The federal Aquatic Life Ambient Freshwater Quality Criterion for copper was revised in 2007 and is potentially relevant and applicable to the Site (EPA 2007). The 2007 copper criterion uses the Biotic Ligand Model to determine acute and chronic concentrations that are protective of aquatic organisms based on ambient conditions and site-specific factors. However, because there was insufficient data to calculate the 2007 criterion for the Site, the 2006 criterion was used.

The potential soil ARARs are based on Washington State and federal standards for the protection of human health and the environment and are summarized in Table 10. Several COIs in the background soil and waste rock at the Site exceeded the soil quality ARARs:

- Several COIs in background soil exceeded human health or ecological ARARs:
  - Arsenic and chromium exceeded human health ARARs.
  - Aluminum, arsenic, cadmium, chromium, copper, mercury, manganese, lead, antimony, selenium, vanadium, and zinc exceeded ecological ARARs.
- Several COIs in mine waste and soil at the Site exceeded human health or ecological ARARs:
  - Arsenic, cadmium, chromium, copper, iron and TPH exceeded human health ARARs.
  - Silver, aluminum, arsenic, barium, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead, antimony, selenium, thallium, vanadium and zinc exceeded ecological ARARs.
- Future sampling will be required to confirm background concentrations and risk-based cleanup criteria.

The potential sediment ARARs are based on Washington State and federal standards for the protection of human health and the environment and are summarized in Table 11. Several COIs in sediment at the Site exceeded the sediment quality ARARs:

- Antimony was not detected in any of the sediment samples; however, the laboratory RL was above the lowest ecological ARAR criteria. This indicates that antimony could be present at concentrations slightly above the ARAR.
- The background sediment sample contained the highest concentrations of most COIs, most notably cadmium, chromium, nickel and zinc, which all exceeded ecological ARARs. Chromium also exceeded the human health ARAR.
- Sediment in the two downstream sample locations on the MFSF contained concentrations of arsenic and chromium above both human health and ecological ARARs, and concentrations of copper and nickel above ecological ARARs.
- Future sampling will be required to confirm background concentrations.

The potential pore water ARARs are based on Washington State and federal standards for the protection of aquatic life and are listed as ecological screening criteria in Table 7. No COIs were detected in pore water at concentrations above the pore water quality ARARs.

- Future sampling will be required to confirm background concentrations.

3.1.2 Solid/Dangerous Waste (Solids) Disposal Requirements

These potential ARARs set minimum functional performance standards for proper handling and disposal of solid waste; describe responsibilities of various entities; and stipulate requirements for solid waste handling facility location, design, construction, operation, and closure. All substantive requirements for closure and post-closure of limited purpose landfills (WAC 173-350-400) are potential ARARs (WAC 173-340-710[7][c]). The waste rock/soils at the Site are landfills that contain solid waste and are releasing hazardous substances above both state and federal cleanup standards.

3.1.3 Forest Plan Standard and Guidelines

Portions of the Land and Resource Management Plan (LRMP) for Mt. Baker Snoqualmie National Forest (1990), as amended by Pacific Northwest Forest Plan (NWFP) (1994) are potentially applicable or relevant and appropriate for assessing Site removal alternatives. The LRMP and NWFP include standards and guidelines that are potentially relevant and appropriate to actions at the Site, including activities within, or that affect Riparian Management Areas along the MFSF. These standards and guidelines include RF-2 through RF-7, which control the design, construction, and use of temporary and permanent roads and other modifications within Riparian Reserves; and MM-3, which controls solid waste and mine waste facilities within Riparian Reserves. Particular aspects of MM-3 that are potentially relevant and appropriate to closure of the waste rock piles at the Site include requirements for: (1) analysis based on best conventional methods; (2) designing waste facilities using best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials; and (3) reclamation and monitoring waste facilities to ensure chemical and physical stability, and to meet ACS objectives.

3.2 Risk–based Cleanup Concentrations

MTCA cleanup regulations (WAC 173-340) allow for the establishment of soil cleanup levels based on only two types of land use – unrestricted land use and industrial land use (WDOE 2001a). Other land uses (such as recreational, commercial or agricultural) may not be used for the purpose of establishing cleanup levels. However, WAC 173-340-708 allows these land uses to be used for the purpose of assessing the protectiveness of a remedy that does not achieve cleanup standards and allows a quantitative site-specific risk assessment to be used to determine if a cleanup action alternative is protective of human health and the environment. As discussed in Section 2.4, CES conducted a streamlined HHRA of the Site in April 2006 and calculated a site-specific risk-based arsenic cleanup level of 109 mg/kg[2] for mine waste and soil at the Site. While this cleanup level may not meet MTCA's soil cleanup level definition, it provides a cleanup goal in the event the MTCA cleanup level is not practicable considering the exigencies of the circumstances; it can also be used to assess the protectiveness of removal action alternatives. While the risk-based cleanup level is significantly higher than MTCA's cleanup standard for arsenic in industrial soil (20 mg/kg), it's based on a recreational land use with limited exposure, which is more representative of the Site. This is typical of risk-based criteria calculated for recreational uses at remote areas, such as the Kromona Mine, which tend to be much higher than chemical-specific ARARs because of the reduced exposure frequency and duration at remote sites. For example, EPA's Industrial PRGs for soil are based on an exposure frequency of 250 days per year, whereas the streamlined HHRA used an exposure frequency of 12 days for a recreationist at the Kromona Mine under the RME scenario.

The risk-based cleanup level for arsenic in mine waste and soil at the Site was developed using site-specific exposure factors (EF) and human health risk equations for a RME scenario. EFs are variables that determine the chronic daily intake rate, and include receptor body weight, exposure frequency and duration, averaging time, intake rates, chemical bioavailability, and other factors. The site-specific EFs are entered into human health risk equations and the cleanup level is back-calculated using an acceptable non-carcinogenic HI of 1.E+00 and carcinogenic risk of 1.E-06 (CES 2006)[3].

Areas exceeding the risk-based arsenic cleanup level are presented in Table 12 and summarized below.

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[2] The final Human Health and Ecological Risk Assessment report (CES 2006) stated an arsenic cleanup level of 164 mg/kg; however, errors in the calculations were discovered and the cleanup level was later revised to 109 mg/kg (Technical Assessment Services 2009).

[3]Washington ARARs specify 1.E-06 excess cancer risk for individual carcinogens and 1.E-05 total risk for multiple carcinogens.

- Arsenic concentrations in all areas of the Site and in 10 of the 15 mine waste and soil samples exceeded the cleanup level of 109 mg/kg:
  - In four of eight samples from the millsite area = 533 to 1,410 mg/kg
  - In all five samples from the tailings impoundment = 395 to 624 mg/kg
  - In eight of the nine partially processed ore samples = 496 to 10,500 mg/kg
  - In all four samples from the waste rock pile at the upper workings = 997 to 2,490 mg/kg

Cleanup criteria for lead in mine waste and soil cannot be calculated using standard risk assessment algorithms because toxicological reference values (i.e. reference doses and slope factors) have not been established for lead. However, according to the risk assessment, there does not appear to be a human health risk from exposure to lead at the Site. The maximum detected lead concentration in soil at the Site (220 mg/kg) is well below WDOE's MTCA Method A Industrial Soil Cleanup Level of 1,000 mg/kg (2007), and EPA Region 9's Industrial Soil PRG of 800 mg/kg.

Groundwater is not used for drinking water at the Site and future use as a drinking source is not anticipated; therefore, no risk-based cleanup levels were identified for groundwater. Risk-based cleanup levels were also not developed for drinking water or sediment at the Site.

4.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The general goal of a removal action is to protect human health and the environment by preventing or minimizing the potential release of a hazardous substance and reducing the potential for direct contact and transport of contaminants to the environment. Based on the human health and ecological risks identified at the Kromona Mine, the following non-time critical removal action objectives (RAO) were developed for the Site:

- Reduce human and wildlife exposure to metals in the waste rock piles;
- Improve surface water quality and decrease metals loading to MFSF; and
- Attain ARARs to the extent practical considering the urgency of the situation and scope of the removal.

As an adjunct to addressing the risks posed by hazardous substance releases through the above RAOs, this EE/CA considers public safety associated with physical hazards at the Site. The following sections discuss the justification for a removal action at the Site, scope of the removal action, and the proposed removal action schedule.

4.1 Removal Action Justification

40 CFR 300.415(b), lists several factors to be considered in determining whether a removal action is appropriate. The factors relevant at this Site, and the conditions establishing the presence of those factors, are summarized below:

- **Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminates:**
  - The streamlined risk assessment indicated potential risk to human and ecological receptors from exposure to metals in the mine waste, soil, surface water, and sediment.
    - The maximum detected concentration (MDC) of arsenic (10,500 mg/kg) in soil and mine waste at the Site exceeds the human health risk-based cleanup level of 109 mg/kg by a factor of more than 60.
    - The MDC of three metals (arsenic, cadmium, and chromium) in soil and mine waste at the Site exceeds WDOE's MTCA Method A Industrial Soil cleanup levels.

    - The MDC of 17 metals (aluminum, antimony, arsenic, barium, cadmium, cobalt, chromium, copper, mercury, manganese, nickel, lead, selenium, silver, thallium, vanadium and zinc) in soil and mine waste at the Site exceeds WDOE's MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plant and Animals.
    - Metals concentrations in surface water discharging from the two open adits, the tailings impoundment, and the sump drain exceed human health and ecological screening criteria; however, none of those sources appear to directly contribute contaminant loading to the MFSF.
  - Land uses in areas surrounding the Site include minerals prospecting, timber harvesting, firewood cutting, and recreational activities such as hiking, swimming, camping, fishing, and hunting.
    - Since abandoned mines, especially those sites containing old structures, equipment, and mineral specimens attract these forest users, it is likely they would come into contact or potentially be exposed to high concentrations of arsenic, cadmium, chromium, copper, and iron.
    - While vehicular access to the Site is restricted, physical access is possible and recreational use of the Site is promoted in the NWUE's publication *"Discovering Washington's Historic Mines"* (1997).
- **Actual or potential contamination of drinking water supplies or sensitive ecosystems:**
  - During extreme storm events or times of high flow, surface water and storm water runoff from the Site may reach the MFSF.
  - There are no public water supplies at the Site and no drinking water wells within a 4-mile radius; however, Spada Lake, which is the drinking water source for the City of Everett (population ~400,000), is less than 4 miles downstream of the Site. Also, recreationists may occasionally use water from the MFSF for cooking and as a drinking source.
    - The maximum detected concentration of arsenic (30.7 μg/L) in discharge from the Main Adit exceeds WDOE and EPA human health screening criteria (0.018 μg/L) by a factor of more than 1,700.
    - Four COIs in the tailings impoundment and sump drain exceeded ecological screening criteria: arsenic, barium, copper, and nickel.
  - The MFSF is habitat to the Rainbow trout (*Oncorhynchus mykiss*), which is a state priority species.
    - Arsenic in the MFSF downstream of the Site exceeded both human health and ecological screening criteria.
  - Sensitive red-legged frog populations are at risk because their small home ranges may include pooled water on the tailings impoundment and around the mill foundation, and the sump drain outfall pond.
- **Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release:**
  - Members of NWUE reportedly observed dynamite, which contains the hazardous substance nitroglycerin, in the Main Adit during an exploration of the underground workings in October 2004 (NWUE 2004).
- **High levels of hazardous substances, pollutants, or contaminants in soils, at or near the surface that may migrate:**
  - There is estimated to be about 730 bcy of tailings and 7,500 bcy of waste rock at the millsite.
    - The tailings and waste rock contain high concentrations of several metals.
    - Extreme storm events and surface water runoff may erode the tailings and waste rock and carry fines to the MFSF.
  - There is about 265 bcy of partially processed ore on the multi-tiered mill foundation (CES 2005).

    - The ore contains high concentrations of several hazardous substances.
    - The ore is unvegetated and subject to erosion.
    - Under extreme conditions, fines eroding from the piles may migrate to the MFSF.
  - The waste rock pile at the upper workings contains about 8,250 bcy (CES 2005).
    - The waste rock contains high concentrations of several hazardous substances.
    - The pile is unvegetated and subject to erosion.
  - Insulating tiles containing asbestos were identified in the structural debris at the upper workings. The exposed tiles are subject to degradation from weathering which will increase the asbestos inhalation risk.
- **Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released:**
  - The waste rock pile, tailings, and partially processed ore are subject to erosion during rain events and snowmelt.
  - According to the SI, the estimated average annual precipitation at the Site is approximately 82 inches per year (CES 2005).
- **Threat of fire or explosion:**
  - Members of NWUE reportedly observed dynamite in the Main Adit during an exploration of the underground workings in October 2004 (NWUE 2004).
- **Other situations or factors that may pose threats to public health or the environment:**
  - Physical hazards at the Site pose a significant risk to the public and include the access road, open adits, and Site debris. The presence of dynamite in underground workings also poses a significant risk to the public.
  - There is one UST at the millsite. The tank is suspected to have stored diesel fuel or lube oil. The tank is sealed and it is unknown whether the tank still contains fluid. TPH is present in soils surrounding the UST at a concentration of 19,200 mg/kg, which is well above WDOE's human health and ecological criteria.
  - There is one AST at the upper workings. The tank is suspected to have contained diesel fuel or heating oil and is believed to currently be empty based on external observation during the Site reconnaissance by MSE in September 2008.

4.2 Scope of Removal Action

The scope of removal actions evaluated in this EE/CA focus on:

1) Eliminating direct human and animal contact with high concentrations of COIs in the mine waste and soil,
2) Reducing or eliminating the migration of contaminants to the environment, and
3) Improving surface water quality.

As an adjunct to addressing the risks posed by hazardous substance releases through the above RAOs, this EE/CA considers public safety associated with physical hazards at the Site. The primary sources of contaminants at the Site contain high concentrations of metals and consist of the partially processed ore, tailings and waste rock. Fine-grained material (i.e., sediment) that may have been deposited in, or migrated to MFSF is considered a secondary contaminant source. Surface and groundwater flowing through the mine waste at the millsite are also considered secondary contaminant sources because impairments to surface water quality at the millsite are believed to result from direct contact with the mine waste. Removal of the primary contaminant sources (i.e. mine waste) or minimizing contact with surface and groundwater should improve surface water quality and reduce metals loading to the MFSF. Therefore, this removal action focuses on the mine waste and contaminated soil. The EE/CA does not consider treatment of surface water at the millsite in the removal scope because source control is expected to address the surface water contamination. Surface water quality monitoring will help determine whether there is a need for additional CERCLA response actions. The EE/CA does not consider sediment that has already migrated to the MFSF for the following reasons: (1) Sediment does not pose a significant human health risk; (2) there is no apparent impact to aquatic organisms downstream of the Site; (3) metals concentrations are generally consistent with or below background levels; and (4) because of excessive collateral damage to aquatic habitat/organisms caused by an in-stream removal action. Groundwater is not used for drinking water at the Site and future use as a drinking source is not anticipated; therefore, treatment of groundwater is beyond the scope of this removal action.

At the upper workings, the two adit discharges do not appear to pose a significant threat to human health because of the remoteness of the Site, very difficult access to the upper workings, and the presence of more suitable drinking water sources in the area. The adit discharges also do not have a surface water connection to the MFSF and there is minimal ecological risk. Therefore, active treatment of the two adit discharges was eliminated from the scope of this removal action.

Post-removal action monitoring will be required to evaluate the removal action effectiveness and compliance with the ARARs. The monitoring should include confirmation soil sampling during mine waste and contaminated soil removal, and post-removal monitoring of the aquatic habitat in MFSF immediately downstream of the Site.

4.3 Removal Action Schedule

The removal action is tentatively proposed for 2010; however, the date is dependent on funding and may be subject to change by the Forest Service.

5.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section describes the selection of a removal action using a two–step process:

1) Identify potential removal action options and alternatives applicable to the Site and screen to eliminate ineffective or unfeasible alternatives;
2) Analyze selected removal action alternatives based on effectiveness, implementability, and cost.

Removal action technologies applicable to the Site were identified based on a review of technical literature and previous experience at similar mine sites. The technologies, described in Table 13, were screened to eliminate inappropriate, ineffective, infeasible or cost prohibitive methods. In addition, technologies with unproven or uncertain performance were eliminated if they had relatively high implementation costs and/or would likely require implementation with other costly mitigation components. Technologies with uncertain or unproven performance were retained if they represented potentially cost effective mitigation and the performance can be investigated through pilot or bench scale testing. For this EE/CA, a potentially cost effective technology is one that could provide protection comparable to other standard methods utilized in mine reclamation, at a cost similar to or less than the costs of those methods. All components not screened out were retained as potential technologies that could be implemented at the Site.

The technologies were assessed relative to others in the same sub-category based on effectiveness, implementability, and cost. This allowed each technology to be assigned a relative ranking of high, medium, or low for each evaluation criterion. Table 13 summarizes the results of the removal action technology screening process, including the technologies retained for incorporation into removal action alternatives.

5.1 Identification and Screening of Removal Action Options and Alternatives

Conceptual removal alternative designs (Figures 4 through 8) were developed from technologies that passed the screening process. Key design features are estimates only and provided for comparison purposes. The material quantities provided in this section are estimates only and should be more accurately quantified for final design and removal action. Bulk excavated mine waste and contaminated soil quantities are presented in bcy; all other bulk material quantities are presented in loose cubic yards (lcy). The referenced figures are conceptual only.

Current access to the millsite is limited to foot traffic because of several hazards and fallen trees along FR 6110. Major improvements would be required to provide heavy access to the millsite. Access to the upper workings is even more difficult because of the extremely steep (~70 percent) slopes and lack of any established roads. Constructing an access road to the upper workings was screened out because of the considerable risk, collateral impacts to the environment, and significant cost. Similarly, excavating and removing the large volume (~8,250 bcy) of waste rock at the upper workings was also screened out because of the remote location and extremely difficult access. Two options were evaluated for accessing the Site and completing a removal action. Depending on the option selected, institutional controls such as traffic barriers and warning signs may be required following completion of the removal action.

- **Option A: Access via the existing road.** This option applies only to accessing the millsite and involves reconstructing the existing access road (FR 6110) from Olney Pass to the MFSF crossing to provide full access by heavy equipment for the removal action and post-removal monitoring. Access from the MFSF crossing to the millsite is specific to each removal action alternative and discussed below. Reconstruction of the existing access road would require major improvements including clearing fallen trees, installing two bridges and three 60-inch diameter corrugated metal culverts, and blasting rock to widen and stabilize the road in areas where it is sloughing away from the hillside. Forest Service and/or WDNR specifications may require additional actions. Maintenance of the road may also be required, including light to heavy brushing, spot surfacing, seasonal closure, and seeding. The estimated cost for this access option is $464,173, and does not include maintenance.
- **Option B: Access via helicopter.** A helicopter would fly in all equipment and materials to the millsite and upper workings. This would require establishing a temporary staging area at Gold Bar (~5 miles by air from the millsite) and preparing a helipad at the millsite. The existing access road would be minimally improved to provide temporary access via all terrain vehicles (ATV) to the millsite for the field crew and ground support in the event of an emergency. This would require some clearing of fallen trees and improving stream crossings where culverts have washed out using timbers from the road clearing. No bridges would be installed and a temporary suspended cable car crossing would be installed to ferry the crew, supplies, and small equipment across the MFSF at the Site. Access for post-removal monitoring would be via ATV and foot. This option assumes that a suitable soil borrow source can be identified at the Site. The estimated cost for this option is $42,641 plus ATV rental fees and helicopter costs ranging from $120,000 to $800,000 depending on the removal action alternative selected.

During the Site reconnaissance by MSE in September 2008, potential borrow soil sources were identified near the millsite and on a ridge along the access road about 2 miles from the millsite. However, because of Site access limitations, equipment needed to fully evaluate on-Site borrow sources could not be utilized. If a suitable on-Site borrow source can be identified, removal action costs could be significantly reduced depending on the alternative selected.

Five removal action alternatives were selected for detailed analysis based on the access options and results of the removal action technology screening process discussed above:

- **ALTERNATIVE 1 – NO ACTION**
- **ALTERNATIVE 2 – EXCAVATION AND OFF-SITE DISPOSAL**
- **ALTERNATIVE 3 – ON-SITE DISPOSAL VIA ROAD**
    - Option A: Excavation and Disposal in Repository at Millsite
    - Option B: Excavation and Disposal in Repository along Access Road
    - Option C: Capping in Place
- **ALTERNATIVE 4 – ON-SITE DISPOSAL VIA HELICOPTER**
    - Option A: Excavation and Disposal in Repository at Millsite
    - Option B: Capping In Place
- **ALTERNATIVE 5 – UPPER WORKINGS CAPPING IN PLACE**
    - Option A: Capping in Place – Main Adit Bench
    - Option B: Capping in Place – Entire Bench/Waste Rock Pile

Each alternative and the removal action elements common to the four action alternatives are discussed below.

Removal Action Elements Common to all Action Alternatives

Certain work elements would be employed and implemented regardless of the action alternative selected. These elements include: (1) addressing data gaps, (2) mitigating physical hazards at the Site, (3) disposing of storage tanks and hazardous materials, (4) implementing best management practices (BMP), and (5) conducting post-removal monitoring and maintenance.

- **Data Gaps.** Several data gaps were identified during the preparation of this EE/CA. The recommended actions to address the data gaps are specific to each removal action alternative and are discussed in Section 5.3.
- **Physical Hazards.** May be mitigated through institutional controls such as fencing, gating and/or signs, which limit public access, or by removal of the hazard, e.g. plugging with foam or filling the hazard. Each physical hazard and the recommended mitigative measures are described below:
    - **Main Adit.** Clearing soil and rock from the opening and installing a bat gate or culvert, shown in Figure 8, to prevent public access while maintaining potential bat habitat.
    - **Reservoir Adit.** This adit appears to pose minimal public risk because of the poor accessibility and limited underground workings; therefore, the adit portal would be left as is. However, the adit portal and underground workings should be inspected to determine whether physical closure of the portal may be warranted.
    - **Miscellaneous Debris.** Removing miscellaneous debris from the millsite and placing in an on-Site repository, or transporting off-Site for disposal in a sanitary landfill depending on the final removal action alternative selection. Structural wood and metal debris at the upper workings would be moved and stockpiled only if necessary for work on the bench. The stockpiled material would be placed back on the bench when the work is completed.
- **Disposal of Tanks and Hazardous Materials.**
    - **UST.** Filling the tank with sand and leaving in place or removing the tank and petroleum-contaminated soil and transporting to an off-Site disposal facility. Removal activities will depend on the tank contents and the concentration and extent of contaminated soil, and may require developing a risk-based cleanup level under MTCA. For cost estimation purposes, the quantity of petroleum-contaminated soil was conservatively estimated to be 50 bcy. The tank was also assumed to contain 200 gallons of fluid requiring disposal.
    - **AST.** Removing the tank and disposing of in a pit excavated at the end of the upper workings bench or transporting via helicopter to the staging area and hauling to an off-Site disposal

facility. Removal activities will depend on the tank contents and presence of any petroleum-contaminated soil, and may require developing a risk-based cleanup level under MTCA. The tank was assumed to be empty with no petroleum-contaminated soil at the upper workings.
    - **ACM.** Contracting a certified asbestos removal team to remove the red insulation tiles and transport to an off-Site disposal facility via helicopter. For cost estimation purposes, the quantity of ACM was conservatively estimated to be 5 lcy.
    - **Dynamite.** Contracting a certified explosives handler to properly dispose of the dynamite.
- **Best Management Practices.** During removal activities, BMPs will be employed to contain run-off, minimize erosion, and prevent contaminant transport to the MFSF during the removal action.
    - Specific BMPs will depend on the removal action selected and may include, but not be limited to: silt fencing, straw bales, check dams, temporary surface water diversions, sediment retention, and dust suppression.
    - Establishing a temporary staging area at Olney Pass or Gold bar for the transfer of equipment, materials, and crew. Specific details of the staging area will depend on the Site access option and removal action options selected.
- **Post-removal Monitoring and Maintenance.**
    - Post-removal monitoring of the aquatic habitat at the Site would be conducted for at least 3 years following completion of the removal action to assess the overall removal action effectiveness and compliance with ARARs.
        - The post-removal monitoring will consist of biannual sampling of surface water, pore water, sediment, and benthic macroinvertebrates from three locations on the MFSF.
        - The sampling approach and methodology, and analytical suite will be based on a refined set of parameters to be derived from the SI.
        - If post-removal water quality monitoring indicates that water quality ARARs have not been met or that a significant risk from surface water or sediment in MFSF remains, additional monitoring and evaluation may be necessary to determine the need for further removal actions.
    - Post-removal maintenance may include:
        - Maintaining the access road;
        - Inspecting any soil or engineered caps for erosion and areas of exposed waste or geocomposite capping material;
        - Inspecting the reclaimed areas and surface water diversions for signs of erosion, vandalism or other damage; and
        - Making any necessary repairs, replacing any damaged geocomposite materials, importing clean fill material, and spot seeding.

ALTERNATIVE 1 – NO ACTION

This alternative consists of no further action and leaving the Site as is:

- Waste rock, tailings, partially processed ore, and contaminated soil would remain in the current locations;
- Site safety issues (i.e. dangerous access, open adits, hazardous materials, debris, etc.) would remain as is;
- Water would continue to flood the tailings impoundment and mill foundation, and discharge from the sump at the millsite, and
- Water discharging from the Main Adit and surface drainage at the upper workings would continue to flow through culverts and discharge onto the waste rock pile.

ALTERNATIVE 2 – EXCAVATION AND OFF-SITE DISPOSAL

This alternative would fully reconstruct the access road (Access Option A), excavate soil, waste rock, tailings and partially processed ore from the millsite with arsenic concentrations above the risk-based cleanup level of 109 mg/kg and transport to an off-Site facility for disposal. Disposal options depend on whether the mine waste is considered a hazardous waste under Washington Dangerous Waste Rules (WAC Chapter 173-303). The mine waste is not listed as discarded chemical product or dangerous waste source, nor does it exhibit the characteristics of a hazardous waste. The results of all mine waste leachate samples analyzed during the SI using SPLP and TCLP were well below RCRA TCLP disposal limits. Therefore, the mine waste is not considered to be a Washington Dangerous Waste or a RCRA Hazardous Waste. The mine waste and petroleum-contaminated soil may be considered a special waste because they pose a relatively low hazard to human health and the environment. The Roosevelt Regional private landfill in Klickitat County confirmed that it will accept mine waste that passes TCLP disposal limits and petroleum-contaminated soil (Dillishaw 2008). Rabanco provides 25-ton capacity bins that they pick up and haul to a rail station for transport to the landfill. The rail station is located about 30 miles from the Site.

- Access: Option A; full reconstruction of the mine access road. An alternative using Access Option B was not evaluated because of spill and safety risks and because of the high cost associated with the transport of mine waste and contaminated soil by helicopter.
- Construction equipment would likely consist of:
  - Large track hoe,
  - Medium track hoe,
  - Skid steer,
  - Skip loader,
  - Several dump trucks, and
  - Water truck and various support vehicles.
- Cover soil would be imported from an off-Site source to minimize disturbance on-Site.
- Waste rock around the mill foundation, petroleum-contaminated soil, tailings from the tailings impoundment, and partially processed ore on the multi-tiered mill foundation would be excavated and transported to an off-Site facility for disposal.
  - Clearing old access roads or constructing new access roads for equipment access:
    - Clearing ~500 feet of old road from the bridge crossing at the MFSF to the millsite,
    - Clearing ~200 feet of old road leading from the south end of the millsite up the hillside to the middle tiers of the concrete mill foundation, and
    - Constructing ~200 feet of temporary access road to the sump outfall pond.
  - Installing temporary erosion control BMPs.
  - Excavating waste rock, contaminated soil, tailings, and partially processed ore with arsenic concentrations above the risk-based cleanup level of 109 mg/kg and TPH concentrations above 2,000 mg/kg.
    - ~7,500 bcy of waste rock
    - ~730 bcy of tailings
    - ~265 bcy of partially processed ore
    - ~10 bcy of soil from the sump outfall and pond
    - ~50 bcy of petroleum-contaminated soil from around the UST
  - Loading the mine waste and contaminated soil (~8,555 bcy total) in 12-cy dump trucks and transporting to the temporary staging area at Olney Pass for transfer to the 25-ton Rabanco bins.
  - Using a Niton X-ray fluorescence (XRF) to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
  - Transporting the bins to the rail station (~30 miles) for transfer to the Roosevelt Regional Landfill for disposal.
  - Plugging the sump drain with concrete to prevent surface water from flowing through sump.

- o Grading the millsite, access roads, and areas (~2 acres) from which the mine waste and soil have been excavated to blend with the surrounding topography and promote drainage.
  - Ripping 900 feet of access road, grading to blend with the natural hillside to the extent possible, seeding with a Forest Service approved seed mix, and mulching.
  - Importing ~600 lcy of clean soil from an off-Site source (assumed to be within 50 miles of the Site) assuming there is not a suitable borrow source at the Site.
  - Applying 6 to 12 inches of clean soil (~600 lcy) to the excavated waste areas, seeding with a Forest Service approved seed mix, and mulching.

ALTERNATIVE 3 – ON-SITE DISPOSAL VIA ROAD

This alternative requires full reconstruction of the access road to the millsite (Access Option A). Mine waste and contaminated soil with arsenic concentrations above the cleanup level of 109 mg/kg would be capped in place, or excavated and disposed of in an on-Site repository. Access Option B was not evaluated because of spill and safety risks and because of the high cost associated with the transport of mine waste and contaminated soil by helicopter. Three options were evaluated under Alternative 3: (A) excavation and disposal in a repository at the millsite, (B) excavation and disposal in a repository along the access road about 2 miles from the millsite, and (C) capping the mine waste and contaminated soil in place.

Two cover configurations and two drain configurations were evaluated for each option under Alternative 3. The two cover options consist of: (1) a 24-inch soil cover, and (2) an engineered cover with a geocomposite sheet drain system (AmerDrain 200/500 or equivalent) consisting of a dimpled polymeric core covered with a non-woven, needle-punched filter fabric and 12 inches of soil. The dimpled core creates a void space for the water to enter and flow to a discharge point while the filter fabric prevents soil particles from plugging the void space. The core also prevents infiltration, has a high flow capacity (ranges from 9 to 15 gallons per minute per foot), has a high compressive strength (10,800 to 35,000 pounds per square foot) that prevents against crushing under soil and equipment loads, and eliminates the need for drain rock. The material comes in 4-foot-wide rolls and is overlapped during placement to promote shingle flow. The cover soil for both options would be imported from an off-Site source to minimize disturbance on-Site.

The two drain options consist of: (1) a traditional French drain, and (2) a geocomposite drain system. The traditional French drain would be constructed using drain rock, filter fabric, perforated drain pipe, and HDPE liner. The perforated pipe is installed in a trench filled with drain rock. Filter fabric is placed between the drain rock and native soil to prevent soil particles from plugging the drain and 60-mil HDPE liner is placed between the drain rock and mine waste to prevent water that percolates though the waste material from entering the drain. The geocomposite drain system would be constructed of a high-capacity, dimpled, polymeric core covered with a non-woven, needle-punched filter fabric (AmerDrain Total-Drain or equivalent). The dimpled core creates a void space for the water to enter and flow to a discharge point while the filter fabric prevents soil particles from plugging the void space. The core has a high flow capacity (80 gallons per minute per foot), eliminates the need for drain gravel and an HDPE liner, and can be combined with the sheet drain system described above.

Option 3A: Excavation and Disposal in Repository at Millsite

Under this option, the repository would be constructed on the bench at the millsite (Figure 4). This location is well above the MFSF floodplain, relatively flat and easily accessible. The conceptual configuration shown in Figure 4, allows the area to easily accommodate the estimated volume of mine waste with capacity to accommodate swell (~6,840 lcy total).

- Construction equipment would likely consist of:
  - o Large track hoe,
  - o Medium track hoe,

    - Small dozer,
    - Skid steer,
    - Skip loader,
    - Rock screening plant,
    - Small dump truck, and
    - Water truck and various support vehicles.
- Clearing old access roads or constructing new access roads for equipment access:
    - Clearing ~500 feet of old road from the bridge crossing at the MFSF to the millsite,
    - Clearing ~200 feet of old road leading from the south end of the millsite up the hillside to the middle tiers of the concrete mill foundation, and
    - Constructing ~200 feet of temporary access road to the sump outfall pond.
- Installing temporary erosion control BMPs.
- Clearing and grubbing the millsite and repository footprint (~1 acre) and stockpiling the woody debris.
- Excavating a diversion channel to intercept surface water run on along the old access road that leads from the south end of the bench up the hillside to the middle tiers of the mill foundation. The V-shaped channel will be 1 to 2 feet deep with 2H:1V side slopes and lined with riprap. For cost estimation purposes, the assumed channel length is 275 feet.
- Installing a drainage system (Figure 4) between the repository and hillside to intercept groundwater that may seep from the hillside during wet conditions and divert the flow around the repository. Two drainage system options were evaluated:
    - Option 1 – Traditional French Drain:
        - Excavating a 4-foot-deep, 2-foot-wide trench in the existing bench along the hillside from the mill foundation to a discharge point on the hillside below the repository (~240 feet).
        - Placing ~1,380 square yards (sy) of non-woven filter fabric in the trench and against the exposed hillside within the repository footprint.
        - Installing ~240 feet of 6-inch-diameter perforated drain pipe and ~70 lcy of drain rock in the trench. The trench and pipe would be sloped at a minimum of 2 percent and routed around the south end of repository to discharge on the hillside below the existing bench.
        - Installing ~2 lcy of riprap at the point of discharge to dissipate energy and prevent erosion.
        - Placing ~370 lcy of drain gravel in a 12-inch-thick layer over the filter fabric on the hillside.
        - Placing ~1,380 sy of 60-mil HDPE liner over the drain rock and anchoring in the hillside.
    - Option 2 – Geocomposite Sheet Drain:
        - Excavating a 4-foot-deep, 2-foot-wide trench in the existing bench along the hillside from the mill foundation to a discharge point on the hillside below the repository (~240 feet).
        - Installing ~190 lineal feet of geocomposite trench drain (AmerDrain Total-Drain or equivalent) in the trench. The trench and drain would be sloped at a minimum of 2 percent and routed around the south end of repository to discharge on the hillside below the existing bench.
        - Installing ~50 feet of non-perforated pipe from the geocomposite trench drain to the discharge point.
        - Installing ~2 lcy of riprap at the point of discharge to dissipate energy and prevent erosion.
        - Placing ~9,980 square feet (sf) of geocomposite sheet drain material (AmerDrain 500 or equivalent) against the exposed hillside within the repository footprint and connecting to the trench drain.
- Draining the UST, excavating the tank and petroleum-contaminated soil (~50 bcy) with TPH concentrations above 2,000 mg/kg and transporting the fluid and waste off-Site for disposal.

- Excavating waste rock, contaminated soil, tailings, and partially processed ore with arsenic concentrations above the risk-based cleanup level of 109 mg/kg.
    - ~3,750 bcy of waste rock (less than the estimated 7,500 bcy total volume of waste rock because a portion [~1/2] would be covered in place by the repository)
    - ~730 bcy of tailings
    - ~265 bcy of partially processed ore
    - ~10 bcy from the sump outfall and pond
- Using a Niton XRF to assist in delineating the extent of excavation and to field check removal efforts. Collect a minimum of one composite confirmation sample from each area for verification of contaminant removal.
- Placing and compacting the waste rock, tailings, partially processed ore and contaminated soil (~4,755 bcy total) in the repository in 12-inch-thick lifts to the approximate configuration shown on Figure 4. The proposed design is conceptual and the actual engineered design may differ considerably based on site-specific conditions and constraints. Before commencing final design, the Site should be inspected and additional information gathered regarding the suitability of the proposed location. However, the general design configuration and site preparation tasks described in the following bullets will likely be very similar independent of location.
- Placing a cover over the repository (Figure 5). Two cover options were evaluated:
    - Option 1 – Soil Cover:
        - Importing ~870 lcy of clean, well-graded soil from an off-Site source (assumed to be within 50 miles of the Site) and installing an earthen cover consisting of 24 inches of well-graded soil over the repository (Figure 5).
        - Placing the soil cap in one lightly compacted 12-inch lift and one loose 12-inch lift.
        - Seeding the cover with a Forest Service approved seed mix and mulching (~2 acres).
        - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
    - Option 2 – Engineered Cover:
        - Selectively placing the mine waste in the repository so that the finer material (i.e. tailings) is placed in the final lifts and on the outer surface to provide a bedding layer for the geocomposite sheet drain.
        - Installing ~11,760 sf of geocomposite sheet drain material (AmerDrain 200 or equivalent) over the prepared mined waste (Figure 5).
        - Importing ~435 lcy of clean, well-graded soil from an off-Site source (assumed to be within 50 miles of the Site) and placing 12 inches of soil over the liner in one lightly compacted lift.
        - Seeding the cover with a Forest Service approved seed mix and mulching (~2 acres).
        - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
- Grading the millsite and areas (~1 acre) from which the mine waste and soil have been excavated to blend with the surrounding topography and promote drainage.
    - Importing ~400 lcy of clean, well-graded soil from an off-Site source (assumed to be within 50 miles of the Site)
    - Applying 6 to 12 inches of growth media (~400 lcy), seeding with a Forest Service approved seed mix, and mulching.
    - Ripping 900 feet of access road, grading to blend with the natural hillside to the extent possible, seeding with a Forest Service approved seed mix and mulching.
    - Placing woody debris generated during the removal action over the seeded areas to prevent erosion and provide natural habitat.

Option 3B: Excavation and Disposal in Repository along Access Road

Under this option, the repository would be constructed in an area adjacent to the east side of the reconstructed access road (FR 6110), about 2 miles from the millsite on WDNR lands (Figure 1). Use of this location would require approval and permitting by WDNR. The repository will have a minimum available storage capacity of 10,200 lcy (estimated volume of mine waste and soil plus 20 percent swell).

- Construction equipment would likely consist of:
  - Large track hoe,
  - Medium track hoe,
  - Small dozer,
  - Skid steer,
  - Skip loader,
  - Multiple dump trucks, and
  - Water truck and various support vehicles.
- Clearing old access roads or constructing new access roads for equipment access:
  - Clearing ~500 feet of old road from the bridge crossing at the MFSF to the millsite,
  - Clearing ~200 feet of old road leading from the south end of the millsite up the hillside to the middle tiers of the concrete mill foundation, and
  - Constructing ~200 feet of temporary access road to the sump outfall pond.
- Installing temporary erosion control BMPs.
- Clearing and grubbing the repository site (~1 acre) and stockpiling the woody debris. Excavating a shallow area for the repository base and stockpiling the excavated material (~4,160 bcy) for use in the repository cap and to cover the waste excavation areas.
- Draining the UST, excavating the tank and TPH-contaminated soil (~50 bcy) with TPH concentrations above 2,000 mg/kg and transporting the fluid and waste off-Site for disposal.
- Excavating waste rock, contaminated soil, tailings, and partially processed ore with arsenic concentrations above the risk-based cleanup level of 109 mg/kg.
  - ~7,500 bcy of waste rock
  - ~730 bcy of tailings
  - ~265 bcy of partially processed ore
  - ~10 bcy of soil from the sump outfall and pond
- Loading the mine waste and contaminated soil (~8,505 bcy total) in 12-cy dump trucks and transporting to the repository.
- Using a Niton XRF to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
- Placing and compacting the waste rock, tailings, partially processed ore and contaminated soil in the repository in 12-inch-thick lifts to the approximate configuration shown on Figure 5. The proposed design is conceptual and the actual engineered design may differ considerably based on site-specific conditions and constraints. Before commencing final design, the proposed location should be inspected and additional information gathered to verify suitability. However, the general design configuration and site preparation tasks described in the following bullets will likely be very similar independent of location.
- Shaping the repository to blend with the surrounding topography. The foundation slope should not exceed 10 percent. The repository side slopes should not exceed a 3:1 horizontal to vertical (3H:1V) ratio and the top surface should be graded to minimize erosion, promote drainage, and prevent ponding on the repository surface.
- Placing a cover over the repository (Figure 5). Two cover options were evaluated:
  - Option 1 – Soil Cover:
    - Placing ~3,560 lcy of soil stockpiled during the repository excavation over the repository in one lightly compacted 12-inch lift and one loose 12-inch lift (Figure 4).

    - Seeding the cover with a Forest Service approved seed mix and mulching (~1 acre).
    - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
  - Option 2 – Engineered Cover:
    - Selectively placing the mine waste in the repository so that the finer material (i.e. tailings) is placed in the final lifts and on the outer surface to provide a bedding layer for the geocomposite sheet drain.
    - Installing ~48,000 sf of geocomposite sheet drain material (AmerDrain 200 or equivalent) over the mine waste (Figure 5).
    - Placing ~1,480 lcy of soil stockpiled during the repository excavation over the sheet drain material in one lightly compacted 12-inch lift.
    - Seeding the cover with a Forest Service approved seed mix and mulching (~1 acre).
    - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
- Grading the millsite and areas (~1 acre) from which the mine waste and soil have been excavated to blend with the surrounding topography and promote drainage.
  - Hauling ~600 lcy of stockpiled soil from the repository to the millsite (~2 miles).
  - Applying 6 to 12 inches of growth media (~600 lcy), seeding with a Forest Service approved seed mix, and mulching.
  - Ripping 900 feet of access road, grading to blend with the natural hillside to the extent possible, seeding with a Forest Service approved seed mix and mulching.
  - Placing woody debris generated during the removal action over the seeded areas to prevent erosion and provide natural habitat.

Option 3C: Capping in Place

Under this option, the mine waste and contaminated soil with arsenic concentrations above the cleanup level of 109 mg/kg would be capped in place. The partially processed ore and arsenic-contaminated soil from around the sump outfall and pond would be excavated and placed on the tailings impoundment. The impoundment and millsite would then be capped with 2 feet of clean soil or an engineered cover (Figure 6). The UST and petroleum-contaminated soil would be removed and disposed of off-Site.

- Construction equipment would likely consist of:
  - Large track hoe,
  - Small dozer,
  - Skid steer,
  - Skip loader,
  - Rock screening plant,
  - Dump trucks, and
  - Water truck and various support vehicles.
- Clearing old access roads or constructing new access roads for equipment access:
  - Clearing ~500 feet of old road from the bridge crossing at the MFSF to the millsite,
  - Clearing ~200 feet of old road leading from the south end of the millsite up the hillside to the middle tiers of the concrete mill foundation, and
  - Constructing ~200 feet of temporary access road to the sump outfall pond.
  - Installing temporary erosion control BMPs.
- Clearing and grubbing the waste areas and existing bench (~1 acre), and stockpiling the woody debris.
- Installing two trench drain systems to intercept groundwater that may seep from the hillside during wet conditions and divert the flow around the mine waste (Figure 6): (1) between the tailings impoundment and hillside, and (2) along the saturated area where the bench meets the hillside. Two drainage system options were evaluated:

- Option 1 – Traditional French Drain:
  - Excavating a 4-foot-deep, 2-foot-wide trench in the existing bench along the hillside from the mill foundation sloping to a discharge point on the hillside below the bench (~200 feet).
  - Excavating a 4-foot-deep, 2-foot-wide trench between the tailings impoundment and hillside from the mill foundation sloping to a discharge point on the hillside below the tailings impoundment (~150 feet).
  - Placing ~390 sy of non-woven filter fabric in the trenches.
  - Installing ~350 feet of 6-inch-diameter perforated drain pipe and ~110 lcy of drain rock in the trench. The trench and pipe would be sloped at a minimum of 2 percent and routed around the south end of repository to discharge on the hillside below the existing bench.
  - Installing ~2 lcy of riprap at each point of discharge to dissipate energy and prevent erosion.
- Option 2 – Geocomposite Sheet Drain:
  - Excavating a 4-foot-deep, 2-foot-wide trench in the existing bench along the hillside from the mill foundation sloping to a discharge point on the hillside below the bench (~200 feet).
  - Excavating a 4-foot-deep, 2-foot-wide trench between the tailings impoundment and hillside from the mill foundation sloping to a discharge point on the hillside below the tailings impoundment (~150 feet).
  - Installing ~350 lineal feet of geocomposite trench drain (AmerDrain Total-Drain or equivalent) in the trenches.
  - Installing ~20 feet of non-perforated pipe from the geocomposite trench drains to each discharge point.
  - Installing ~2 lcy of riprap at each point of discharge to dissipate energy and prevent erosion.

- Draining the UST, excavating the tank and TPH-contaminated soil (~50 bcy) with TPH concentrations above 2,000 mg/kg and transporting the fluid and waste off-Site for disposal.
- Excavating the partially processed ore and arsenic-contaminated soil from around the sump outfall and pond with arsenic concentrations above the risk-based cleanup level of 109 mg/kg.
  - ~265 bcy of partially processed ore
  - ~10 bcy of soil from the sump outfall and around the pond
- Using a Niton XRF to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
- Spreading the partially processed ore and contaminated soil on the tailings impoundment in one 12-inch lift and compacting.
- Excavating diversion channels to intercept and divert surface water run on around the millsite and capped waste material. The V-shaped channels would be 1 to 2 feet deep with 2H:1V side slopes and lined with riprap. Presumably, the riprap would be obtained from an on-Site source.
- Capping the consolidated mine waste. Two cover options were evaluated:
  - Option 1 – Soil Cover:
    - Importing ~1,930 lcy of clean, well-graded soil from an off-Site source (assumed to be within 50 miles of the Site) and installing an earthen cover consisting of 24 inches of well-graded soil over the consolidated mine waste (Figure 5).
    - Placing the soil cap in one lightly compacted 12-inch lift and one loose 12-inch lift.
    - Seeding the cover with a Forest Service approved seed mix and mulching (~1 acre).
    - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.

- Option 2 – Engineered Cover:
  - Preparing the mine waste surface to provide a bedding layer for the geocomposite sheet drain.
  - Installing ~11,760 sf of geocomposite sheet drain material (AmerDrain 200 or equivalent) over the mine waste (Figure 5).
  - Importing ~970 lcy of clean, well-graded soil from an off-Site source (assumed to be within 50 miles of the Site) and placing 12 inches of soil over the geocomposite sheet drain material in one lightly compacted lift.
  - Seeding the cover with a Forest Service approved seed mix and mulching (~1 acre).
  - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
- Grading the temporary access roads and disturbed areas (~1 acre) to blend with the surrounding topography and promote drainage.
  - Applying 6 to 12 inches of growth media (~10 lcy), seeding with a Forest Service approved seed mix, and mulching.
  - Placing woody debris generated during the removal action over the seeded areas to prevent erosion and provide natural habitat.

ALTERNATIVE 4 – ON-SITE DISPOSAL VIA HELICOPTER

Primary access is by helicopter (Access Option B). The mine road would be minimally improved to provide ATV access to the millsite for the field crew and ground support in the event of an emergency. Cover soil would be obtained on-Site. Two options were evaluated for this alternative: (A) excavation and disposal in a repository at the millsite, and (B) capping the material in place. Because of the high cost of transporting bulk material to the Site via helicopter, both options assume an on-Site soil borrow source. If an on-Site source of suitable and sufficient borrow material cannot be located, this alternative becomes cost-prohibitive compared to Alternative 3.

Option 4A: Excavation and Disposal in Repository at Millsite

Under this option, the mine waste and contaminated soil would be disposed of in a repository at the millsite as described under Option 3A, except that the cover soil will come from an on-Site borrow source rather than importing from an off-Site source. All other removal action activities would be as described under Option 3A, including off-Site disposal of the UST and petroleum-contaminated soil, and construction of a geocomposite sheet drainage system and diversion channel.

- Construction equipment would likely consist of:
  - Medium track hoe,
  - Small dozer,
  - Skid steer,
  - Skip loader, and
  - Rock screening plant.
- Constructing ~200 feet of temporary access road to the repository for equipment access.
- Installing temporary erosion control BMPs.
- Clearing and grubbing the borrow site (~1 acre) and stockpiling the woody debris.
- Excavating ~1,270 lcy of clean borrow soil for use in the repository cap and covering the excavated waste areas, and hauling to the millsite (assumed to be within 200 feet).
- Reclaiming the borrow source, excavated waste areas, and 600 feet of access road by ripping compacted surfaces, grading to blend with the natural hillside to the extent possible, seeding ~1 acre with a Forest Service approved seed mix and mulching.

Option 4B: Capping in Place

Under this option, the mine waste and contaminated soil would be capped in place as described under Option 3C, except that the cover soil will come from an on-Site borrow source rather than importing from an off-Site source. All other removal action activities would be as described under Option 3C, including off-Site disposal of the UST and petroleum-contaminated soil, and construction of geocomposite sheet drainage systems and diversion channels.

- Construction equipment would likely consist of:
  - Medium track hoe,
  - Small dozer,
  - Skid steer,
  - Skip loader, and
  - Rock screening plant.
- Constructing ~200 feet of temporary access road to the repository for equipment access.
- Installing temporary erosion control BMPs.
- Clearing and grubbing the borrow site (~1 acre) and stockpiling the woody debris.
- Excavating ~1,930 lcy of clean borrow soil (depending on cover option selected) for use in the repository cap and hauling to the millsite (assumed to be within 200 feet).
- Reclaiming the borrow source, excavated waste areas and 600 feet of access road by ripping compacted surfaces, grading to blend with the natural hillside to the extent possible, seeding ~1 acre with a Forest Service approved seed mix and mulching.

ALTERNATIVE 5 – UPPER WORKINGS VIA HELICOPTER

Access will be via helicopter. No access road to the upper workings will be constructed. The bench at the upper workings is too narrow for a helicopter to land and all equipment and materials would need to be transported in a cable sling beneath the helicopter. The field crew would need to hike up and down the steep trail to the upper workings. Two options were evaluated for this alternative and are discussed below: (1) capping only the bench in place, and (2) capping the entire waste rock pile in place.

Removal actions common to both options include:

- Removing the AST and ACM as described above.
- Installing a bat gate or culvert in the Main Adit as described above.
- Clearing and stockpiling the wood and metal structural debris from the bench (~0.25 acre).
- Rerouting the Main Adit discharge and surface drainage that currently flow through two culverts and discharge onto the waste rock pile and diverting the flow around the waste rock pile onto native, undisturbed ground (Figure 7).
  - Installing collection systems at the Main Adit portal and the surface drainage.
    - Excavating the area around the adit portal and surface drainage to expose the existing collection system.
    - Excavating a 200-feet long trench along the back of the bench and installing a 24-inch HDPE pipe. The trench and pipe would be sloped at a minimum of 2 percent and routed around the end of the bench to a discharge point. An infiltration pit or riprap apron (~2 lcy) would be placed at the outlet to prevent erosion.

Option 5A: Capping in Place – Main Adit Bench

Under this option, only the top surface of the waste rock pile, i.e. the bench, would be capped with soil excavated from the northwest end of the bench and hillside above the bench.

- Construction equipment would likely consist of:
  - Small track hoe, and
  - Skip loader.

- Installing a 2-foot thick earthen cover over the bench.
  - Excavating ~450 lcy of soil from the native hillside at the northwest end of the bench and stockpiling for use in the cap.
  - Spreading the soil over the bench in one lightly compacted 12-inch lift and one loose 12-inch lift.
  - Seeding the cover with a Forest Service approved seed mix and mulching (~0.25 acre).
- Placing the stockpiled wood and metal structural debris back over the final bench cover surface to prevent erosion and provide natural habitat.

Option 5B: Capping in Place – Entire Bench/Waste Rock Pile
Under this option, the entire waste rock pile and bench would be capped with soil airlifted to the upper workings.

- Construction equipment would likely consist of:
  - Small track hoe,
  - Small dozer, and
  - Skip loader.
- Excavating benches along the existing waste rock pile slope at 10-foot intervals to provide a stable configuration for the soil cap. The benches would be approximately 6 feet wide and up to 130 feet long.
- Installing a 2-foot thick earthen cap over the waste rock pile and bench.
  - Excavating ~450 lcy of soil from the native hillside at the northwest end of the bench and stockpiling for use in the cap.
  - Spreading the soil over the bench in one lightly compacted 12-inch lift and one loose 12-inch lift.
  - Airlifting ~2,750 lcy of additional soil from an off-Site source (assumed to be within 50 miles) to the upper workings via helicopter and dumping the soil on the benches.
  - Spreading the soil along the bench and slopes between the benches.
  - Seeding the cover with a Forest Service approved seed mix and mulching (~1 acre).
- Placing the stockpiled wood and metal structural debris back over the final bench cover surface to prevent erosion and provide natural habitat.

5.2 Analysis of Selected Removal Action Alternatives

The removal action alternatives were evaluated based on the following criteria:

- Effectiveness
- Implementability
- Cost

Effectiveness is defined as the ability of an alternative (relative to other options in the same technology sub-category) to:

- Protect public health and the community, protect workers during implementation, and protect the environment – addresses whether or not the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls; and
- Comply with ARARs – addresses whether or not a remedy will meet all ARARs or other federal and state environmental statutes and/or provide grounds for invoking a waiver.

Implementability encompasses the technical and administrative feasibility of implementing a removal action and the availability of resources needed to implement the removal action. It also takes into account legal considerations. Factors of particular consideration include removal action and operational feasibility; availability of equipment, personnel, and treatment capacity; community acceptance; and the ability to obtain necessary permits for off-Site actions.

- Technical feasibility – refers to construction and operational considerations, the demonstrated performance and useful life, adaptability to site-specific environmental conditions, whether it contributes to remedial performance.
- Administrative feasibility – refers to the permits required, easements or right-of-ways required, impacts on adjoining properties, the ability to implement institutional controls, and the likelihood of obtaining an exemption from statutory limits, if needed.
- Availability – includes the availability of equipment, personnel and services, outside laboratory testing services (if needed), off-Site treatment and disposal capacity (if needed).

The relative cost of each alternative was evaluated based on professional experience, engineering judgment, and standard cost estimating tools. Primary cost considerations include:

- Capital costs,
- Engineering and design costs, and
- Operation and maintenance (O&M) costs.

The estimated costs for each task are provided in Appendix C and summarized in Table 14. Costs are based on experience at similar sites, on published data and reports, and on inquiries to possible vendors. Many removal action unit costs were obtained from R.S. Means data, and include overhead and profit (2005, adjusted for 2009). Estimated costs relied on several significant assumptions regarding Site conditions and are based on conceptual design only. The estimated costs are intended for alternative comparison only and are not suitable for construction bidding purposes.

Assumptions made in preparing the cost estimate include:

- All removal actions can be completed in one field season using standard removal action equipment.
- All borrow soil will be available either (1) from within the repository footprint, (2) a borrow source at the millsite, or (3) from a nearby (within 50 miles) off-Site source.
- Significant cost savings may be realized from using a suitable on-Site borrow source for growth medium and other materials.
- A temporary staging area can be established at Olney Pass for offloading equipment and materials. This will lessen the degree of required improvements to FR 6110. For helicopter access, a temporary staging area can be established at Gold Bar.
- The proposed locations for the on-Site repository are suitable and accessible, and will not require significant modification.
- Site debris are generally non-hazardous and can be disposed of in an on-Site repository or at the local sanitary landfill.
- The Reservoir Adit will not require installation of a bat gate or culvert.
- The Forest Service and State Historic Preservation Officer (SHPO) will approve covering of the lower mill foundation.
- The road-side repository would be permitted by the land owner (WDNR).

- All trees and brush felled at the Site during the removal action will be stockpiled and placed over the seeded areas to minimize erosion, or burned on-Site. All trees and brushed cleared from the access road (FR 6110) will be hauled out and disposed of at the direction of the Forest Service.
- Post-removal monitoring costs are based on biannual Site visits for a 3-year period following completion of removal action.
- Post-removal monitoring will consist of visually inspecting the repository cap and reclaimed areas, and assessing the aquatic habitat in the MFSF immediately upstream and downstream of the Site. Post-removal sampling will be limited to the aquatic habitat in MFSF and consist of surface water, pore water, sediment, and benthic macroinvertebrate samples from three locations on the MFSF. The analytical suite will be limited to a select set of metals based on sample results from the SI.
- Data collected during the SI provides acceptable baseline for post-removal monitoring and a pre-removal monitoring event will not be required.
- The estimated fees for removal action design and work plan preparation range from 10 to 20 percent based on the removal action cost for each task and the complexity of the removal action.
- The estimated fees for removal action oversight were based on the anticipated duration and scope of the removal action and ranged from $20,000 to $70,000.
- The total estimated removal action costs include a 25 percent contingency.
- Present value corrections were not calculated because of the short duration of the removal action and monitoring.

5.3 Identification of Data Gaps

Several data gaps were identified during the preparation of this EE/CA, including:

- Extent of blasting that will be required to widen and stabilize the existing access road;
- Lack of sufficient background samples to develop reasonably accurate average background COI concentrations for all media;
- Lack of sufficient soil samples, including samples at depth, from the bench at the millsite;
- Lack of a fluid sample from the UST and soil samples from depth around the tank;
- Lack of a fluid sample from the AST and soil samples from around the base of the tank;
- Quantity of ACM at the upper workings is unknown;
- Integrity of the Reservoir Adit portal and extent of underground workings unconfirmed;
- Risks associated with human and ecological exposure to petroleum-contaminated soil at the millsite not assessed in the streamlined risk assessment by CES (2006);
- Potential presence of sensitive amphibian species in areas around the tailings impoundment, sump drain, and sump outfall pond at the millsite, and bat species in the open adits;
- Suitability of proposed repository locations;
- Availability of a suitable borrow soil source at the millsite and upper workings; and
- Lack of detailed topographical data for the Site.

The data gaps, potential issues, recommended actions, and estimated costs are summarized in Table 15. Broad assumptions regarding material quantities and Site conditions were used to address the data gaps in the development of conceptual designs presented in this EE/CA. While these data can affect the overall removal action cost and will be needed for preparing the final design, we don’t expect it to significantly effect the alternative selection.

6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives were compared based on the following criteria:

- **Effectiveness**
  - Protective of human health and the environment
  - Complies with ARARs, especially key ARARs identified for the Site
  - Achieves RAOs
- **Implementability**
  - Technical Feasibility
  - Administrative Feasibility
  - Availability of Resources
- **Cost**

The comparative analysis of removal action alternatives is described in Table 16 and summarized below by criteria. State and community acceptance will be determined during the public comment period.

<u>**Effectiveness**</u>

- **Alternative 1** – No Action is the least effective.
  - The mine waste and physical hazards would continue to pose a significant threat to public visiting the Site.
  - The mine waste would also continue to pose a threat to ecological receptors and continue contributing metals loading to the MFSF, Spada Lake, and the Sultan River.
  - Not protective of human health and the environment, and would not comply with ARARs or achieve any RAOs.
- **Alternative 2** – Off-Site Disposal provides the most protection to human health and the environment by removing the mine waste and contaminated soil from the Site and disposing of in a controlled facility.
  - Removing mine waste and contaminated soil from the millsite would achieve the RAOs by eliminating exposure to metals in the mine waste, eliminating metals loading from the mine waste to the MFSF, and attaining ARARs to the extent practical.
  - Removal criteria are protective of human health.
  - Most key chemical-specific ARARs would be attained:
    - Surface Water Quality ARARs – Surface water, including MFSR and area runoff/seepage will meet water quality criteria (Table 9) or background conditions after removal and isolation of the mine waste and tailings that are leaching contaminants into surface water at the millsite. Post-removal monitoring would determine compliance success. Discharge from mine adits would be unchanged and some constituents may exceed surface water criteria.
    - Soil Quality ARARs – The mine waste and contaminated soil would be removed to eliminate the surface exposure pathway. Risk-based soil cleanup levels, background levels, or the lowest MTCA soil cleanup standards (Table 10) would be attained, whichever is greater. MTCA ARARs may not be met because the soil cleanup standards are based on industrial or unrestricted land uses as discussed in Section 3.2; however, the risk-based cleanup levels were developed specifically for the Site and are based on recreational land use.
    - Sediment Quality ARARs – Sediment in the MFSF contains metals concentrations that may slightly exceed ARARs. However, removal of the mine waste and contaminated soil from the millsite will eliminate or significantly reduce contaminant loading to the MSFS

and sediment quality may eventually achieve ARARs. Stream sediments would not be addressed to avoid excessive collateral environmental impacts (see Section 4.2).

  - Compliance with Solids Disposal ARARs – Key action-specific ARARs would be attained. Contaminated wastes would be isolated from the environment in off-Site permitted waste facilities.
  - Compliance with FP S&G ARARs – Key location-specific ARARs would be attained. Wastes would be stored outside the Riparian Reserve; roads and disturbance in the Riparian Reserve would be minimized.
  - High short-term and long-term effectiveness and permanence (see Table 16).
  - There is additional risk to human health and the environment during off-Site transportation of mine waste from potential accidents, spills or releases at transfer points and in route.
  - No reduction in toxicity or volume through treatment, but moderate to high reduction in toxicity through containment and capping.
  - This alternative does not address the upper workings.
- **Alternatives 3 & 4** – On-Site Disposal is highly protective of the human health and environment by removing the exposure pathway.
  - Consolidating and/or capping the mine waste and contaminated soil would achieve RAOs by eliminating exposure to metals in the mine waste, decreasing metals loading to the MFSF, and attaining ARARs to the extent practical.
  - Removal criteria are protective of human health.
  - Most key chemical-specific ARARs will be attained:
    - Surface Water Quality ARARs – Surface water, including MFSR and area runoff/seepage will meet water quality criteria (Table 9) or background conditions after encapsulation of the mine waste and tailings that are leaching contaminants into surface water at the millsite. Post-removal monitoring would determine compliance success. Discharge from mine adits would be unchanged and some constituents may exceed surface water criteria.
    - Soil Quality ARARs – The mine waste and contaminated soil would be consolidated and/or capped to eliminate the surface exposure pathway. Risk-based soil cleanup levels, background levels, or the lowest MTCA soil cleanup standards (Table 10) would be attained, whichever is greater. MTCA ARARs may not be met because the soil cleanup standards are based on industrial or unrestricted land uses as discussed in Section 3.2; however, the risk-based cleanup levels were developed specifically for the Site and are based on recreational land use.
    - Sediment Quality ARARs – Sediment in the MFSF contains metals concentrations that may slightly exceed ARARs. However, removal or encapsulation of the mine waste and contaminated soil from the millsite will eliminate or significantly reduce contaminant loading to the MSFS and sediment quality may eventually achieve ARARs. Stream sediments would not be addressed to avoid excessive collateral environmental impacts (see Section 4.2).
  - Compliance with Solids Disposal ARARs – Key action-specific ARARs would be attained. Contaminated wastes would be isolated from the environment by capping in place or in an earthen repository.
    - The repository along the access road (Option 3B) would be more effective than a repository at millsite (Options 3A & 4A) or capping in place (Options 3C & 4B), and may better meet the intent of FP S&Gs because the mine waste would be relocated to an area above the 500-year MFSF flood elevation and out of the Riparian Reserves. The millsite repository may be a less stable configuration than along the access road because of groundwater seepage along the hillside at the millsite.
    - The repository along the access road may be subject to more potential vandalism and require more maintenance because it would be visible from FR 6110.

        - Both cover options would be moderately effective in reducing infiltration through the waste material; however, neither cover would not satisfy the substantive Solids Disposal ARARs (i.e. state landfill standards [WAC 173-350-400] or WAC 173-350-400(3)(e)(I).
    - Compliance with FP S&G ARARs – Key location-specific ARARs would be attained. Wastes currently located in the Riparian Reserve would be stabilized and chemical releases eliminated; roads and disturbance in the Riparian Reserve would be minimized.
    - High short-term effectiveness and moderate to high long-term effectiveness and permanence (see Table 16).
    - No reduction in toxicity or volume through treatment, but moderate to high reduction in toxicity through containment and capping.
    - Neither alternative addresses the upper workings.
- **Alternative 5** – Upper Workings, Capping in Place is moderately to highly protective of the human health and environment by removing some or the entire exposure pathway.
    - Removing the hazardous materials and capping the mine waste would achieve RAOs by eliminating or decreasing exposure to metals in the mine waste, decreasing metals loading to the MFSF, and attaining ARARs to the extent practical.
    - Removal criteria are protective of human health.
    - Most key chemical-specific ARARs will be attained:
        - Surface Water Quality ARARs – It is anticipated that potential chemical-specific ARARs (Table 9) would ultimately be attained through natural attenuation by diverting the water away from the waste rock and infiltrating in native soils. Post-removal monitoring may determine compliance success.
        - Soil Quality ARARs – Hazardous materials would be removed and the mine waste would be capped in place to remove the exposure pathway. Risk-based soil cleanup levels, background levels, or the lowest MTCA soil cleanup standards (Table 10) would be attained, whichever is greater. MTCA ARARs may not be met because the soil cleanup standards are based on industrial or unrestricted land uses as discussed in Section 3.2; however, the risk-based cleanup levels were developed specifically for the Site and are based on recreational land use.
    - Compliance with Solids Disposal ARARs – Key action-specific ARARs would be partially or completely attained. Contaminated wastes would be isolated from the environment by capping in place with an earthen cover.
        - Option 5B would cover more waste than Option 5A; however, Option 5A costs significantly less and would address the area with the highest expected potential exposure (i.e. bench surface versus the steep waste rock slope).
    - Moderate to high short-term and long-term effectiveness and permanence (see Table 16).
    - No reduction in toxicity or volume through treatment, and low to moderate reduction in mobility through capping.

<u>Implementability</u>

- **Alternative 1** – No Action is most technically feasible and easiest to implement.
- **Alternative 2** – Off-Site Disposal would be highly implementable.
    - The services and materials required for this alternative are easily obtained and readily available
- **Alternatives 3 & 4** – On-Site Disposal is moderately to highly implementable.
    - The availability of service and materials is high.
    - Alternative 3 – On-Site Disposal via Road would be difficult to implement because of the significant road improvements required. Specialized equipment and construction methods may be required to install the bridges and stabilize the road in critical areas. Alternative 4 – On-Site Disposal via Helicopter would also be difficult to implement because of the

specialized equipment (i.e. helicopter) and methods required to airlift materials and equipment to the Site. The implementability of Alternative 4 is also partially dependent on the availability of a sufficient source of suitable cover soil in close proximity to the millsite.
    - Options 3A and 4A – Disposal in Repository at Millsite would be easier to implement than Option 3B because the mine waste would not have to be hauled.
    - Options 3C and 4B – Capping in Place would be the easiest to implement because it would require the least amount of excavation and moving of waste materials, whether access is by road or helicopter. Of the two options, 3C (road access) would be easier to implement if cover soil needs to be imported from off-Site.
- **Alternative 5 –** Upper Workings, Capping in Place is moderately to highly implementable.
    - The availability of service and materials is high.
    - Both options would require specialized construction equipment and methods to access the upper workings and dispose of the hazardous materials (i.e. dynamite and ACM).
    - Option 5B would be more difficult to implement than Option 5A because of the large volume (~2,750 lcy) of soil that would need to be airlifted to the upper workings for the soil cap and difficulties associated with placing the soil on the steep waste rock slope. The implementability of Option 5A is partially dependent on the availability of a sufficient source of suitable cover soil at the upper workings.

<u>Cost</u>

- Alternative 1 – No Action is the least expensive alternative.
- Alternative 2 – Off-Site Disposal is the most expensive alternative because of the waste transport and disposal costs ($2,240,333).
- Alternatives 3 & 4 – The Two On-Site Disposal Alternatives and eight options are all expensive and differ by less 20 percent for all options ($1,119,025 to $1,381,941).
    - Alternative 3C with an Engineered Cover is the least expensive alternative ($1,119,025).
    - Alternative 3B with the Engineered Cover is the most expensive alternative ($1,381,941) because of the waste hauling cost.
    - Significant savings (approximately $15,000 to $80,000) could be achieved for Alternatives 3A and 3C if a suitable on-Site borrow soil source can be identified.
    - Under Alternative 4, if a suitable on-Site borrow soil source cannot be identified the removal action costs would increase significantly (approximately $140,000 for Alternative 4A and $670,000 for Alternative 4B).
- Alternative 5A (capping the bench only) is less expensive ($402,476) compared to capping the entire waste rock pile (Alternative 5B, $1,458,509) because of the high cost of transporting soil to the upper workings using a helicopter.

7.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Key features of the recommended removal action alternative are discussed below. Details are provided in Section 5.1 and on Figures 5 through 8. The recommendation expressed here is based on the analysis discussed in Sections 5.3 and 6.0, and summarized in Table 16. The recommended alternative is a combination of Alternatives 3C and 5A with Site access Option A:

- **Site Access Option A – Rebuild Access Road**
- **Alternative 3C – Capping Mill Waste in Place with an Engineered Cover**
- **Alternative 5A – Capping Mine Waste in Place – Main Adit Bench**

Rebuilding the access road and capping the mill waste in place with an engineered cover is the least expensive alternative. RAOs will be met by eliminating exposure to metals in the mine waste and contaminated soil at the millsite, decreasing metals loading to the MFSF and attaining ARARs to the extent possible. Capping the mill waste in place will minimize the amount of overall Site disturbance and eliminate the need to haul the material off-Site. The engineered cap is less expensive than a soil cap and will minimize infiltration through the mine waste material; however, additional soil over the engineered cap would increase revegetation success and provide better long-term protection against erosion and re-exposure of the waste material. Long-term maintenance of the engineered cap would be similar to a soil cap and involve inspecting for erosion and areas of exposed geocomposite material. Any damaged geocomposite material would need to be replaced; however, damage to the geocomposite is unlikely assuming there will be no vehicular or ATV access to the capped area. While the estimated costs are based on importing cover soil to the Site, identifying a suitable on-Site borrow source could decrease construction costs by about $30,000.

Capping the Main Adit bench at the upper workings in place is the least expensive alternative for the upper workings. While capping the entire waste pile would be more protective of human health and the environment, the cost would be significantly higher (>$1,000,000). Also, the difficult access to the upper workings and steep waste pile slope should deter access and minimize public exposure, and the abundance of more suitable habitat surrounding the upper workings should minimize ecological exposure.

The existing access road (FR 6110) would be fully reconstructed to provide full equipment access to the millsite for the removal action and post-removal monitoring. At the millsite, the UST, petroleum contaminated soil, and empty drums and debris would be removed and transported off-Site for disposal. Soil from the sump outfall and partially processed ore on the foundation tiers with arsenic concentrations above the risk-based cleanup level of 109 mg/kg would be excavated and placed on the tailings impoundment. The tailings impoundment and portion of the millsite bench with soil above the arsenic cleanup concentration would then be capped in place with an engineered cover consisting of a geocomposite sheet drain and 12 inches of growth medium from an off-Site source. The cover would be seeded with a Forest Service-approved seed mix and mulched. Two diversion channels would be installed above the millsite to divert stormwater run on and two geocomposite drains would be constructed to intercept and divert groundwater seepage around the capped waste material.

At the upper workings, wood and metals debris scattered on the bench would be cleared and stockpiled at one end of the bench. A certified asbestos removal team would remove the red insulation tiles (ACM) and transport to an off-Site disposal facility via helicopter. Dynamite inside the Main Adit would be burned and disposed of inside the underground workings by a certified explosives handler. The Main Adit portal and area around the surface drainage would be excavated and stabilized, and a 24-inch HDPE pipe would be installed to divert the surface drainage flow and adit discharge around the bench to the native hillside. Bat gates or culverts would be installed in the Main Adit and Reservoir Adit. The AST would be buried at one end of the bench. The bench would be covered with 2 feet of soil, seeded, and mulched. The soil would be generated from the hillside and northwest end of the bench. The stockpiled wood and metal debris would be placed back over the final surface. The tram terminal wooden platform would be left undisturbed. BMPs would be implemented during removal action activities as described in Section 5.1 under Removal Action Elements Common to All Removal Action Alternatives.

Specifics of the recommended removal action alternative are described below:

- **Rebuild Access Road:**
    - Clearing ~5 miles of the existing access road (FR 6110) from Olney Pass to the Site.
    - Loading and hauling ~2 miles of deadfall material out.
    - Rough grading ~3 miles of the existing access road.
    - Installing three 60-inch diameter corrugated steel culverts
    - Purchasing, transporting, and installing two temporary bridges (60-foot and 80-foot).

- Blasting the highwall along ~1,000 feet of road to stabilize and widen for equipment access.
- Forest Service and/or WDNR specifications may require additional actions. Maintenance of the road may also be required, including light to heavy brushing, spot surfacing, seasonal closure, and seeding.

- **Capping Mill Waste in Place at Millsite:**
  - Clearing ~500 feet of the old access road from the bridge crossing at the MFSF to the millsite and ~200 feet of an old access road leading from the south end of the millsite up the hillside to the middle tiers of the concrete mill foundation. Constructing a temporary access road (~200 feet) to the sump outfall pond.
    - Installing temporary erosion control BMPs.
  - Clearing and grubbing the waste areas, existing bench, and soil borrow source (~2 ac), and stockpiling the woody debris.
  - Installing two geocomposite drain systems to intercept groundwater that may seep from the hillside during wet conditions and divert the flow around the mine waste (Figure 6): (1) between the tailings impoundment and hillside, and (2) along the saturated area where the bench meets the hillside.
    - Excavating 350 feet of trench, 4-feet-deep and 2-feet-wide, and installing a geocomposite trench drain and 6-inch diameter drain pipe in the trench. The trenches would be sloped at a minimum of 2 percent and routed around the north and south ends of the bench to discharge on the hillside below the bench. Riprap erosion protection (~2 lcy each) would be placed at the outlets to prevent erosion.
  - Draining the UST, excavating the tank and TPH-contaminated soil (~50 bcy) with TPH concentrations above 2,000 mg/kg and transporting the fluid and waste off-Site for disposal.
  - Excavating the partially processed ore and arsenic-contaminated soil from around the sump outfall and pond with arsenic concentrations above the risk-based cleanup level of 109 mg/kg.
    - ~265 bcy of partially processed ore
    - ~10 bcy of soil from the sump outfall and around the pond
  - Using a Niton XRF to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
  - Spreading the partially processed ore and contaminated soil on the tailings impoundment in one 12-inch lift and compacting.
  - Excavating ~420 feet of diversion channels to intercept surface water run on and divert around the millsite and capped waste material. The V-shaped channels would be 1 to 2 feet deep with 2H:1V side slopes and lined with riprap. Presumably, the riprap would be obtained on-Site.
  - Installing an engineered cover consisting of a geocomposite sheet drain (AmerDrain 200 or equivalent) and 12 inches of growth medium over the consolidated mine waste (Figure 5).
    - Preparing the mine waste surface to provide a bedding layer for the geocomposite sheet drain.
    - Installing ~11,760 sf of geocomposite sheet drain material (AmerDrain 200 or equivalent) over the mine waste (Figure 5).
    - Importing ~970 lcy of clean, well-graded soil from an off-Site source (assumed to be within 50 miles of the Site) and placing 12 inches of growth medium over the geocomposite sheet drain material in one lightly compacted lift.
    - Seeding the cover with a Forest Service approved seed mix and mulching (~1 acre).
    - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
  - Grading the millsite and areas (~1 acre) from which the mine waste and soil have been excavated to blend with the surrounding topography and promote drainage.

- Applying 6 to 12 inches of growth media (~10 lcy), seeding with a Forest Service approved seed mix, and mulching.
- Ripping 900 feet of access road, grading to blend with the natural hillside to the extent possible, seeding with a Forest Service approved seed mix and mulching.
- Placing woody debris generated during the removal action over the seeded areas to prevent erosion and provide natural habitat.

- **Capping Mine Waste in Place at the Upper Workings:**
  - Clearing and stockpiling the wood and metal structural debris on the bench.
  - Installing a 2-foot thick earthen cover over the bench.
    - Excavating ~450 lcy of soil from the native hillside at the northwest end of the bench and stockpiling for use in the cap.
    - Spreading the soil over the bench in one lightly compacted 12-inch lift and one loose 12-inch lift.
    - Seeding the cover with a Forest Service approved seed mix and mulching (~0.25 acre).
  - Placing the stockpiled wood and metal debris back over the final bench cover surface to prevent erosion and provide natural habitat.

The recommended alternative would cap a total of ~8,505 bcy of waste rock, tailings, partially processed ore, and contaminated soil at the millsite, and the top surface of an 8,250-bcy waste rock pile at the upper workings. The removal action would achieve RAOs and attain ARARs to the extent practical by eliminating the surface exposure pathway to mine waste and hazardous materials, minimizing contaminant transport to surface water, and mitigating physical hazards at the Site. The recommended alternative would significantly reduce potential human and ecological risk from exposure to mine waste at the Site.

The recommended alternative will satisfy the eight factors in 40 CFR 300.415(b) as described below.

Factor	Site Condition	Satisfied?
(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants	Public access to mine waste and contaminated soil will be eliminated by capping the source. Overall surface water quality at the Site should improve by diverting flows away from of the primary waste source.	Yes
(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems	There is no public water supply and, although water discharging from adits exceeds ARAR-based criteria, there is no measurable impact to the MFSF. The Main Adit water quality will be improved by preventing contact with upper waste rock pile and promoting natural attenuation by discharging to native soils.	Yes
(3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release	One UST at the millsite and one AST at the upper workings. The UST will be filled in-place with sand or removed and transported to an off-Site facility for disposal. The AST will be buried on-Site or removed and transported to an off-Site facility for disposal.	Yes
(4) High levels of hazardous substances, pollutants, or contaminants in soils largely at, or near, the surface that may migrate	The hazardous materials will be removed and the mine waste and contaminated soils will be capped in place.	Yes
(5) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released	The hazardous materials will be removed and the mine waste and contaminated soils will be capped in place.	Yes
(6) Threat of fire or explosion	Dynamite in the Main Adit will be destroyed or removed.	Yes
(7) The availability of other appropriate federal or state response mechanisms to respond to the release	The Site is on Forest Service land and is being addressed by the Forest Service.	Yes
(8) Other situations or factors that may pose threats to public health or the environment	Physical hazards will be mitigated.	Yes

The total estimated removal action cost is **$1,521,501.**

The proposed removal action designs presented in this EE/CA are conceptual only and not intended for construction. All material quantities are estimates only and should be verified for final design.

Prepared by:

Millennium Science and Engineering, Inc.

11/09/09

Michael J. Puett, P.E. — Date
Principal Author

Millennium Science and Engineering, Inc.

11/09/09

Don Tibbets, E.I.T. — Date
Technical Reviewer

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Tables

Table 1. Mine Waste Analytical Results Summary
Kromona Mine EE/CA

Area	Sample ID	Depth (ft bgs)	Date Collected	pH	Analyte Concentration (mg/kg)																										Sulfur Forms (%)			Acid Base Accounting (t $CaCO_3$/Kt)		
					Ca	K	Mg	Na	WAD CN	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn	Total	Pyritic	Sulfate	AGP	ANP	ABP
Millsite Soils	KM-DS-SS1	0-0.5	5/18/2005	NA	5280	2430	9000	455	NA	9.21	17000	NA	NC	4470	97.6	*0.1*	0.22	93.5	36	12600	51400	0.91	1140	26.8	118	5.70	2.96	*1.0*	79.4	373	NA	NA	NA	NA	NA	NA
	KM-S-1	0-0.5	6/28/2005	4.9	6680	969	3170	213	*0.25*	*0.25*	9490	38.78	1371	1410	110	*0.1*	7.46	86.4	54	6410	193000	0.122	2500	39.1	169	5.85	4.12	*0.75*	52.7	2010	0.42	0.26	0.14	8.13	*0.15*	-8.13
	KM-S-2	0-0.5	6/28/2005	5.2	13500	486	1870	87	NA	*0.25*	10700	NA	NC	533	241	*0.1*	6.34	99	29	4380	83400	*0.017*	9680	26.1	130	4.15	2.24	2	65.5	592	NA	NA	NA	NA	NA	NA
	KM-S-3	0-0.5	6/28/2005	7.8	16800	6620	12300	415	*0.25*	2.83	16700	*0.114*	947	947	104	*0.1*	0.52	25.5	63	6160	48100	0.172	770	18.5	27.6	1.53	2.11	*0.75*	100	123	0.77	0.4	0.2	12.5	51	38.5
	KM-S-4	0-0.5	6/29/2005	4.8	1660	2810	11500	192	NA	*0.25*	30100	NA	NC	56	140	0.47	0.59	14.4	62	82	36500	0.037	690	59.4	20.5	*0.15*	0.37	*0.75*	83.7	95.5	NA	NA	NA	NA	NA	NA
	KM-S-5	0-0.5	6/29/2005	4.9	2850	6750	9790	304	*0.25*	*0.25*	32300	*0.119*	56	56	184	0.67	0.78	17.6	72	104	40800	0.449	817	80.1	10.1	*0.15*	*0.15*	*0.75*	106	91.8	0.03	0.02	0.01	0.63	7.56	6.93
	KM-S-6	0-0.5	6/29/2005	5.2	2770	824	12000	164	NA	*0.25*	21700	NA	NC	11	50.4	0.25	0.4	12.5	53	46	33400	*0.017*	621	61	7.7	*0.15*	*0.15*	*0.75*	58.7	77.1	NA	NA	NA	NA	NA	NA
	KM-S-7	0-0.5	6/29/2005	NA	7770	4090	10500	537	NA	*0.25*	16800	NA	NC	97	106	*0.1*	0.55	11.6	94	243	31300	0.052	526	28.4	25	0.502	*0.30*	*0.75*	77.2	341	NA	NA	NA	NA	NA	NA
	KM-S-4-MSE[a]	0-0.5	9/10/2008	5.2	1720	957	9610	144	NA	NA	18300	NA	NA	140	50.2	0.337	*0.10*	10.9	32.7	1010	29200	0.053	431	30.2	20.3	2.2	*2.0*	2.6	58.3	70.3	NA	NA	NA	NA	NA	NA
	KM-S-5-MSE[a]	0-0.5	9/10/2008	4.4	1600	1100	9170	123	NA	NA	17400	NA	NA	98.2	45.4	0.333	*0.10*	10.6	40.6	414	29700	0.065	409	32.0	26.3	2.2	*2.0*	2.2	58.1	63.4	NA	NA	NA	NA	NA	NA
Tailings	KM-TP-1-1	0-0.5	6/28/2005	7.4	14900	6930	13000	778	NA	*0.25*	18200	NA	NC	546	126	*0.1*	*0.1*	19.7	53	1140	42400	*0.017*	750	20.3	16.1	*0.15*	*0.15*	*0.75*	101	67.3	NA	NA	NA	NA	NA	NA
		0.5-1	6/28/2005	7.2	15600	6470	12300	660	*0.25*	*0.25*	17800	3.242	549	462	116	*0.1*	*0.1*	19.6	57	925	40000	*0.017*	698	19.2	10	*0.15*	*0.15*	*0.75*	94.3	53.4	0.09	0.08	0.01	2.5	56.6	54.1
	KM-TP-1-2	0-0.5	6/28/2005	7.4	11300	7030	12900	901	NA	*0.25*	20600	NA	NC	624	135	*0.1*	*0.1*	23.3	68	1290	46200	*0.017*	850	22.10	17.5	*0.15*	*0.15*	*0.75*	108	71.7	NA	NA	NA	NA	NA	NA
		0.5-1	6/28/2005	7.3	15800	6270	12600	678	*0.25*	*0.25*	17500	7.611	387	395	114	*0.1*	*0.1*	18.5	62	1080	39300	*0.017*	691	20.5	12.7	*0.15*	*0.15*	*0.75*	93.5	60.7	0.13	0.09	0.04	2.81	53.2	50.4
	KM-TP-1-SS1	0-0.5	6/28/2005	7.0	10800	4700	10600	689	NA	*0.25*	15800	7.9	520	528	101	*0.1*	*0.1*	20.8	69	1490	39400	*0.017*	638	18.7	22.4	*0.15*	0.6	*0.75*	82.7	103	NA	NA	NA	NA	NA	NA
Partially Processed Ore	KM-WR-1-1	0.5-1	6/28/2005	7.5	10400	7870	12000	842	NA	*0.25*	18600	1.183	637	638	135	*0.1*	*0.1*	23.6	59	1800	44300	*0.017*	595	21.5	11	0.674	7.07	*0.75*	104	91.7	0.14	0.11	0.02	3.44	32.9	29.5
		1.5-2	6/28/2005	6.4	7210	7830	12500	736	NA	*0.25*	19500	2.194	494	496	143	*0.1*	*0.1*	25.7	61	2090	46800	*0.017*	623	23	10.4	0.674	8.7	*0.75*	114	101	NA	NA	NA	NA	NA	NA
	KM-WR-1-2	0.5-1	6/28/2005	4.6	2940	3760	6710	418	NA	26.4	9820	52.076	10448	10500	76.7	*0.1*	2.16	112	46	36000	96000	0.22	521	38.6	180	6.04	17.6	*0.75*	66.8	366	3.7	2.42	0.39	75.6	4.64	-71
	KM-WR-1-3	0.5-1	6/28/2005	6.9	8500	4450	8480	473	NA	13.3	10700	3.783	6526	6530	100	*0.1*	1.93	114	44	20200	68700	0.11	878	39.5	103	4.2	8.67	*0.75*	74.5	360	NA	NA	NA	NA	NA	NA
	KM-WR-1-4	0.5-1	6/28/2005	7.7	15200	6030	11200	379	NA	4.15	14800	NA	NC	1530	102	*0.1*	0.94	39	56	8650	47700	0.122	715	23.8	22.6	0.724	2.7	*0.75*	94.8	163	NA	NA	NA	NA	NA	NA
		1.5-2	6/28/2005	7.8	18000	5370	11500	370	NA	3.88	14000	1.109	858	859	96.1	*0.1*	0.68	29.2	51	8110	47300	0.075	8741	20.3	14.6	0.512	2.56	*0.75*	93.9	138	NA	NA	NA	NA	NA	NA
		2-2.5	6/28/2005	5.5	3370	2500	10700	468	NA	*0.25*	20500	NA	NC	33	89	0.24	*0.1*	11.7	70	211	31400	0.05	452	32.5	6.23	*0.15*	*0.15*	*0.75*	81.8	64.6	0.07	0.02	0.05	0.63	8.3	7.67
	KM-WR-1-5	0.5-1	6/28/2005	7.3	12600	6630	11700	522	NA	14.9	16600	NA	NC	1650	118	*0.1*	2.33	112	63	19100	58100	0.047	810	25.6	133	0.52	4.64	*0.75*	105	316	NA	NA	NA	NA	NA	NA
		1.5-2	6/28/2005	7.4	13000	7490	10900	718	NA	8.23	16700	NA	NC	497	143	*0.1*	1.4	83.6	72	12600	45600	0.063	608	23.6	21	*0.15*	3.19	*0.75*	97	218	NA	NA	NA	NA	NA	NA
Wasterock at Upper Workings	KM-WR-2-1	0.5-1	6/29/2005	7.3	11900	4970	14500	166	NA	5.53	20000	1.54	2488	2490	100	*0.1*	1.55	81.9	46	5760	54500	0.119	882	55.5	220	0.30	1.04	*0.75*	106	161	0.19	0.14	0.03	4.38	25.6	21.2
	KM-WR-2-2	0.5-1	6/29/2005	7.7	6480	4650	14700	199	NA	7.26	20900	NA	NC	997	97.9	*0.1*	1.65	47.5	46	10400	57100	0.1	1100	58.5	48	*0.15*	0.99	*0.75*	113	164	NA	NA	NA	NA	NA	NA
	KM-WR-2-3	0.5-1	6/29/2005	7.5	7180	3660	11100	227	NA	4.11	14900	3.744	1496	1500	107	*0.1*	1.11	31.1	34	4000	47800	0.114	968	42.6	41	0.525	1.63	*0.75*	96.4	137	NA	NA	NA	NA	NA	NA
	KM-TH-1	0.5-1	6/29/2005	7.3	29200	3110	12100	50	NA	39.1	11900	NA	NC	6370	48.8	*0.1*	5.08	186	25	42100	101000	0.349	1270	57.1	118	0.915	6.46	*0.75*	65.7	409	NA	NA	NA	NA	NA	NA
minimum =				4.4	1600	*486*	1870	*50*	*0.25*	*0.25*	9490	0.114	56	11	45.4	*0.1*	0.1	*10.6*	25.00	46.3	29200	*0.0165*	409	18.5	6.23	*0.15*	*0.15*	*0.75*	52.7	53.4	NC	NC	NC	NC	NC	NC
MDC =				**7.80**	**29200**	**7870**	**14700**	**901**	***0.25***	**39.1**	**32300**	**52.1**	**10448**	**10500**	**241**	**0.67**	**7.46**	**186**	**94.0**	**42100**	**193000**	**0.910**	**9680**	**80.1**	**220**	**6.04**	**17.6**	**2.6**	**114**	**2010**	NC	NC	NC	NC	NC	NC
average =				6.52	9822	4527	10657	425	*0.25*	5.5	17475	9.5	2060	1588	110	0.16	1.31	49.3	54.2	7443	54657	0.121	1406	34.4	56	1.4	3.0	0.9	86.9	246	NC	NC	NC	NC	NC	NC
95% UCL =				NC	12525	5538	11748	530	*0.25*	23.5	19337	26	4053	2763	128	0.26	2.22	91.2	60.7	13341	68344	0.500	3459	40.6	183	5.2	4.9	0.9	95	587	NC	NC	NC	NC	NC	NC
# of samples = 26; Standard Deviation =				NC	6275	2306	2824	246	NC	9.1	5061	15.7	2908	2417	40.0	NC	1.88	44.3	15.2	10385	32031	0.182	2202	16.2	61	1.9	NC	NC	18	366	NC	NC	NC	NC	NC	NC
Frequency detected =				NC	100%	100%	100%	100%	0%	46%	100%	85%	85%	100%	100%	15%	69%	100%	100%	100%	100%	65%	100%	100%	100%	58%	69%	4%	100%	100%	NC	NC	NC	NC	NC	NC
Human Health Screening Criteria																																				
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001a)									NS	NS	NS	NS	NS	20	NS	NS	2	NS	19	NS	NS	2	NS	NS	1000	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004)									1200	5100	100000	NS	NS	1.6	67000	1900	450	1900	450	41000	100000	310	19000	20000	800	410	5100	67	1000	100000	NS	NS	NS	NS	NS	NS
Ecological Screening Criteria																																				
WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals, lowest value (WDOE 2001b)									NS	2	50	7	10	7	102	10	4	20	42	50	NS	0.1	1100	30	50	5	0.3	1	2	86	NS	NS	NS	NS	NS	NS
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005)									NS	4.2	NS	NS	NS	18	330	21	0.36	13	28	NS	NS	NS	220	38	11	0.27	0.52	NS	7.8	46	NS	NS	NS	NS	NS	NS

Notes:
Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.
[shaded] Screening criteria exceeded.
ft = Feet
mg/kg = Milligram per kilogram
t $CaCO_3$/Kt = Ton calcium carbonate per kiloton of waste
ABP = Acid-base potential
AGP = Acid generation potential
ANP = Acid neutralization potential
bgs = Brelow ground surface
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
MTCA = Model Toxics Control Act
NA = Not analyzed for
NC = Not calculated
NS = No standard
PRG = Preliminary remediation goal
UCL = Upper confidence limit
WAD = Weak acid dissociable
WDOE = Washington Department of Ecology

TABLE 2
Toxicity Characterization Leaching Procedure and Synthetic Leaching Procedure Analytical Results Summary
Kromona Mine EE/CA

Sample ID	Date Collected	Sample Depth (feet)	Leachate Concentration (mg/L)															
			Arsenic		Barium		Cadmium		Chromium		Lead		Mercury		Selenium		Silver	
			TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP	TCLP	SPLP
Tailings:																		
KM-TP1-1	6/28/2005	0.5 - 1	0.067	0.08	0.603	0.011	0.0025	*0.001*	*0.003*	*0.003*	*0.004*	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
KM-TP1-2	6/28/2005	0.5 - 1	0.126	0.12	0.595	0.005	0.0028	*0.001*	*0.003*	*0.003*	*0.004*	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
Wasterock/Ore:																		
KM-WR1-1	6/28/2005	0.5 - 1	*0.013*	0.03	0.435	*0.001*	0.0059	*0.001*	*0.003*	*0.003*	*0.004*	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
KM-WR1-2	6/28/2005	0.5 - 1	0.064	*0.015*	0.302	0.037	0.0095	*0.001*	*0.003*	*0.003*	0.010	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	0.006	*0.0025*
KM-WR1-4	6/28/2005	2 - 2.5	*0.013*	*0.015*	0.491	0.002	0.0121	*0.001*	*0.003*	*0.003*	0.008	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
KM-WR2-1	6/29/2005	0.5 - 1	0.041	0.12	0.498	*0.001*	0.0061	*0.001*	*0.003*	*0.003*	0.248	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
Soil:																		
KM-S-1	6/28/2005	0 - 0.5	*0.013*	0.03	0.816	0.052	0.024	*0.001*	*0.003*	*0.003*	*0.004*	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
KM-S-3	6/28/2005	0 - 0.5	*0.013*	*0.015*	0.56	0.003	*0.001*	*0.001*	*0.003*	*0.003*	0.008	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
KM-S-5	6/29/2005	0 - 0.5	*0.013*	*0.015*	0.52	0.004	*0.001*	*0.001*	*0.003*	*0.003*	*0.004*	*0.005*	*0.0001*	*0.0001*	*0.02*	*0.02*	*0.0025*	*0.0025*
RCRA TCLP Disposal Limit =			**5**		**100**		**1**		**5**		**5**		**0.2**		**1**		**5**	

Notes:
Italics - result below reporting limit (RL); value = 1/2 RL.
mg/L = Milligram per liter
RCRA = Resource Conservation and Recovery Act
SPLP = Synthetic Precipitation Leaching Procedure
TCLP = Toxicity Characteristic Leaching Procedure

Table 3. Total Petroleum Hydrocarbon and Asbestos Containing Material Analytical Results Summary
Kromona Mine EE/CA

Area	Sample ID	Depth (ft bgs)	Date Collected	TPH as Diesel (mg/kg)	TPH as Lube Oil (mg/kg)	Asbestos Type	% Asbestos Content
Millsite Soils	KM-S-7	0-0.5	6/29/2005	*62.5*	19200	NA	NA
Debris at Upper Workings	KM-Asb/gray	0-0.5	6/29/2005	NA	NA	ND	ND
	KM-Asb/red	0-0.5	6/29/2005	NA	NA	Chrysotile	2
Human Health Screening Criteria							
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001a)				2000	2000	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004)				NS	NS	NS	NS
Ecological Screening Criteria							
WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals, lowest value (WDOE 2001b)				200	200	NS	NS
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005)				NS	NS	NS	NS

Notes:
Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.
(Shaded) Screening criteria exceeded.
ft bgs = Feet below ground surface
mg/kg = Milligram per kilogram
EPA = U.S. Environmental Protection Agency
MTCA = Model Toxics Control Act
NA = Not analyzed for
ND = Not detected
NS = No standard
PRG = Preliminary remediation goal
TPH = Total petroleum hydrocarbon
WDOE = Washington Department of Ecology

Table 4. Background Soil Analytical Results Summary
Kromona Mine EE/CA

Sample ID	Date Collected	pH	Analyte Concentration (mg/kg)																							
			Ca	K	Mg	Na	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
KM-BGS-1	6/28/2005	2.9	179	322	321	129	0.71	3060	*0.2535*	18.5	18.5	64.7	*0.1*	0.45	0.96	26.8	19.2	2940	0.107	17.2	5.4	89.7	4.34	1.01	*0.75*	13.9	50.1
KM-BGS-2	6/28/2005	3.6	815	724	3650	226	*0.25*	10400	NA	NC	16.3	32.2	*0.1*	*0.1*	3.81	64	55.6	18600	0.088	172	11.8	17.4	*0.15*	*0.03*	*0.75*	58.6	25.2
KM-BGS-3	6/29/2005	4.2	464	307	511	95	0.51	4560	*0.1535*	30.2	30.2	20.6	*0.1*	0.39	1.00	8.01	18.9	10000	0.047	17.1	6.1	18.5	*0.15*	0.41	*0.75*	38.1	13.6
KM-BGS-4	6/29/2005	4.2	236	915	3710	74	*0.25*	23700	NA	NC	64.7	43.5	*0.1*	0.43	4.16	35.9	107	26100	0.085	75.9	24.9	15.7	*0.15*	0.60	*0.75*	93	23.7
KM-BGS-5	6/29/2005	3.80	228	740	3180	82	*0.25*	14600	NA	NC	28.7	60.3	*0.1*	0.41	3.33	28.1	65.4	22100	0.095	108	14.4	13.7	*0.15*	0.77	*0.75*	87.8	23
KM-BGS-6	6/29/2005	4.2	600	858	1380	113	*0.25*	6150	*0.2890*	35.4	35.4	58.3	*0.1*	0.38	5.48	19.9	11.8	14300	0.075	569	11.4	44.4	0.48	0.66	*0.75*	67.9	26.7
minimum =		2.9	179	307	321	74	*0.25*	3060	*0.1535*	18.5	16.3	20.6	*0.1*	*0.1*	0.96	8.01	11.8	2940	0.047	17.1	5.4	13.7	*0.15*	*0.03*	*0.75*	13.9	13.6
MDC =		**4.2**	**815**	**915**	**3710**	**226**	**0.71**	**23700**	***0.2890***	**35.4**	**64.7**	**64.7**	***0.1***	**0.45**	**5.48**	**64**	**107**	**26100**	**0.107**	**569**	**24.9**	**89.7**	**4.34**	**1.01**	***0.75***	**93**	**50.1**
average =		3.82	420	644	2125	120	0.84	10412	*0.2320*	28.0	32.3	46.6	*0.1*	0.36	3.12	30.5	46.3	15673	0.083	160	12.3	33.2	0.90	0.58	*0.75*	60	27.1
95% UCL =		NC	628	863	3419	166	0.54	16790	*0.2890*	35.4	46.7	61.1	*0.1*	0.59	4.61	46.0	76.7	22603	0.100	559	18.2	89.7	7.76	0.86	*0.75*	85	37.1
# of samples = 6; Standard Deviation =		NC	231	242	1436	51	0.18	7078	0.0574	7.1	15.9	16.0	0.0	0.12	1.65	17.3	33.7	7690	0.019	191	6.5	27.3	1.54	0.31	0.00	27	11.1
Frequency detected =		NC	100%	100%	100%	100%	33%	100%	0%	100%	100%	100%	0%	83%	100%	100%	100%	100%	100%	100%	100%	100%	33%	83%	0%	100%	100%
Human Health Screening Criteria																											
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001a)							NS	NS	NS	NS	20	NS	NS	2	NS	19	NS	NS	2	NS	NS	1000	NS	NS	NS	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004)							5100	100000	NS	NS	1.6	67000	1900	450	1900	450	41000	100000	310	19000	20000	800	410	5100	67	1000	100000
Ecological Screening Criteria																											
WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals (WDOE 2001b)							2	50	7	10	7	102	10	4	20	42	50	NS	0.1	1100	30	50	5	0.30	1	2	86
EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2008)							4.2	NS	NS	NS	18	330	21	0.36	13	28	NS	NS	NS	220	38	11	0.27	0.52	NS	7.8	46

Notes:

Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.

(shaded) Screening criteria exceeded.

mg/kg = Milligram per kilogram

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

MTCA = Model Toxics Control Act

NA = Not analyzed for

NC = Not calculated

NS = No standard

PRG = Preliminary remediation goal

UCL = Upper confidence limit

WDOE = Washington Department of Ecology

Table 5. Surface Water Analytical Results Summary
Kromona Mine EE/CA

Sample ID	Area	Date Collected	Analyte Concentration (total recoverable µg/L) Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr_T	Cu	Fe	Hg	Hg_{Trace}	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
NFSF-SW1	Different Drainage	5/17/2005	*0.06*	50	<u>0.009</u>	*0.2105*	*0.215*	2.3	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.000932	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
MFSF-SW1	Background	5/18/2005	*0.06*	50	0.026	*0.202*	*0.215*	*1*	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.000513	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
MFSF-SW2	Downstream	5/18/2005	*0.06*	*15*	0.034	0.476	0.51	2.3	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.000461	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
MFSF-SW3	Downstream	5/17/2005	*0.06*	52	NA	NC	0.61	2.6	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.000583	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
SFSR-SW1	Downstream	5/17/2005	*0.06*	75	0.041	*0.1945*	*0.215*	2.3	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.000703	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
SFSR-SW2	Downstream	5/16/2005	*0.06*	45	NA	NC	0.46	2.6	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.000988	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
KM-TP1-SW1	Tailings Pond	5/18/2005	*0.06*	62	0.591	12.51	13.1	5.5	*0.33*	*0.06*	*3*	*3*	94.5	127	*0.1*	0.003190	*2*	*5*	0.62	*2.8*	*0.31*	*0.12*	*2.5*	*5*
KM-DS-SW1	Sump Drain	5/18/2005	*0.06*	57	2.01	9.39	11.4	6.3	*0.33*	*0.06*	*3*	*3*	58.5	69	*0.1*	0.001640	4.2	*5*	0.65	*2.8*	*0.31*	*0.12*	*2.5*	*5*
KM-AS1	Main Adit	6/29/2005	*0.06*	42	1.16	29.54	30.7	2.3	*0.33*	*0.06*	*3*	*3*	30.6	*30*	*0.1*	0.002630	*2*	*5*	*0.3*	*2.8*	*0.62*	*0.24*	*2.5*	*5*
KM-AS2	Reservoir Adit	6/29/2005	*0.06*	42	0.081	2.1	2.18	3.3	*0.33*	*0.06*	*3*	*3*	110	*30*	*0.1*	0.000320	*2*	*5*	*0.3*	*2.8*	*0.62*	*0.24*	*2.5*	*5*
minimum (excluding BG) =			*0.06*	*15*	0.026	*0.1945*	*0.215*	*1*	*0.33*	*0.06*	*3*	*3*	*1.5*	*30*	*0.1*	0.00032	*2*	*5*	*0.3*	*2.8*	*0.31*	*0.12*	*2.5*	*5*
MDC (excluding BG) =			***0.06***	**75**	**2.01**	**29.54**	**30.7**	**6.3**	***0.33***	***0.06***	***3***	***3***	**110**	**127**	***0.1***	**0.00319**	**4.2**	***5***	**0.65**	***2.8***	***0.62***	***0.24***	***2.5***	***5***
average (excluding BG) =			*0.06*	49	0.56	7.77	6.6	3.1	*0.33*	*0.06*	*3*	*3*	33	45	*0.1*	0.00123	2.2	*5*	0.37	*2.8*	*0.38*	*0.15*	*2.5*	*5*
95% UCL =			*0.06*	59	2.22	29.54	28.9	4.3	*0.33*	*0.06*	*3*	*3*	59	94	*0.1*	0.00215	2.7	*5*	0.47	*2.8*	*0.47*	0.18	*2.5*	*5*
# of samples = 10; Standard Deviation =			0.00	16	0.71	9.99	9.8	1.6	0.00	0.00	0	0	41	31	0.0	0.00098	0.7	0	0.14	0.0	0.13	0.05	0.0	0
Frequency detected =			0%	90%	100%	63%	70%	90%	0%	0%	0%	0%	40%	20%	0%	100%	10%	0%	20%	0%	0%	0%	0%	0%
Human Health Screening Criteria[a]																								
1 - Washington HH AQWC			NS	NS	NS	NS	0.018	NS	NS	NS	NS	NS	NS	NS	0.14	0.14	NS	610	NS	14	170	1.7	NS	NS
2 - Washington DWS			100	NS	NS	NS	10	2000	4	5	NS	100	1300	300	2	2	50	100	15	6	NS	2	NS	50000
3 - EPA AWQC			NS	NS	NS	NS	0.018	1000	NS	NS	NS	NS	1300	300	NS	NS	50	610	NS	5.6	170	0.24	NS	7400
Ecological Screening Criteria[a]																								
4 - Washington Eco AWQC			NS	NS	NS	NS	190	NS	NS	0.08	NS	NS	0.6	NS	0.012	0.012	NS	8	0.05	NS	5	NS	NS	5
5 - EPA FW AWQC			0.36	NS	NS	3.1	150d	4	0.66	0.02	23	NS	0.4	1000	0.77d	0.77d	120	3	0.05	30	5	12	20	6

Sample ID	Area	Flow (cfs)	Temp. (C)	pH (su)	Hard ($CaCO_3$)	Eh (µS/cm)	Turb. (NTU)	ORP (mV)	Analyte Concentration (mg/L)[a] TDS	TSS	Sulfate	Ca	K	Mg	Na
NFSF-SW1	Different Drainage	100	6.37	5.9	2.06	9	22	204	10	*2.5*	0.73	0.68	*0.25*	0.088	*0.25*
MFSF-SW1	Background	22	5.36	6.4	2.98	11	28	225	10	*2.5*	0.98	0.95	*0.25*	0.15	*0.25*
MFSF-SW2	Downstream	25.0	5.5	6.4	4.36	15	21	218	10	*2.5*	1.21	1.30	*0.25*	0.274	0.54
MFSF-SW3	Downstream	40.0	6.6	6.4	7.22	21	16	201	10	*2.5*	1.46	2.31	*0.25*	0.356	0.63
SFSR-SW1	Downstream	140	6.98	6.2	3.67	13	29	201	10	*2.5*	0.94	1.18	*0.25*	0.176	*0.25*
SFSR-SW2	Downstream	150	7.15	6.3	4	15	51	192	10	*2.5*	0.96	1.23	*0.25*	0.225	0.53
KM-TP1-SW1	Tailings Pond	NM	15.8	7	6.75	18	12	140	10	5.0	1.76	1.93	0.56	0.469	0.53
KM-DS-SW1	Sump Drain	0.012	20	6.7	8.93	25	1	134	10	*2.5*	1.66	2.73	*0.25*	0.52	0.72
KM-AS1	Main Adit	0.017	4.2	7.5	27.5	72	NM	45.7	NM	*2.5*	7.36	9.31	1.14	1.03	1.11
KM-AS2	Reservoir Adit	0.012	4.6	7.5	8.29	16	MN	64.2	NM	*2.5*	2.54	2.77	*0.25*	0.337	0.87
minimum (excluding BG) =		4.2	6.2	2.98	11	1	45.7	10	2.5	0.94	0.95	0.25	0.15	0.25	
MDC (excluding BG) =		**20**	**7.5**	**27.5**	**72**	**51**	**225**	**10**	**5.0**	**7.36**	**9.31**	**1.14**	**1.03**	**1.11**	
average (excluding BG) =		8.5	6.7	8.2	23	23	158	10	2.8	2.10	2.63	0.38	0.39	0.60	
Frequency detected =		NC	NC	NC	NC	NC	NC	100%	10%	100%	100%	20%	100%	70%	

Notes:
1-State of Washington ambient water quality criteria for protection of human health (WDOE 2003)
2-State of Washington drinking water standards, WAC 246-290-310 (WSDH 2006)
3-EPA recommended chronic ambient water quality criteria for human consumption of water and fish (EPA 2006)
4-State of Washington ambient water quality criteria for protection of aquatic life, chronic criterion (WDOE 2003)
5-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 2006); if none existed then used Tier II secondary chronic values (NOAA 1999)
Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.
<u>Underline</u> - Result between MDL and practical quantitation limit (PQL), reported at detected concentration
[shaded] Screening criteria exceeded.
[a]Screening criteria for hardness dependent metals are based on a apparent background hardness of 3 and were converted to toal concentrations where applicable.

Notes:
µg/L = Microgram per liter
µS/cm = MicroSiemans per centimeter
mg/L = Milligram per liter
C = Celcius
$CaCO_3$ = Calcium carbonate
cfs = Cubic feet per second
mV = Millivolt
NTU = Nephelometric turbidity units
su = Standard unit
AWQC = Ambient water quality criteria
BG = Background
DWS = Drinking water standards
Eh = Conductivity
EPA = U.S. Environmental Protection Agency
FW = Freshwater
Hard = Hardness
HH = Human health
MDC = Maximum detected concentration
NA = Not analyzed for
NC = Not calculated
NM = No measurement
NOAA = National Oceanic and Atmospheric Administration
NS = No standard
ORP = Oxygen reduction potential
TDS = Total dissolved solids
Temp = Temperature
TSS = Total suspended solids
UCL = Upper confidence limit
WDOE = Washington Department of Ecology
WSDH = Washington State Department of Health

Table 6. Sediment Analytical Results Summary
Kromona Mine EE/CA

Sample ID	Date Collected	TOC (%)	Analyte Concentration (mg/kg)																					
			Ca	K	Mg	Na	Ag	Al	As_T	Ba	Be	Cd	Co	Cr_T	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Tl	V	Zn
NFSF-SS-1 - Different Drainage	5/17/2005	0.16	1360	1390	3640	161	*0.25*	6730	3.11	59.1	*0.1*	*0.1*	3.69	8.81	44.5	11500	*0.015*	141	5.6	2.79	*1.0*	*0.1*	28.7	20.2
MFSF-SS-1 - Background	5/18/2005	0.08	4040	6380	11500	531	*0.25*	25700	12.6	202	0.32	0.72	12.4	69.1	60	35000	0.09	540	56.3	7.83	*1.0*	0.2	91.3	163
MFSF-SS-2	5/18/2005	0.17	3360	5920	9730	468	*0.25*	21300	27.4	203	0.31	0.37	11.5	57.5	143	32300	0.05	461	40.7	7.77	*1.0*	0.2	86.3	86.5
MFSF-SS-3	5/17/2005	0.24	2970	4030	9210	390	*0.25*	19500	26.9	151	0.29	0.20	9.83	49.6	121	28900	0.17	424	37.2	6.11	*1.0*	*0.1*	78	73.7
SFSR-SS-1	5/18/2005	0.14	1610	1700	5420	170	*0.25*	9050	5.17	68	*0.1*	*0.1*	5.26	10.8	57.4	15400	*0.015*	207	7.3	2.81	*1.0*	*0.1*	39.2	26.7
SFSR-SS-2	5/16/2005	0.79	2420	2390	8690	196	*0.25*	14600	22.6	108	0.21	*0.1*	9.27	34.3	125	24600	*0.015*	339	29	5.68	*1.0*	*0.1*	64.8	48.0
minimum (excluding BG) =			1610	1700	5420	170	*0.25*	9050	5.17	68	*0.1*	*0.1*	5.26	10.8	57.4	15400	*0.015*	207	7.3	2.81	*1.0*	*0.1*	39.2	26.7
MDC (excluding BG) =			**4040**	**6380**	**11500**	**531**	***0.25***	**25700**	**27.4**	**203**	**0.32**	**0.72**	**12.4**	**69.1**	**143**	**35000**	**0.17**	**540**	**56.3**	**7.83**	***1.0***	**0.2**	**91.3**	**163**
average (excluding BG) =			2880	4084	8910	351	*0.25*	18030	18.9	146	0.25	0.30	9.65	44.3	101.3	27240	0.068	394	34.1	6.04	*1.0*	0.1	71.9	79.6
95% UCL =			3760	6061	11026	505	*0.25*	24136	27.4	203	0.33	0.55	12.28	65.8	139.2	34559	0.13	516	51.2	7.83	*1.0*	0.2	91.8	129
# of samples = 6; Standard Deviation =			826	1855	1985	144	NC	5729	8.7	52.8	0.08	0.23	2.47	20.2	35.6	6866	0.06	114	16.1	1.8	0.00	0.05	18.7	47
Frequency detected =			100%	100%	100%	100%	0%	100%	100%	100%	67%	50%	100%	100%	100%	100%	50%	100%	100%	100%	0%	33%	100%	100%
Human Health Screening Criteria																								
WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001a)							NS	NS	20	NS	NS	2	NS	19	NS	NS	2	NS	NS	1000	NS	NS	NS	NS
EPA Region IX Industrial Soil PRGs (EPA 2004)							5100	100000	1.6	67000	1900	450	1900	450	41000	100000	310	19000	20000	800	410	67	1000	100000
Ecological Screening Criteria																								
State of Washington Development of Freshwater Sediment Quality Values (WDOE 2004) - recommended only							2.0	NS	20	NS	NS	0.6	NS	95.0	80.0	NS	0.5	NS	60.0	335	0.4	NS	NS	140
State of Washington Development of Freshwater Sediment Quality Values (WDOE 2004) - in development							3.9	NS	5.9	NS	NS	0.6	NS	26.0	16.0	NS	0.17	NS	16.0	31	35.0	NS	NS	110
EPA Threshold Effects Level (NOAA 1999)							NS	NS	5.9	NS	NS	0.596	NS	37.3	35.7	NS	0.174	NS	18	35	NS	NS	NS	123
EPA Freshwater Probable Effects Level (NOAA 1999)							NS	NS	17	NS	NS	3.53	NS	90	197	NS	0.486	NS	35.9	91.3	NS	NS	NS	315

Notes:

Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.

[grey shading] Screening criteria exceeded.

mg/kg = Milligram per kilogram

BG = Background

EPA = U.S. Environmental Protection Agency

MDC = Maximum detected concentration

MTCA = Model Toxics Control Act

NC = Not calculated

NOAA = National Oceanic and Atmospheric Administration

NS = No standard

PRG = Preliminary remediation goal

TOC = Total organic carbon

UCL = Upper confidence limit

WDOE = Washington Department of Ecology

Table 7. Pore Water Analytical Results Summary
Kromona Mine EE/CA

Sample ID	Date Collected	Analyte Concentration (dissolved µg/L)[a]																						
		CN	Ag	Al	As_3	As_5	As_T	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Hg_{Trace}	Mn	Ni	Pb	Sb	Se	Tl	V	Zn
NFSF-PW1 - Different Drainage	5/17/2005	*0.005*	*0.06*	70	*0.0035*	0.19	0.19	*1.0*	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.000694	*2*	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
MFSF-PW1 - Background	5/18/2005	*NA*	*0.06*	*15*	<u>0.01</u>	0.44	0.45	*1.0*	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.000536	*2*	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
MFSF-PW2	5/18/2005	*0.005*	*0.06*	*15*	*0.0035*	1.49	1.49	3.3	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.000768	*2*	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
MFSF-PW3	5/17/2005	NA	*0.06*	50	<u>0.008</u>	1.00	0.67	2.4	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.000583	*2*	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
SFSR-PW1	5/17/2005	NA	*0.06*	72	*0.0035*	0.22	0.22	2.2	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.000881	*2*	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
SFSR-PW2	5/16/2005	NA	*0.06*	64	0.223	0.74	0.96	3.0	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.001850	13.8	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
minimum (excluding BG) =		*0.005*	*0.06*	*15*	*0.0035*	0.22	0.22	*1.0*	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.000536	*2*	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
MDC (excluding BG) =		***0.005***	***0.06***	**72**	**0.223**	**1.49**	**1.49**	**3.3**	***0.33***	***0.05***	***3***	***3***	***1.5***	***30***	***0.1***	**0.00185**	**13.8**	***5***	***0.3***	***2.8***	***0.20***	***0.12***	***2.5***	***5***
average (excluding BG) =		*0.005*	*0.06*	43	0.050	0.78	0.76	2.4	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.00092	4.4	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
95% UCL =		*0.005*	*0.06*	69	0.223	1.25	1.23	3.2	*0.33*	*0.05*	*3*	*3*	*1.5*	*30*	*0.1*	0.00143	13.8	*5*	*0.3*	*2.8*	*0.20*	*0.12*	*2.5*	*5*
# of samples = 6; Standard Deviation =		0.00	0.00	24	0.087	0.44	0.44	0.8	0.00	0.00	0	0	0.0	0.0	0.0	0.00048	4.7	0	0.0	0.0	0.00	0.00	0.0	0
Frequency detected =		0%	0%	67%	50%	100%	100%	67%	0%	0%	0%	0%	0%	0%	0%	100%	17%	0%	0%	0%	0%	0%	0%	0%
Ecological Screening Criteria																								
1- Washington Eco AWQC		5.2	NS	NS	NS	NS	190	NS	NS	1.8	NS	NS	21	NS	0.012	0.012	NS	289	5	NS	5	NS	NS	190
2- EPA Eco AWQC		5.2	0.36	NS	NS	NS	150d	4	0.66	0.4	23	NS	17	1000	0.7d	0.77	120	96	5	30	5	12	20	220

Sample ID	Temp. (C)	pH (su)	Turb. (NTU)	Eh (uS/cm)	ORP (mV)	Hard. ($CaCO_3$)	Analyte Concentration (mg/L)[a]					
							DO	Sulfate	Ca	K	Mg	Na
NFSF-PW1 - Different Drainage	6.8	6.7	52	9	165	1.93	10.64	0.72	0.645	*0.25*	0.0778	*0.25*
MFSF-PW1 - Background	6.1	6.7	20	11	115	2.99	10.39	0.99	0.929	*0.25*	0.163	*0.25*
MFSF-PW2	6.13	6.6	13	24	203	8.14	9.33	1.48	2.30	*0.25*	0.58	0.68
MFSF-PW3	7.47	7	40	21	142	7.05	10.47	1.47	2.24	*0.25*	0.354	0.66
SFSR-PW1	7.41	6.7	19	10	182	2.37	10.55	0.75	0.766	*0.25*	0.111	*0.25*
SFSR-PW2	8.01	6.2	39	17	161	4.57	5.83	0.85	1.36	*0.25*	0.286	0.54
minimum (excluding BG) =	6.1	6.2	13	10	115	2.37	5.83	0.75	0.766	*0.25*	0.111	*0.25*
MDC (excluding BG) =	**8.01**	**7**	**40**	**24**	**203**	**8.14**	**10.55**	**1.48**	**2.3**	***0.25***	**0.58**	**0.68**
average (excluding BG) =	7.0	7	26	17	161	5.02	9.31	1.1	1.52	*0.25*	0.30	0.48
Frequency Detected =							100%	100%	100%	0%	100%	50%

1-State of Washington ambient water quality criteria for protection of aquatic life, chronic criterion (WDOE 2003)
2-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 2006); if none existed, used Tier II secondary chronic values (NOAA 1999).
Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.
<u>Underline</u> - Result between method detection limit and practical quantitation limit, reported at detected concentration.
[shaded] Screening criteria exceeded.
[a]Dissolved concentrations
[b]Screening criteria for hardness dependent metals are based on a average hardness of 205.

Notes:
µg/L = Microgram per liter
µS/cm = MicroSiemans per centimeter
mg/L = Milligram per liter
C = Celcius
$CaCO_3$ = Calcium carbonate
mV = Millivolt
NTU = Nephelometric turbidity units
su = Standard unit
AWQC = Ambient water quality criteria
BG = Background
DO = Dissolved oxygen
Eh = Conductivity
EPA = U.S. Environmental Protection Agency
Hard = Hardness
MDC = Maximum detected concentration
NOAA = National Oceanic and Atmospheric Administration
NS = No standard
ORP = Oxygen reduction potential
Temp = Temperature
UCL = Upper confidence limit
WDOE = Washington Department of Ecology

Table 8. Summary of Waste Volumes and Selected Metal Concentrations
Kromona Mine EE/CA

Area	Estimated Volume (bcy)	Maximum Detected Concentration (mg/kg)					
		Arsenic	Cadmium	Chromium	Copper	Iron	Zinc
Human Health Lowest Screening Criteria	NA	2	2	19	41,000	100,000	100,000
Ecological Lowest Screening Criteria	NA	7	0.36	28	50	NS	46
Background	NA	65	0.45	64	107	26,100	50
Millsite soils	7,500	947	0.55	94	12,600	48,100	123
Sump outfall and pond soil	10	4,470	7.00	54	6,160	193,000	2,010
Partially processed ore	265	10,500	2	72	36,000	96,000	366
Tailings	730	624	*0.1*	69	1,490	46,200	103
Waste rock at upper workings	8,250	6,370	5	46	42,100	101,000	409
Total estimated mine waste volume =	**16,755**	**bcy**					

Notes:
Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.
(shaded) Screening criteria exceeded
mg/kg = Milligram per kilogram
bcy = Bank cubic yard
NA = Not applicable
NS = No screening criteria

Table 9. Surface Water Quality ARARs (total recoverable µg/L)
Kromona Mine EE/CA

			State of Washington		Federal			
			WAC 173-201A	WAC 246-290	Clean Water Act Section 304		National Toxics Rule 40 CFR 131.26	
Analyte[a]	Apparent Background Concentration[b]	Maximum Detected Concentration	Protection of Aquatic Life, Chronic[c,d]	Drinking Water Criteria	Human Health Consumption of Water+Organism	Freshwater Chronic[c]	Human Health Consumption of Water+Organism	Freshwater Chronic[c]
Arsenic	*0.215*	30.7	190	10	0.018	150	0.018	190
Copper	*1.5*	110	0.6	1300	1300	0.4[e]	NS	0.6
Lead	*0.3*	0.65	0.05	15	NS	0.05	NS	0.05

Notes:
Italics - Result below laboratory reporting limit (RL) ; value = 1/2 RL
[shaded] ARAR exceeded.
µg/L = Microgram per liter
[a]Includes only analytes with detected concentrations above ARARs.
[b]Based on a single background sample.
[c]Hardness dependent criteria adjusted based on an apparent background hardness of 3.
[d]For protection of human health, State of Washingon defaults to National Toxics Rule 40 CFR 131.26.
[e]The federal Aquatic Life Ambient Freshwater Quality Copper Criterion was revised in 2007 and is to be calculated using site-specific water quality parameters; however, there is insufficient site data available to calculate the criterion. Therefore, the 2006 criterion was used.
ARAR = Applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
NS = No standard
WAC = Washington Administrative Code

Table 10. Soil Quality ARARs (mg/kg)
Kromona Mine EE/CA

			State of Washington			Federal
			WAC 173-340-740	WAC 173-340-7492	WAC 170-340-7493	EPA
Analyte	95% UCL Background Concentration[a]	Maximum Detected Concentration	MTCA Method A Industrial Soil (Table 745-1)	MTCA Method B Unrestricted Land Use (Table 749-2)	MTCA Method B Ecological Receptor[b] (Table 749-3)	Region 9 PRGs - Industrial Soil
Aluminum	16,790	32,300	NS	NS	50p	100,000
Antimony	7.8	6.04	NS	NS	5p	410
Arsenic	*0.29*	10,500	20	20	10p (As^5)	1.6
Barium	61.1	241	NS	NS	102w	67,000
Cadmium	0.59	7.5	2	2	4p	450
Chromium	46.0	94	19	19	42p,s	450
Cobalt	4.61	186	NS	NS	20p	1,900
Copper	76.7	42,100	NS	NS	50s	41,000
Iron	22,603	193,000	NS	NS	NS	100,000
Lead	89.7	220	1,000	250	50p	800
Manganese	559	9,680	NS	NS	1,100p	19,000
Mercury	0.10	1	2	2	0.1s	310
Nickel	18.2	80.1	NS	NS	30p	20,000
Selenium	0.86	17.6	NS	NS	0.3w	5,100
Silver	0.54	39.1	NS	NS	2p	5,100
Thallium	*0.75*	2.6	NS	NS	1p	67
Vanadium	84.7	114	NS	NS	2p	1,000
Zinc	37.1	2,010	NS	NS	86p	100,000
TPH as lube oil	NA	19,200	2,000	15,000	200	NS

Notes:
Italics - Result below laboratory reporting limit (RL); value = 1/2 RL.
(shaded) ARAR exceeded.
mg/kg = Milligram per kilogram
[a]Based on six background soil samples.
[b]Lowest value selected from plant(p), soil biota(s), and wildlife(w) receptors.
ARAR = Applicable or relevant and appropriate requirement
EPA = U.S. Environmental Protection Agency
MTCA = Model Toxics Control Act
NA = Not analyzed for
NS = No standard
PRG = Preliminary Remediation Goal
TPH = Total petroleum hydrocarbons
UCL = Upper confidence limit
WAC = Washington Administrative Code

Table 11. Sediment Quality ARARs (mg/kg)
Kromona Mine EE/CA

Analyte	Apparent Background Concentration[a]	Maximum Detected Concentration	State of Washington		Federal	
			WDOE 2004	WAC 173-204-320	EPA/NOAA 1999	
			Freshwater Sediment Quality Standards (Recommended Only)	Marine Sediment Management Standards[b]	Threshold Effects Level	Probable Effects Level
Arsenic	12.6	27.4	20	57	5.9	17
Cadmium	0.72	0.72	0.6	5.1	0.596	3.53
Chromium	69.1	69.1	95	260	37.3	90
Copper	60.0	143	80	390	35.7	197
Nickel	56.3	56.3	60	NS	18	35.9
Zinc	163	163	140	410	123	315

Notes:
(shaded) ARAR exceeded.
mg/kg = Milligram per kilogram
[a]Based on a single background sample.
[b]For reference only - not applicable.
ARAR = Applicable or relevant and appropriate requirement
EPA = U.S. Environmental Protection Agency
NOAA = National Oceanic and Atmospheric Administration
WAC = Washington Administrative Code
WDOE = Washington Department of Ecology

Table 12. Summary of Areas Exceeding Cleanup Levels
Kromona Mine EE/CA

Area	Sample ID	Arsenic Cleanup Level (mg/kg)[a]	Maximum Detected Arsenic Concentration (mg/kg)	TPH Cleanup Level (mg/kg)[b]	Maximum Detected TPH as Lube Oil Concentration (mg/kg)	Estimated Volume > Cleanup Level (bcy)
Sump Outfall and Pond	KM-DS-SS1	109	4,470	2,000	NM	10
	KM-S-1		1,410	NM	NM	
	KM-S-2		533	NM	NM	
Millsite Soils	KM-S-3	109	947	NM	NM	7,500
	KM-S-7		97	2,000	19,200	50
Tailings	KM-TP-1-1	109	546	2,000	NM	730
	KM-TP-1-2		624		NM	
	KM-TP-1-SS1		528		NM	
Partially Processed Ore	KM-WR-1-1	109	638	2,000	NM	265
	KM-WR-1-2		10,500		NM	
	KM-WR-1-3		6,530		NM	
	KM-WR-1-4		1,530		NM	
	KM-WR-1-5		1,650		NM	
Wasterock at Upper Workings	KM-WR-2-1	109	2,490	2,000	NM	8,250
	KM-WR-2-2		997		NM	
	KM-WR-2-3		1,500		NM	
	KM-TH-1		6,370		NM	
TOTAL ESTIMATED VOLUME OF MINE WASTE AND CONTAMINTED SOIL ABOVE CLEANUP LEVELS =						**16,805**

Notes:
[a]Risk-based concentration developed in the Streamlined Risk Assessment by CES (2006) and later revised because of errors (Technical Assessment Services 2009).
[b]WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001a)
bcy = Bank cubic yard
mg/kg = Milligram per kilogram
CES = Cascade Earth Sciences
MTCA = Model Toxics Control Act
NM = Not measured
TPH = Total petroleum hydrocarbons
WDOE = Washington Department of Ecology

Table 13. Removal Action Technology Screening Matrix
Kromona Mine EE/CA

Technology Class	Process Option	Description	Effective–ness	Implemen–tability	Cost	O&M	Land Impact	Pros	Cons	Retained?
No Action										
No action	**No action**	Leave feature(s) as is.	0	0	0	none	none	Cheap, easy	No risk reduction	**Yes**
Institutional Controls										
Access restriction	Barbed-wire fencing	3-strand barbed-wire fence around upper workings	Low	High	Low	Medium–subject to vandalism	Minimal	Simple	Only a mild impediment to access	No
	Chain-link fencing	8-foot chain-link security fence around upper workings	Medium	Low	High	Medium–subject to vandalism	Visual contrast	Simple, more effective than barbed-wire	Unsightly, subject to vandalism	No
	Warning signs	Signs posted at physical hazards to warn of potential risks	Low	High	Low	Medium–subject to vandalism	Minimal	Simple, more effective than barbed-wire	Subject to vandalism, easy to ignore	**Yes**
	Road closure	Augment locked gate closure on FR 6110 to prevent ATV traffic	Medium	High	Low	Medium–subject to vandalism	None	Cheap, easy, gate already in place	Minimizes access to Site, still accessible by foot	**Yes**
Physical Hazards										
Access restriction	**Bat gate/culvert**	Install bat gates or culverts in open adits.	High	High	Medium	Medium—subject to vandalism	None	Reduces ecoreceptor exposure; maintains bat habitat	Potential vandalism, very difficult access, requires helicopter	**Yes**
	Collapse Main Adit portal	Collapse the Main Adit portal by pulling down rock and soil from the slope above the portal to block the opening.	High	Medium	Medium	None	Minimal	Eliminates physical hazard	Removes potential bat habitat; subject to bat survey and Forest Service approval	**Yes**
	Plug open adits	Install polyurethane foam or concrete plug in addition to backfill and cover.	Medium	Medium	Medium	Low–inspect vandalism	Minimal	Eliminates physical hazard	Removes potential bat habitat; subject to bat survey and Forest Service approval. Potential blow out from hydrologic pressure.	No
	Hazardous materials	Remove ACM from Site and and dispose of dynamite in undergournd workings.	High	High	Medium	None	Minimal	Removes hazard from the Site.	Requires specialized equipment and methods.	**Yes**
	Remove or bury debris	Remove scattered debris or bury on site.	High	High	Low	None	Minimal	Removes hazard from the Site.	May require waste characterization	**Yes**
Engineering Controls										
Surface controls	**Runoff diversion**	Use diversion channels to intercept surface water run on.	Medium	High	Low	Minimal; inspect for erosion	Low—channel	Reduce erosion and percolation of water through mine waste and contaminated soil	Not independently effective	**Yes**

Table 13. Removal Action Technology Screening Matrix
Kromona Mine EE/CA

Technology Class	Process Option	Description	Effective–ness	Implemen–tability	Cost	O&M	Land Impact	Pros	Cons	Retained?
Drainage controls	**French drain**	Use french drain(s) to intercept and divert groundwater seepage around waste material.	Medium	Medium	Medium	Low; inspect for plugging	Minimal—outlet	Reduce groundwater seepage through the mine waste and contaminated soil	Potential for plugging	**Yes**
Solids containment, i.e. cap in place	**Soil cover**	Soil cover designed to eliminate surface exposure.	Low	Low	Low to High	Low–inspect for erosion	Minimal for access and soil borrow source, ~0.5 ac	Simple design/installation	May require importing soil from off-site source	**Yes**
	Engineered cover	Engineered multilayer cover with a synthetic liner (i.e. GCL, HDPE, PVC, geocomposite).	High	Medium	High	Low–inspect for erosion		Eliminates infiltration through waste material	Must be installed/tested correctly, expensive	**Yes**
	Clay cover	Bentonite or composite clay geosynthetic cover + soil & seed.	Low	Medium	Medium	High–clay subject to desication in semi-arid climate		Nearly eliminate infiltration; more forgiving installation than geosynthetics	Clay prone to decomposition from desiccation and freeze/thaw (ITRC 2004, expensive	No
	Biological cover	Add carbohydrate– or protein–based nutrient mixes to cover soil.	Medium	High	Medium	Low–inspect for erosion		Reduced leachate metals conc. (EPA 2000)	Strongly depends on mixture; design parameters not developed (EPA 2000)	No
	Cementitious cover	Fiber–reinforced concrete/mortar cover.	High	Medium	High	Low–inspect for erosion		Reduce leachate metals conc.	Subject to cracking; not natural looking	No
	Polyurethane grout	Spray cover of polyurethane grout to inhibit infiltration.	Medium	Medium	Medium	Low–inspect for erosion		Reduced infiltration, leachate metals conc. < MCLs (EPA 2000); more plasticity than cement grouts	Long term stability unknown (EPA 2000)	No
Land Disposal										
On-site repository	**Constructed repository**	Excavate mine waste and contaminated soil and place in on–site repository.	High	High	Medium	Medium—inspect cap and analyze leachate; inspect reclaimed areas	~1 ac for repository and soil borrow source	Eliminates or reduces direct exposure	Waste remains on Site; potential for re-exposure	**Yes**
Off-site disposal	**Landfill**	Excavate mine waste and contaminated soil and dispose in off-site landfill.	High	High	High	Low–material hauled off Site; inspect reclaimed areas	None	Eliminates direct exposure by removing waste from Site	Risk of highway spills	**Yes**
Treatment										
Solidification/ Stabilization	Stabilization	Inject mine waste and contaminated soil with cement or other material to physically stabilize.	Medium to High	High	Medium	Low–inspect for erosion/settling	Minimal for access to waste rock piles	Does not require waste excavation	Expensive	No
Vitrification	Vitrification	Heat mine waste and contaminated soil >2800ºF to melt minerals.	High	Low	High	Low–inspect for erosion/settling	Minimal for access to waste rock piles	Does not require waste excavation	Requires high energy source; high cost; leaves waste in floodplain	No

Table 13. Removal Action Technology Screening Matrix
Kromona Mine EE/CA

Technology Class	Process Option	Description	Effective–ness	Implemen–tability	Cost	O&M	Land Impact	Pros	Cons	Retained?
Washing	Washing	Excavate and wash mine waste and contaminated soil with aqueous solution.	Medium	Low	High	Low–inspect for erosion/settling	Minimal for access to waste rock piles and wash area	Reduces waste toxicity	Requires water source, significant waste handling; and chemical disposal	No

Notes:
ac = Acre
ft = Foot
gpm = Gallon per minute
yr = Year
EPA = U.S. Environmental Protection Agency
GCL = Geosynthetic clay liner
HDPE = High density polyethylene
ITRC = Interstate Technology Regulatory Council
O&M = Operation and maintenance

Table 14. Estimated Removal Action Cost Summary
Kromona Mine EE/CA

TASK	Description	Alternative 2 - Off-site Disposal Cost	Alternative 3 - On-site Disposal with Road Rebuild Cost						Alternative 4 - On-site Disposal with Helicopter Cost		Alternative 5 - Upper Workings Cost		Recommended Alternative Cost
			Alt 3A	Alt 3A2	Alt 3B	Alt 3B2	Alt 3C	Alt 3C2	Alt 4A	Alt 4B	Alt 5A	Alt 5B	
Access Road Improvement	Partial or Complete Road Rebuild	$464,173	$464,173	$464,173	$464,173	$464,173	$464,173	$464,173	$42,641	$42,641			$464,173
	subtotal =	**$464,173**	**$464,173**	**$464,173**	**$464,173**	**$464,173**	**$464,173**	**$464,173**	**$42,641**	**$42,641**	**$0**	**$0**	**$464,173**
Mine Waste Removal	Mine Waste Excavation and Disposal	$958,757	$26,270	$26,270	$36,932	$36,932			$26,270				$0
	Mine Waste Capping in Place						$129,991	$98,327		$71,390	$7,286	$99,581	$105,613
	Drain Construction		$12,021	$12,021			$9,605	$1,868	$72,021	$6,868			$1,868
	Repository Construction[(a)]		$64,338	$87,110	$154,377	$196,930			$33,989				$0
	Excavated Waste Area Reclamation	$44,776	$28,620	$28,620	$13,293	$13,293	$3,736	$3,736	$7,703	$3,736			$3,736
	Adit Water Collection System Construction										$52,198	$52,198	$52,198
	subtotal =	**$1,003,533**	**$131,248**	**$154,020**	**$204,602**	**$247,155**	**$143,332**	**$103,931**	**$139,983**	**$81,994**	**$59,484**	**$151,779**	**$163,415**
Physical Hazards Mitigation	Millsite Debris Removal	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500			$5,500
	UST and Contaminated Soil Removal and Disposal	$22,500	$22,500	$22,500	$22,500	$22,500	$22,500	$22,500	$77,500	$77,500			$22,500
	Sump Drain Plugging	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000			$2,000
	AST Disposal										$12,500	$12,500	$12,500
	ACM Disposal										$10,000	$10,000	$10,000
	Dynamite Disposal										$15,000	$15,000	$15,000
	Bat Gate Installation										$30,000	$30,000	$30,000
	subtotal =	**$30,000**	**$30,000**	**$30,000**	**$30,000**	**$30,000**	**$30,000**	**$30,000**	**$85,000**	**$85,000**	**$67,500**	**$67,500**	**$97,500**
Miscellaneous	Work Plans (HASP, traffic, dust control, etc.)	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$0	$0	$10,000
	Mobilization/Demobilization	$40,000	$30,000	$30,000	$35,000	$35,000	$25,000	$25,000	$25,000	$20,000	$0	$0	$25,000
	Fly Equipment and Personnel to/from Site								$450,660	$425,660	$120,000	$800,000	$120,000
	Staging Area Preparation	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,000	$2,000	$0	$0	$2,500
	Temporary Erosion Control BMPs	$3,000	$3,000	$3,000	$4,000	$4,000	$2,500	$2,500	$1,500	$1,500	$0	$0	$2,500
	subtotal =	**$55,500**	**$45,500**	**$45,500**	**$51,500**	**$51,500**	**$40,000**	**$40,000**	**$489,160**	**$459,160**	**$120,000**	**$800,000**	**$160,000**
	Removal Action Subtotal =	**$1,553,206**	**$670,922**	**$693,693**	**$750,275**	**$792,828**	**$677,505**	**$638,104**	**$756,785**	**$668,796**	**$246,984**	**$1,019,279**	**$885,088**
Design and Oversight	Design	$77,660	$100,638	$100,114	$112,541	$118,924	$101,626	$95,716	$113,518	$100,319	$49,397	$101,928	$145,112
	Removal Action Oversight	$40,000	$60,000	$60,000	$70,000	$70,000	$40,000	$40,000	$60,000	$40,000	$20,000	$40,000	$60,000
	subtotal =	**$117,660**	**$160,638**	**$160,114**	**$182,541**	**$188,924**	**$141,626**	**$135,716**	**$173,518**	**$140,319**	**$69,397**	**$141,928**	**$205,112**
Post-removal Monitoring	Post-removal Monitoring for 3 years	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$0	$0	$75,000
	subtotal =	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$0**	**$0**	**$75,000**
	SUBTOTAL =	**$1,745,867**	**$906,560**	**$928,807**	**$1,007,817**	**$1,056,753**	**$894,131**	**$848,820**	**$1,005,302**	**$884,115**	**$316,381**	**$1,161,207**	**$1,165,201**
Contingency	25% Contingency	$436,467	$226,640	$232,202	$251,954	$264,188	$223,533	$212,205	$251,326	$221,029	$79,095	$290,302	$291,300
	SUBTOTAL =	**$2,182,333**	**$1,133,200**	**$1,161,008**	**$1,259,771**	**$1,320,941**	**$1,117,664**	**$1,061,025**	**$1,256,628**	**$1,105,144**	**$395,476**	**$1,451,509**	**$1,456,501**
Data Gaps	Specific to each alternative	$58,000	$61,000	$61,000	$61,000	$61,000	$58,000	$58,000	$61,000	$58,000	$7,000	$7,000	$65,000

TOTALS[a]:

Alternative 2 - Rebuild Road, Excavation and Off Site Disposal = **$ 2,240,333**
Alternative 3A - Rebuild Road, On-Site Disposal in Repository at Mill Site, Soil Cover = **$ 1,194,200**
Alternative 3A2 - Rebuild Road, On-Site Disposal in Repository at Mill Site, Engineered Cover = **$ 1,222,008**
Alternative 3B - Rebuild Road, On-Site Disposal in Repository Along Access Road, Soil Cover = **$ 1,320,771**
Alternative 3B2 - Rebuild Road, On-Site Disposal in Repository Along Access Road, Engineered Cover = **$ 1,381,941**
Alternative 3C - Rebuild Road, Capping in Place, Soil Cover = **$ 1,175,664**
Alternative 3C2 - Rebuild Road, Capping in Place, Engineered Cover = **$ 1,119,025**
Alternative 4A - Helicopter, On-Site Disposal in Repository at Mill Site, Engineered Cover = **$ 1,317,628**
Alternative 4B - Helicopter, Capping in Place, Engineered Cover = **$ 1,163,144**
Alternative 5A - Upper Workings, Capping in Place Terrace Only = **$ 402,476**
Alternative 5B - Upper Working, Capping in Place Entire Waste Rock Pile = **$ 1,458,509**
Recommended Alternative - (3C2 and 5A) = $ 1,521,501

Notes:

[a]Totals listed for Alternatives 2, 3 and 4 include removal activities for the millsite area only; totals listed for Alternative 5 include removal activites for the upper workings only. The Recommended Alternative total includes removal activities for both the millsite and upper workings.

Table 15. Data Gap Summary

Kromona Mine EE/CA

Data Gap	Potential Issues	Recommended Action	Estimated Cost
Extent of blasting required to widen and stabilize existing access road: • Stability of roadbed and slope unknown	• Extensive blasting may be required to widen and stabilize the existing access road in areas where the roadbed is cracking and beginning to slough away. • May make reconstructing the access road cost prohibitive.	The road should be inspected by a qualified contractor to determine the amount of blasting that will be required to stabilize the road.	$2,000 - $10,000
Lack of sufficient background samples: • Minimal background samples collected for each media type	• Background surface water, pore water, and sediment samples may have been impacted by mining activities upstream of the Site • Prevents establishing statistically representative background concentrations • May result in applying cleanup criteria that are below background levels • Makes it difficult to evaluate removal action effectiveness or compliance with ARARs	It is generally good practice to adequately characterize background conditions at a removal action site to ensure that cleanup criteria are above background levels, to evaluate removal action effectiveness, and determine post-removal compliance with ARARs. Additional background sampling should be conducted to develop statistically valid background concentrations for all media, and the analytical MDLs should be well below applicable screening criteria.	$5,000 - $10,000
Lack of sufficient millsite soil samples: • Only two soils samples collected from the millsite bench • Samples only collected from 0 to 6 inches below ground surface (bgs)	• Characterization of the millsite bench as 7,500 bank cubic yards of waste rock based on very limited information • May actually be only a thin layer of residual waste from milling operations • May result in unnecessarily excavating a large volume of soil	Additional soil characterization samples should be collected to adequately characterize soils on the millsite bench, including samples from depth. Extent of mine waste or contaminated soil should be delineated and the volume of material estimated.	$2,000 - $4,000
Insufficient characterization of underground storage tank (UST): • Only one shallow (0 to 6 inches bgs) soil samples collected from near the UST • No fluid samples collected from the UST	• Unknown whether the tank still contains fluid • Areal and vertical extent of petroleum-contaminated soil is unknown • Quantity of petroleum-contaminated soil unknown	Additional soil characterization samples should be collected from around the UST, including samples at depth to determine the extent of contamination. The tank should be inspected to determine whether it still contains fluids; if so, a fluid samples should be collected for analysis to determine the appropriate method of disposal.	$5,000 - $10,000
Insufficient characterization of aboveground storage tank (AST): • No soil samples collected from near the AST • No fluid samples collected from the AST	• Unknown whether the tank still contains fluid • There may be petroleum-contaminated soil under the AST	Soil characterization samples should be collected from under the AST, including samples at depth to check for petroleum-contaminated soil. The tank should be inspected to determine whether it still contains fluids; if so, a fluid samples should be collected for analysis to determine the appropriate method of disposal.	$2,000 - $4,000

Table 15. Data Gap Summary
Kromona Mine EE/CA

Data Gap	Potential Issues	Recommended Action	Estimated Cost
Risks associated with exposure to petroleum-contaminated soil at the Site not assessed: • Risk assessment by CES in 2006 did not assess risk to human health or the environment from exposure to petroleum-contaminated soil at the Site.	• Must default to established MTCA cleanup levels. • Contaminated soil could potentially be left in place or disposed of on-Site if concentrations are less than a site-specific, risk-based cleanup level.	A site-specific cleanup level should be established for petroleum-contaminated soil at the Site.	$1,000 - $3,000
Quantity of asbestos containing material (ACM) unknown: • The quantity of ACM at the upper workings was not estimated.	• Difficult to estimate removal costs based on an unknown quantity.	The ACM is mixed in with wood and metal structural debris on the terrace making it difficult to determine a material quantity. A reasonable estimate should be made based on visual inspection of the upper workings.	Assumed to be in coordination with other activity
Condition of the Reservoir Adit portal and extent of underground workings: • The adit was not inspected by MSE during the Site reconnaissance. • BLM records show that the adit may only be about 50-feet-long with a 20-foot lateral.	• Access to the adit is extremely difficult and public exploration is likely to be minimal. • The adit may pose only minimal physical hazard to the public and not warrant installation of a bat gate.	The adit portal and underground workings should be inspected to determine whether closure of the adit is warranted.	$1,000 - $3,000
Potential presence of T&E amphibian species: • SI indicates T&E amphibian species may be present at the Site. • SI indicates T&E bat species may be present in the open adits.	• T&E species are to be protected to the individual level. • May require special measures to accommodate a sensitive species.	A detailed biological survey should be conducted to determine whether T&E amphibian species are present at the Site, specifically around the mill foundation and tailings impoundment. Should also determine whether bats inhabit the open adits. Consult with Forest Service biologist.	$1,000
Suitability of proposed repository locations: • Proposed repository locations not characterized. • Available capacity unknown.	• Proposed locations may not be suitable for a repository. • Proposed locations may not have the needed capacity.	The proposed repository locations should be inspected to determine suitability and available storage capacity.	$2,000 - $3,000
Availability of a suitable on-Site borrow soil source: • Potential borrow soil sources not identified at the millsite or upper workings	• If a suitable borrow soil source cannot be identified at the Site, significantly increases the cost of a removal action at the Site.	The millsite and upper workings should be inspected to identify and quantify suitable borrow soil sources.	$5,000 - $10,000

Table 15. Data Gap Summary
Kromona Mine EE/CA

Data Gap	Potential Issues	Recommended Action	Estimated Cost
Lack of detailed Site topography: • No topographical survey of the Site was completed during the SI	• Difficult to prepare an engineered design for removal actions • Difficult to delineate floodplain	Areas that will be addressed in the selected removal action alternative should be surveyed to provide adequate topography needed to prepare engineered designs and accurately estimate costs.	$15,000 - $20,000
		Total Estimated Cost =	**$41,000- $78,000**

Notes:
ACM = Asbestos containing material
ARAR = Applicable or relevant and appropriate requirement
BLM = Bureau of Land Management
SI = Site Inspection
T&E = Threatened and endangered

Table 16. Comparative Analysis of Removal Action Alternatives
Kromona Mine EE/CA

Assessment Criteria	Alternative 1	Alternative 2 - Millsite	Alternatives 3 & 4 - Millsite			Alternative 5 - Upper Workings	
	No Action	Excavation and Off-Site Disposal	On-Site Disposal in Repository at Millsite	On-Site Disposal in Repository along Road	In Place Capping	Capping Terrace in Place	Capping Entire Waste Rock Pile in Place
Compliance with Removal Action Goals and Objectives							
Attributes:	Does not comply	Waste material removed from Site.	Waste material contained on-Site.	Waste material contained on-Site.	Waste material capped in place.	Hazardous materials removed from Site, some waste rock capped in place.	Hazardous materials removed from Site, all waste rock capped in place.
Advantages:	None	+Eliminates exposure at Site	+Reduces exposure potential at Site	+Minimizes exposure potential at Site	+Reduces exposure potential at Site	+Reduces exposure potential at Site	+Minimizes exposure potential at Site
Overall Protectiveness of Public Health, Safety and Welfare							
Attributes:	No protection	Waste material removed from Site.	Waste material contained on-Site.	Waste material contained on-Site.	Waste material capped in place.	Hazardous materials removed from Site, some waste rock capped in place, physical hazards mitigated.	Hazardous materials removed from Site, all waste rock capped in place, physical hazards mitigated.
Advantages:	None	+Highest level of human protection +Eliminates potential for future releases at the Site	+High level of human protection +Eliminates risk to community from long-distance transport of waste	+High level of human protection +Minimizes risk to community from transport of waste	+High level of human protection +Eliminates risk to community from long-distance transport of waste	+Moderate level of human protection +Eliminates risk to community from long-distance transport of waste	+High level of human protection +Eliminates risk to community from long-distance transport of waste
Environmental Protectiveness							
Attributes:	No protection	Waste material removed from Site.	Waste material contained on-Site.	Waste material contained on-Site.	Waste material capped in place.	Hazardous materials removed from Site, some waste rock capped in place.	Hazardous materials removed from Site, all waste rock capped in place.
Advantages:	None	+Highest level of ecological protection +Eliminates potential for future releases at the Site	+High level of ecological protection	+High level of ecological protection	+High level of ecological protection	+Moderate level of ecological protection	+High level of ecological protection
Compliance with Key ARARs							
Attributes:	Does not comply	High compliance with Soil Quality ARARs High compliance with Solids Disposal ARARs High compliance with FP S&G ARARs	Moderate compliance with Soil Quality ARARs Moderate compliance with Solids Disposal ARARs Moderate compliance with FP S&G ARARs	Moderate compliance with Soil Quality ARARs Moderate compliance with Solids Disposal ARARs High compliance with FP S&G ARARs	Moderate compliance with Soil Quality ARARs Moderate compliance with Solids Disposal ARARs Moderate compliance with FP S&G ARARs	Moderate compliance with Soil Quality ARARs Moderate compliance with Solids Disposal ARARs High compliance with FP S&G ARARs	Moderate compliance with Soil Quality ARARs Moderate compliance with Solids Disposal ARARs High compliance with FP S&G ARARs
Advantages:	None	+Eliminates potential for future non-compliances from waste material	+Compliant with Soil Quality ARARs +The soil cover may meet substantive Solids Disposal ARARs	+Compliant with Soil Quality ARARs +More compliant with FP S&Gs +Soil cover may meet substantive Solids Disposal ARARs	+Compliant with Soil Quality ARARs +Soil cover may meet substantive Solids Disposal ARARs	+Minimally compliant with Soil Quality ARARs +Compliant with FP S&Gs +Soil cover may meet substantive Solids Disposal ARARs	+Compliant with Soil Quality ARARs +Compliant with FP S&Gs +Soil cover may meet substantive Solids Disposal ARARs
Long-term Effectiveness and Permanence							
Attributes:	No action	Waste material removed from Site.	Waste material contained on-Site.	Waste material contained on-Site.	Waste material capped in place.	Hazardous materials removed from Site, some waste rock capped in place.	Hazardous materials removed from Site, all waste rock capped in place, sloped cover may be subject to erosion
Advantages:	None	+Most effective and permanent long term	+Highly effective and provides long-term permanence, french drain may be subject to plugging	+Highly effective and provides long-term permanence	+Moderately effective and provides long-term permanence, french drain may be subject to plugging	+Moderately effective and provides long-term permanence	+Highly effective and may provide long-term permanence

Table 16. Comparative Analysis of Removal Action Alternatives
Kromona Mine EE/CA

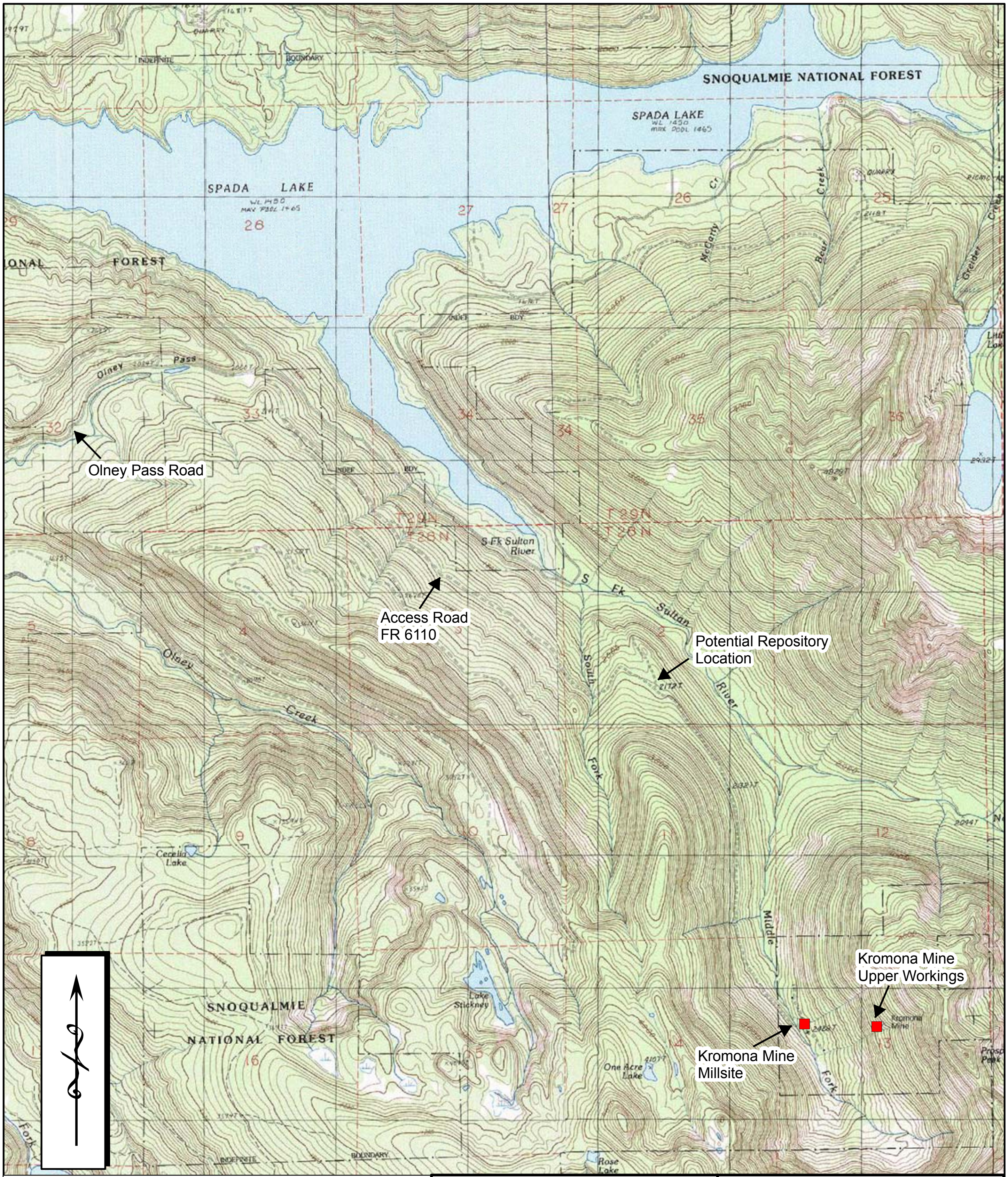
Assessment Criteria	Alternative 1	Alternative 2 - Millsite	Alternatives 3 & 4 - Millsite			Alternative 5 - Upper Workings	
	No Action	Excavation and Off-Site Disposal	On-Site Disposal in Repository at Millsite	On-Site Disposal in Repository along Road	In Place Capping	Capping Terrace in Place	Capping Entire Waste Rock Pile in Place
Reduction of Toxicity, Mobility and Volume							
Attributes:	No action	No reduction in toxicity, but waste removed from Site.	No reduction in toxicity, but mobility is reduced through containment.	No reduction in toxicity, but mobility is reduced through containment.	No reduction in toxicity, but mobility is reduced though capping.	No reduction in toxicity and minimal reduction in mobility.	No reduction in toxicity, but mobility is reduced through capping.
Advantages:	None	+Waste removed from Site +Most likely for reduction of mobility	+Reduction in mobility dependent on cover effectiveness	+Higher reduction in mobility because of repository location and configuration	+Reduction in mobility dependent on cover effectiveness	+Minimal reduction in contaminant migration from erosion	+Minimizes contaminant migration from erosion
Short-Term Effectiveness							
Attributes:	No action	Waste removed from the Site within one field season.	Waste contained on-Site within one field season.	Waste contained on-Site within one field season.	Waste capped on-Site within one field season.	Portion of waste capped on-Site and physical hazards mitigated.	Waste capped on-Site and physical hazards mitigated.
Advantages:	None	+Easily constructed +Minimal risk to community and workers	+Easily constructed +Minimal risk to community and workers +Does not require transport of waste off-Site with risk of spills	+Easily constructed +Minimal risk to community and workers	+Most easily constructed +Minimal risk to community and workers +Does not require transport of waste off-Site with risk of spills	+Easily constructed +Minimal risk to community and workers	+Addresses entire waste rock pile +Moderate risk to community and workers
Implementability							
Attributes:	Not applicable	Waste removal, transport, and Site reclamation accomplished using standard construction equipment and methods.	Waste containment using standard construction equipment and methods. Helicopter required for Alternative 4.	Waste containment using standard construction equipment and methods. Use of this location would require approval and permitting by WDNR.	Waste capping using standard construction equipment and methods. Helicopter required for Alternative 4.	Helicopter required; waste covered using standard construction equipment and methods.	Helicopter required; waste covered using standard construction equipment and methods.
Advantages:	None	+Easily implemented. +Technically and administratively feasible.	+Easily implemented. +Technically and administratively feasible. +Access via helicopter easier to implement than reconstructing road.	+Easily implemented. +Technically and administratively feasible.	+Easiest to implement. +Technically and administratively feasible. +Access via helicopter easier to implement than reconstructing road.	+Easier to implement. +Technically and administratively feasible. +Easier to implement.	+Implementable. +Technically and administratively feasible.
State and Federal Agency, and Community Acceptance							
Attributes:	Not acceptable	Waste removed from Site.	Waste contained on-Site.	Waste contained on-Site.	Waste capped on-Site.	Portion of waste capped on-Site and physical hazards mitigated.	Waste capped on-Site and physical hazards mitigated.
Advantages:	None	+Most acceptable	+Acceptable	+Acceptable	+Acceptable	+Least acceptable	+More acceptable

Table 16. Comparative Analysis of Removal Action Alternatives
Kromona Mine EE/CA

Assessment Criteria	Alternative 1	Alternative 2 - Millsite	Alternatives 3 & 4 - Millsite			Alternative 5 - Upper Workings	
	No Action	Excavation and Off-Site Disposal	On-Site Disposal in Repository at Millsite	On-Site Disposal in Repository along Road	In Place Capping	Capping Terrace in Place	Capping Entire Waste Rock Pile in Place
Estimated Total Present Worth Cost							
Attributes:	$0	$2,240,333	Alternative 3A soil cover = $1,194,200 Alternative 3A eng cover = $1,222,008 Alternative 4A = $1,317,628	Alternative 3B soil cover = $1,320,771 Alternative 3B eng cover = $1,381,941	Alternative 3C soil cover = $1,175,664 Alternative 3C eng cover = $1,119,025 Alternative 4B = $1,163,144	Alternative 5A = $402,476	Alternative 5B = $1,458,509
Advantages (= cost savings over most expensive option):	+$2,240,333	None	Alternative 3A soil cover = +$1,046,134 Alternative 3A eng cover =+$1,018,325 Alternative 4A = +$922,706 Alternative 3A eng cover = $123,428 advantage	Alternative 3B soil cover = +$919,563 Alternative 3B eng cover = +$858,393 Alternative 3B soil cover = $61,170 advantage	Alternative 3C soil cover = +$1,064,669 Alternative 3C eng cover = +$1,121,309 Alternative 4B = +$1,077,189 Alternative 3C eng cover = $56,639 advantage	+$1,056,032 over Alternative 5B	None

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
FP S&Gs = Forest Plan Standard and Guidelines
WDNR = Washington Department of Natural Resources

Figures



0 1,000 2,000 4,000 6,000 8,000 Feet

SCALE: 1 inch = 3,333 feet

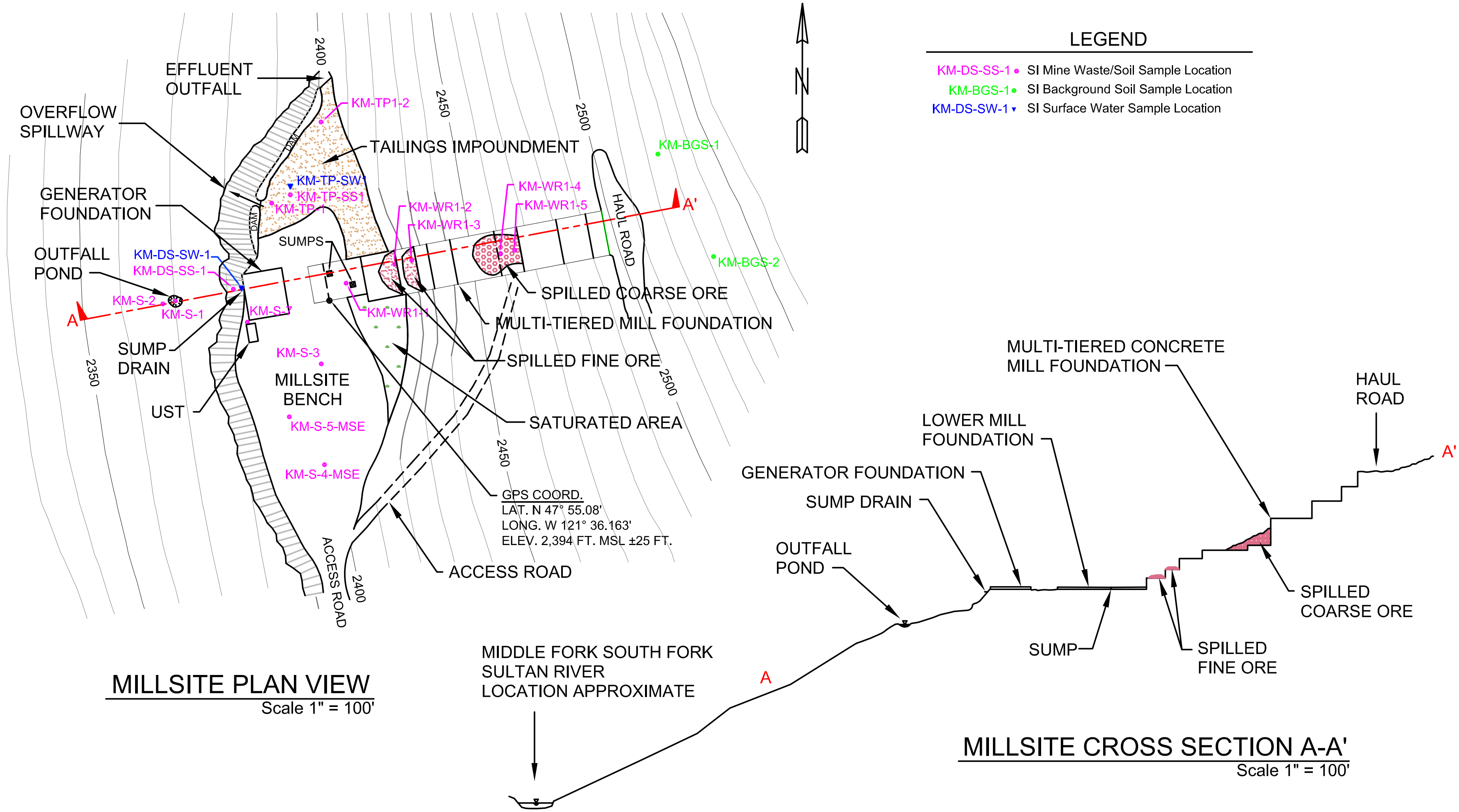
REFERENCE: U.S.G.S. 7.5 MINUTE QUADRANGLE, MOUNT STICKNEY, WA 1986

MSE Millennium Science & Engineering, Inc.
1555 Shoreline Dr., Ste. 150
Boise, ID 83702 USA
Phone: (208) 345-8292

Vicinity Map
Kromona Mine

	kromona_f1.mxd	**11/04/09**	**Figure 1**

:MSE\tibbets\kromona_f1.mxd 12.9.08



MILLSITE PLAN VIEW
Scale 1" = 100'

MILLSITE CROSS SECTION A-A'
Scale 1" = 100'

Sources:
Site map and cross section from "Kromona Mine and Millsite Site Inspection", CES 2005
Topography extrapolated from USGS 7.5 Minute Quadrangle, Mount Stickney, WA 1986
Scale and locations are approximate

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Boise, Idaho 83702
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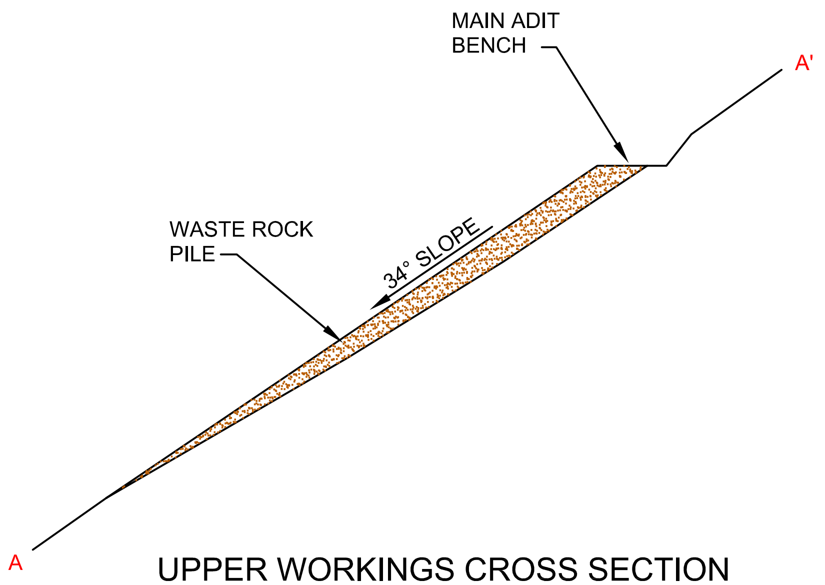
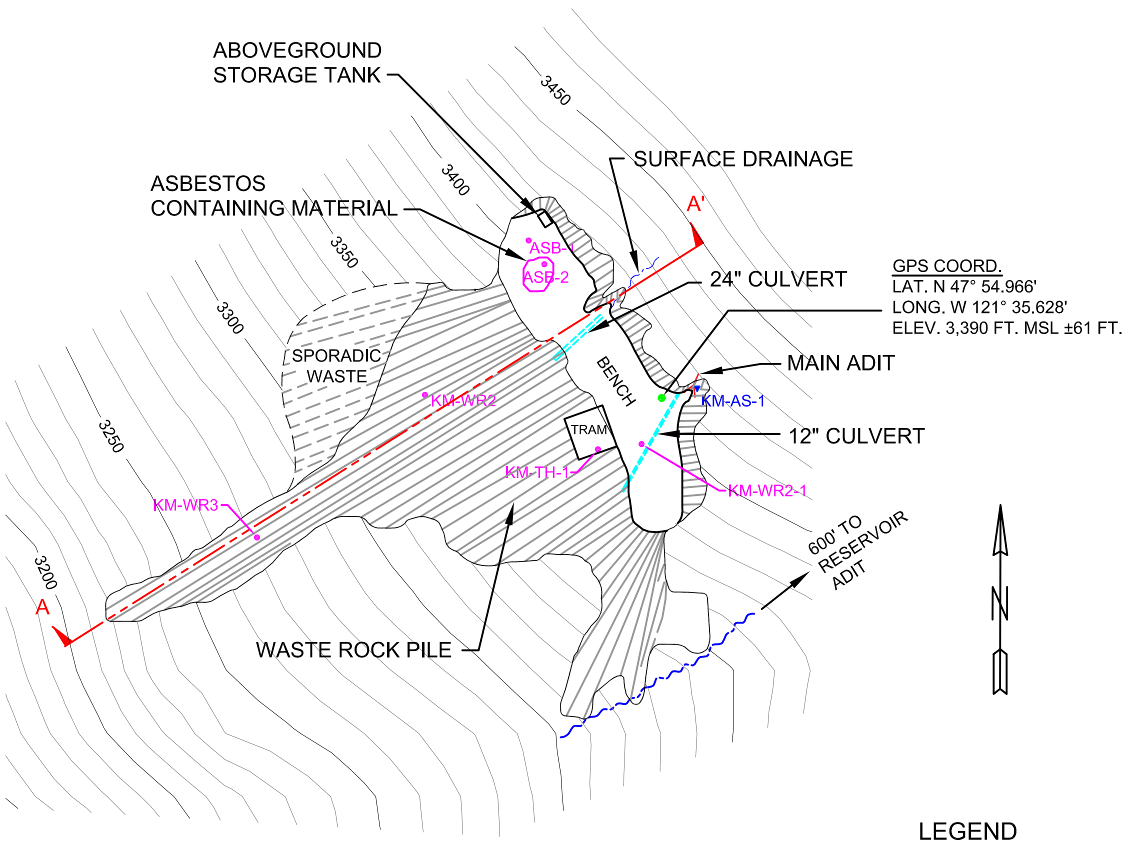
Millsite Features
Kromona Mine

B2473M	fig2.dwg	11/03/09	Figure 2



UPPER WORKINGS CROSS SECTION

Scale 1" = 100'



LEGEND

- KM-DS-SS-1 ● SI Mine Waste/Soil Sample Location
- KM-DS-SW-1 ▾ SI Surface Water Sample Location
- Surface water

UPPER WORKINGS PLAN VIEW

Scale 1" = 100'

Sources:
Site map from "Kromona Mine and Millsite Site Inspection", CES 2005
Topography extrapolated from USGS 7.5 Minute Quadrangle, Mount Stickney, WA 1986
Scale and locations are approximate

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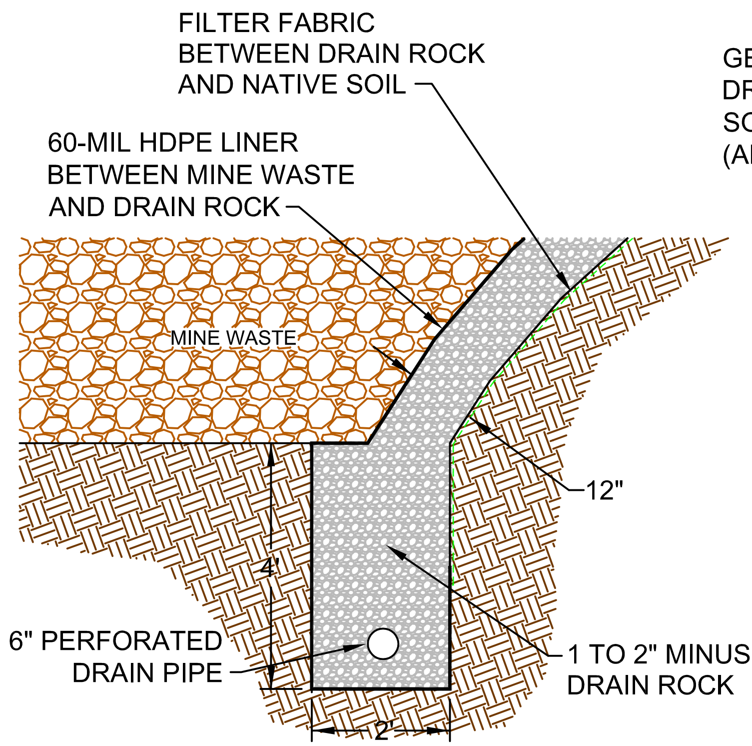
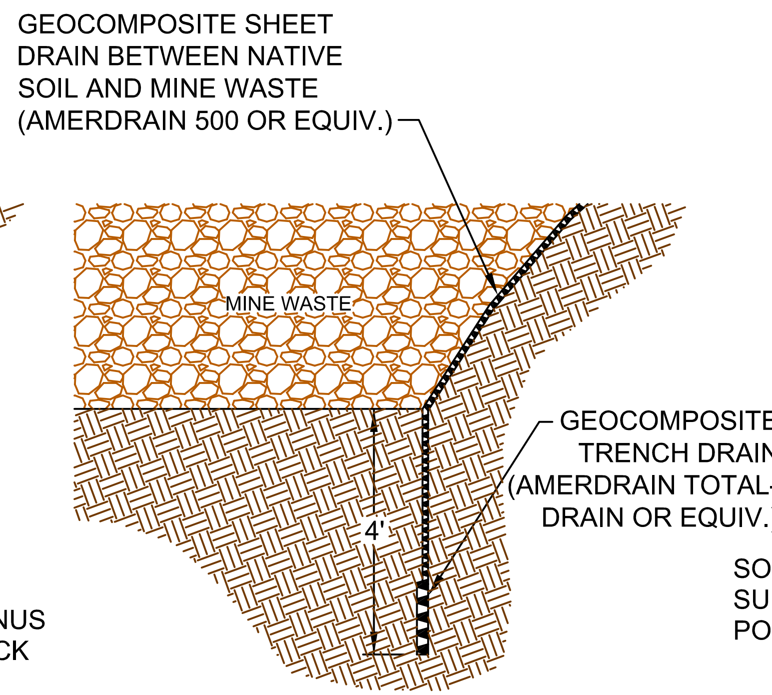
Upper Workings Features
Kromona Mine

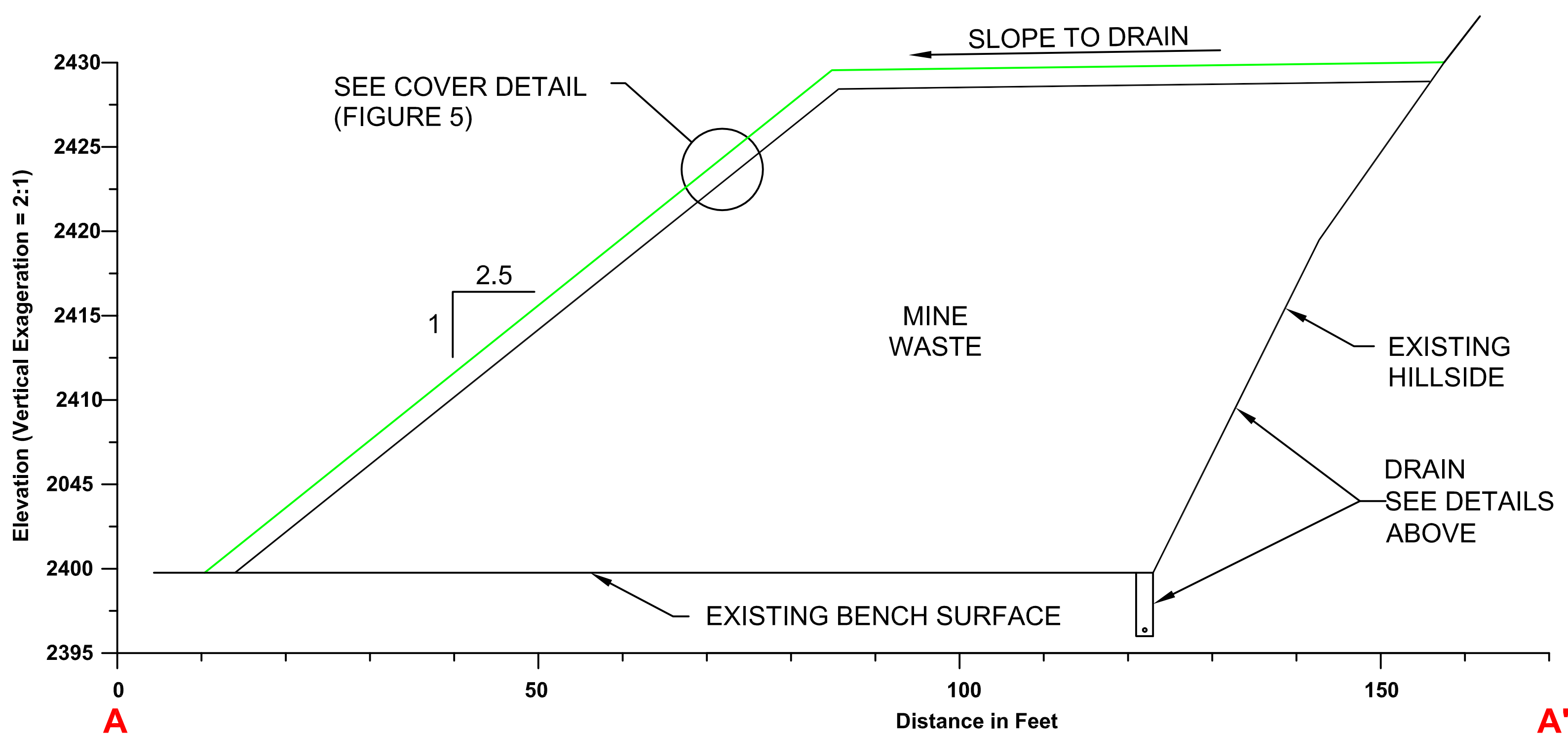
B2473M	Fig 3.dwg	11/03/09	Figure 3



TRADITIONAL FRENCH DRAIN DETAIL
NOT TO SCALE

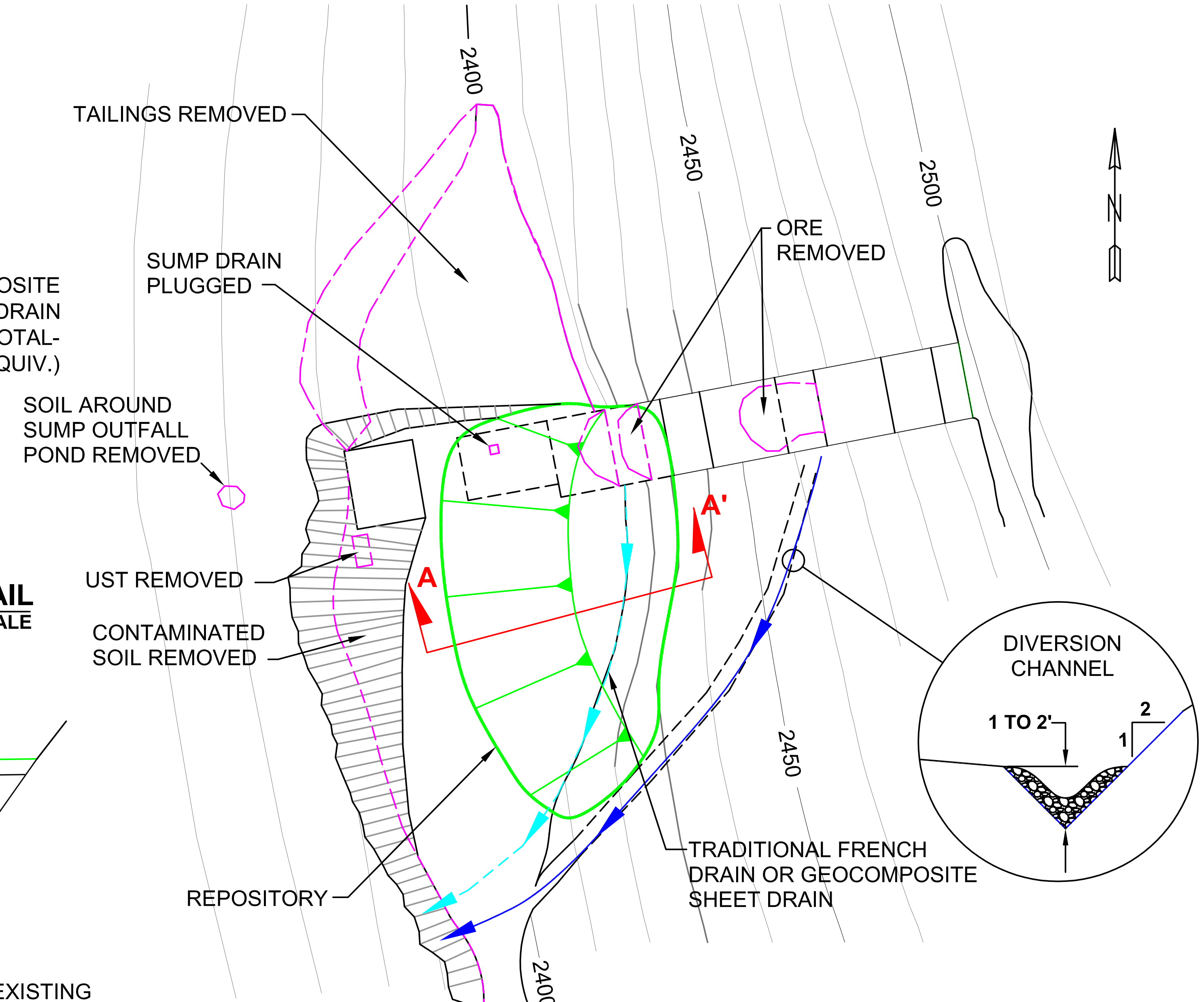


GEOCOMPOSITE SHEET DRAIN DETAIL
NOT TO SCALE



CONCEPTUAL MILLSITE REPOSITORY CROSS SECTION A-A'
Not to Scale

Sources:
Site map from "Kromona Mine and Millsite Site Inspection", CES 2005
Topography extrapolated from USGS 7.5 Minute Quadrangle, Mount Stickney, WA 1986
Scale and locations are approximate



MILLSITE REPOSITORY PLAN VIEW
Scale: 1" = 60'

LEGEND
- MINE WASTE REMOVED
- REPOSITORY
- DIVERSION CHANNEL
- DRAIN

CONCEPTUAL DESIGN DRAWINGS ONLY - NOT INTENDED FOR CONSTRUCTION

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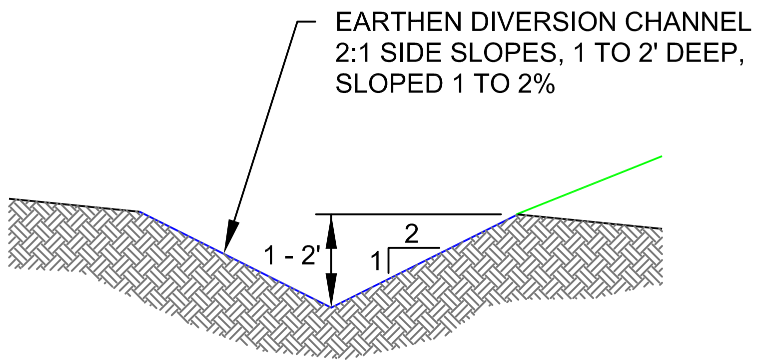
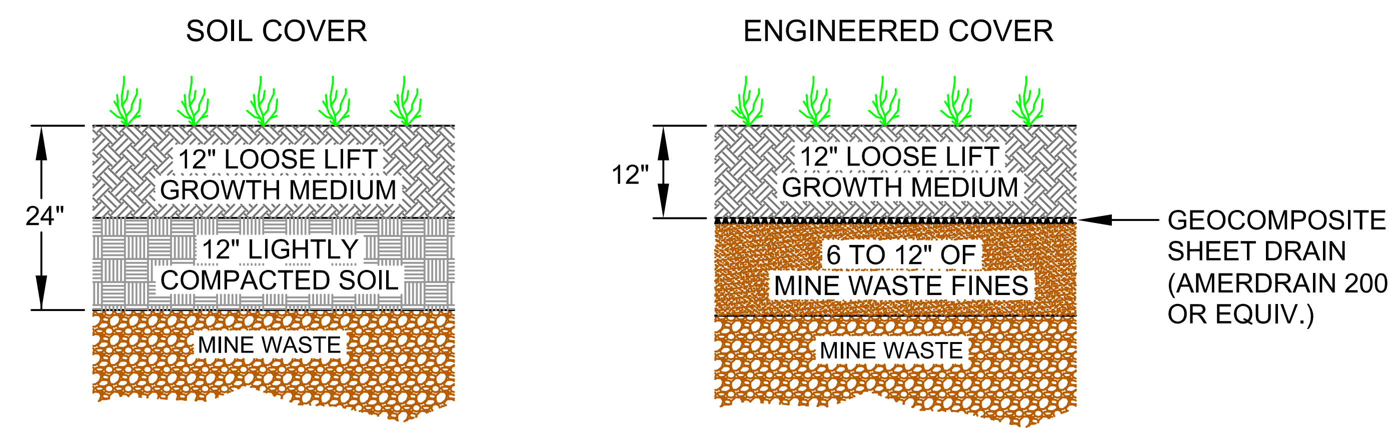
Millsite Repository Kromona Mine			
B2473M	fig4.dwg	11/03/09	Figure 4



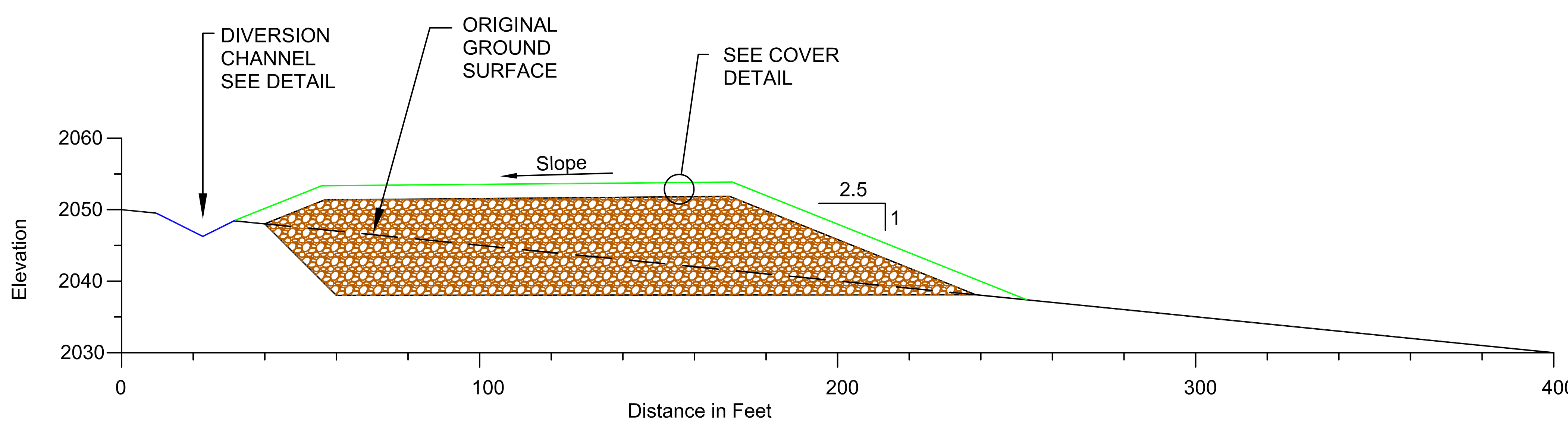
DIVERSION CHANNEL DETAIL

Not to Scale



COVER DETAILS

Not to Scale



Note: Elevation and horizontal distance are conceptual only.

CONCEPTUAL ACCESS ROAD REPOSITORY CROSS SECTION

Not to Scale

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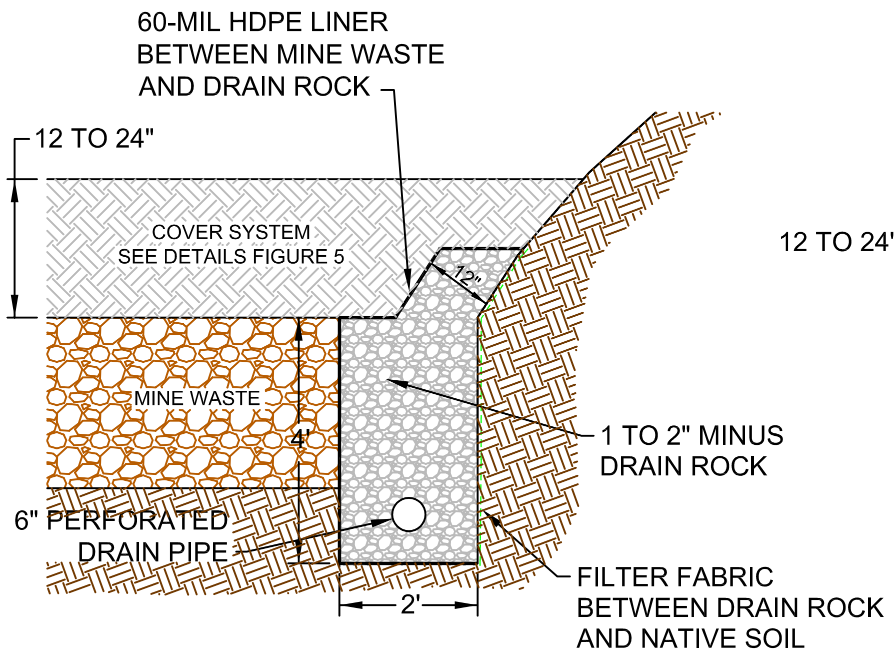
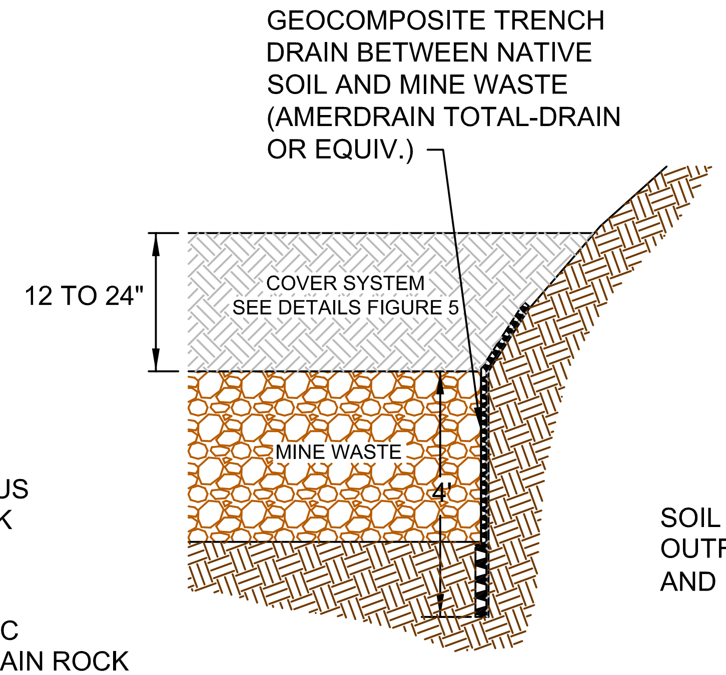
Access Road Repository Kromona Mine

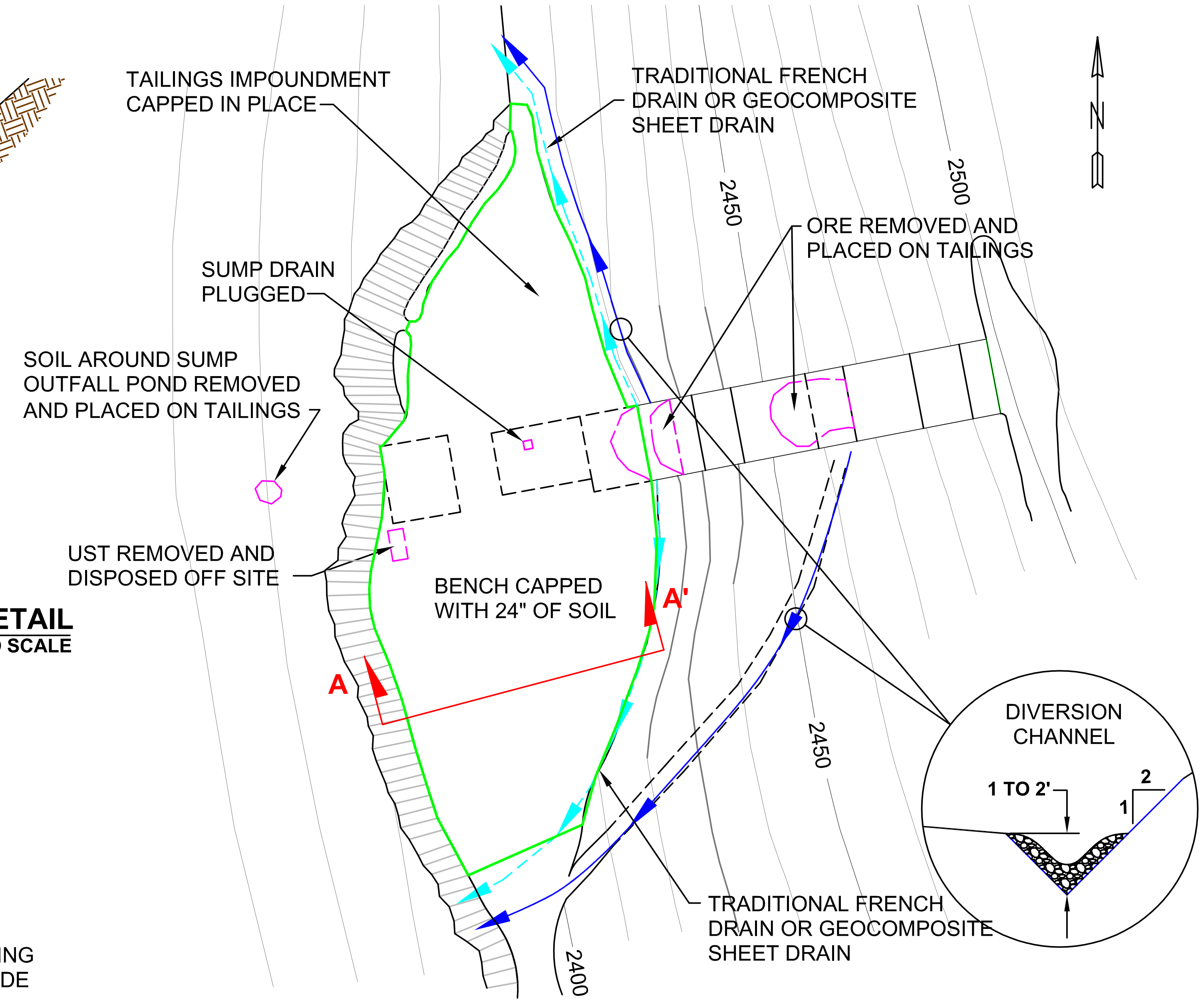
B2473M	fig5.dwg	11/03/09	Figure 5



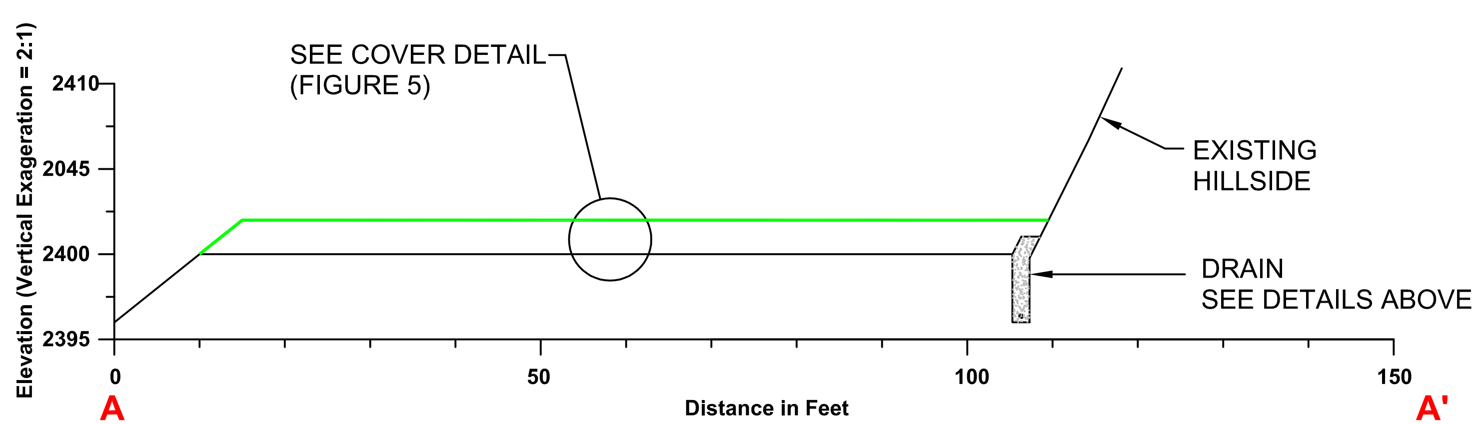
TRADITIONAL FRENCH DRAIN DETAIL
NOT TO SCALE



GEOCOMPOSITE SHEET DRAIN DETAIL
NOT TO SCALE



MILLSITE CAP IN PLACE
Scale: 1" = 60'



CONCEPTUAL MILLSITE CAP IN PLACE CROSS SECTION A-A'
Not to Scale

LEGEND

- MINE WASTE REMOVED
- CAPPED IN PLACE
- DIVERSION CHANNEL
- DRAIN

Sources:
Site map from "Kromona Mine and Millsite Site Inspection", CES 2005
Topography extrapolated from USGS 7.5 Minute Quadrangle, Mount Stickney, WA 1986
Scale and locations are approximate

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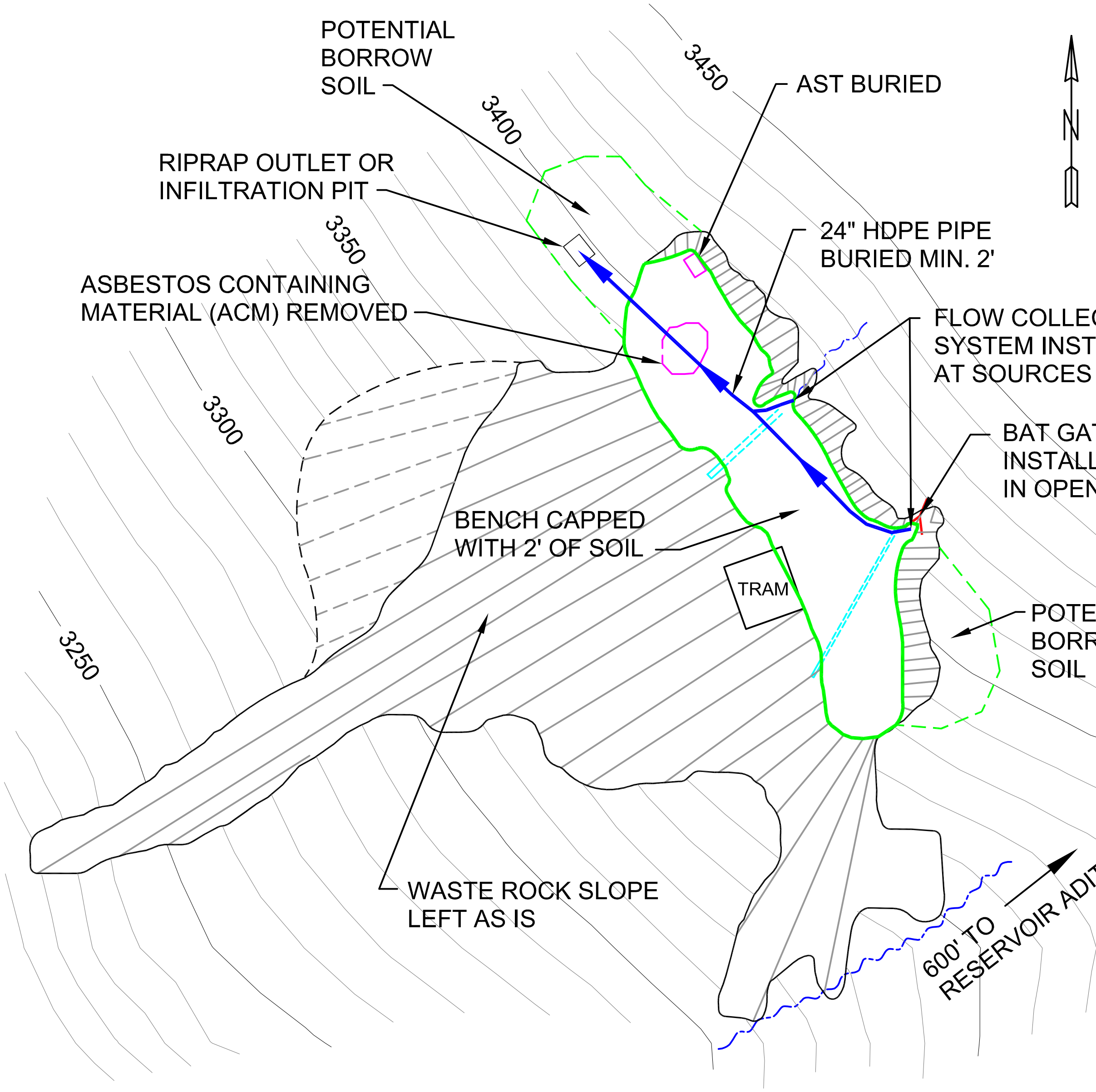
Millsite Cap in Place Kromona Mine			
B2473M	fig4.dwg	11/03/09	Figure 6



UPPER WORKINGS CAP IN PLACE

Scale: 1" = 60'

LEGEND

ACM REMOVED

CAPPED IN PLACE

24" HDPE PIPE

SURFACE WATER

CONCEPTUAL DESIGN DRAWINGS ONLY - NOT INTENDED FOR CONSTRUCTION

Sources:
Site map from Kromona Mine and Millsite Site Inspection, CES 2005
Topography extrapolated from USGS 7.5 Minute Quadrangle, Mount Stickney, WA 1986
Scale and locations are approximate

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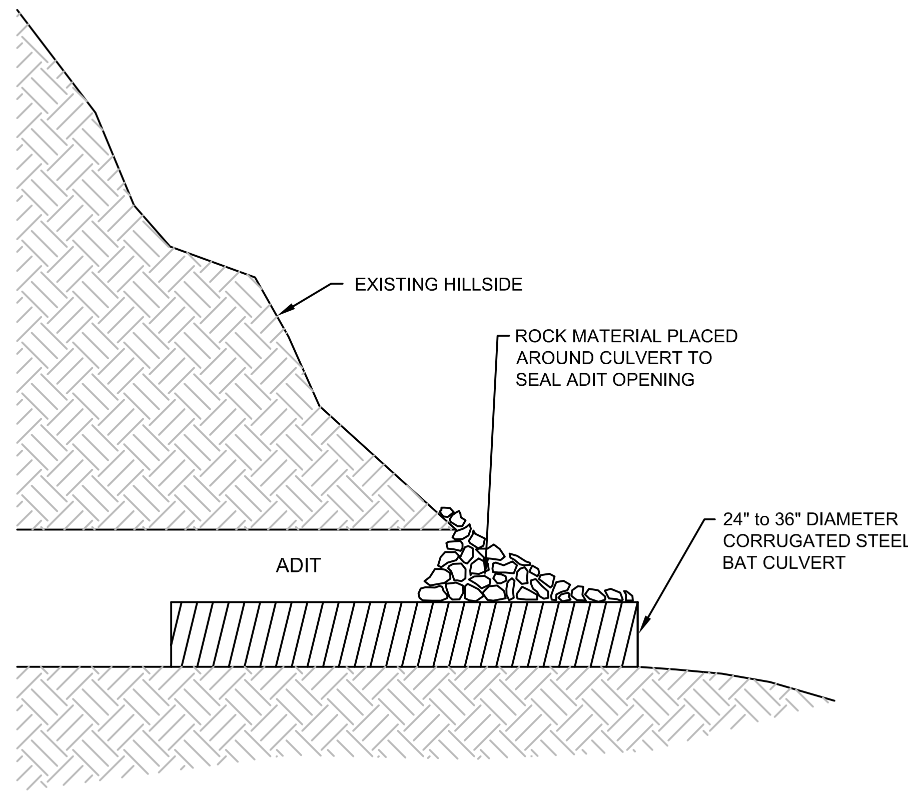
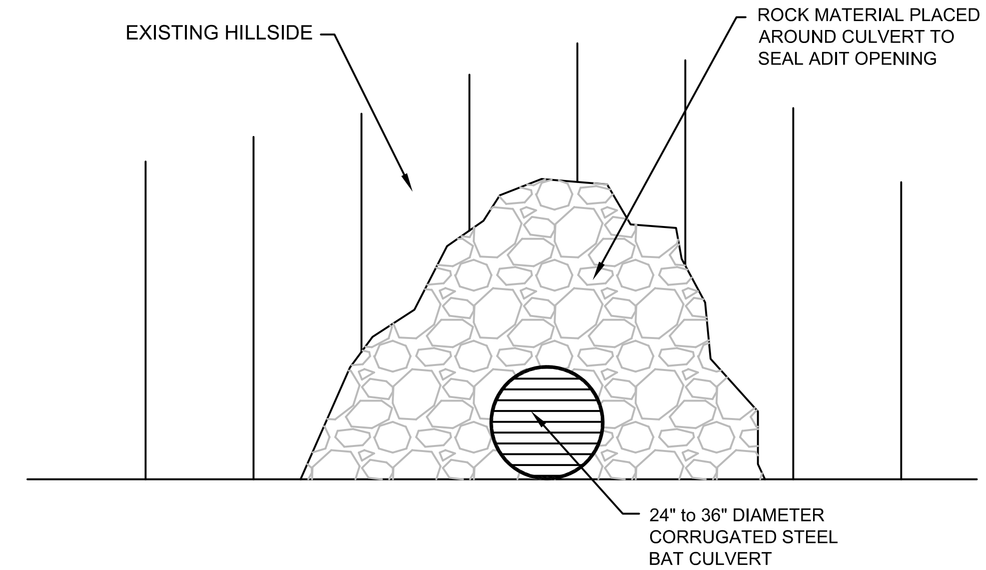
Upper Workings Cap in Place Kromona Mine

B2473M	Fig 7.dwg	11/03/09	Figure 7



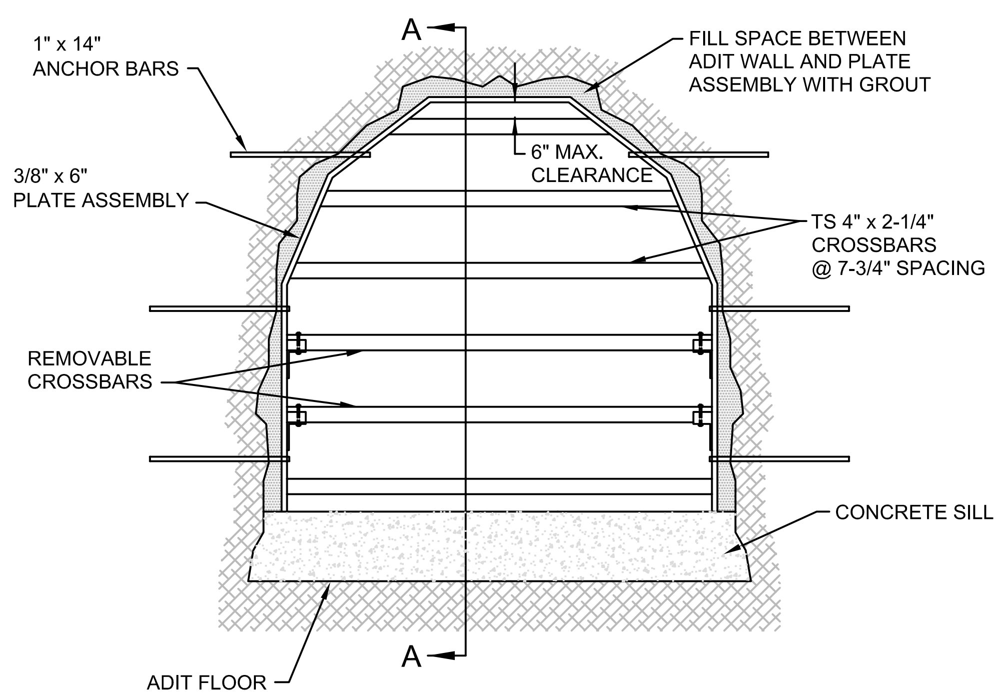
BAT CULVERT PROFILE

Not to scale



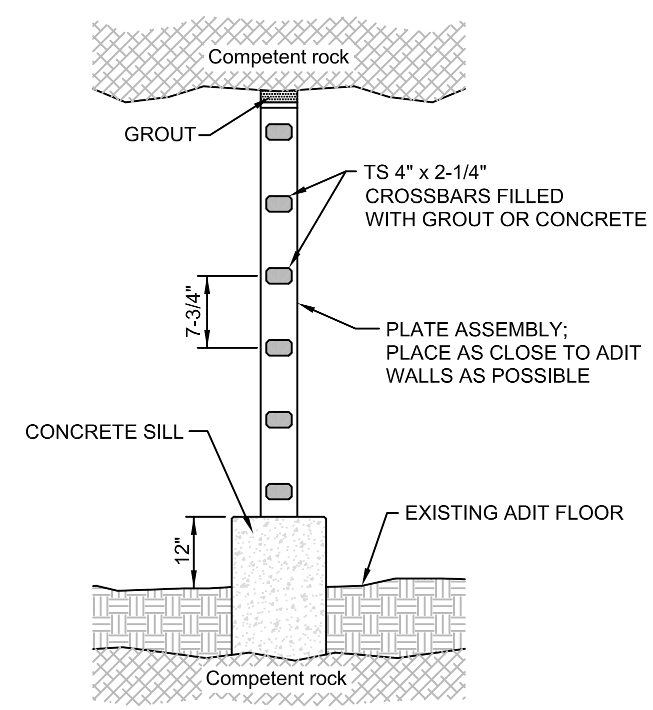
BAT CULVERT FRONT VIEW

Not to scale



BAT GATE ELEVATION

Not to scale



SECTION A-A

Not to scale

CONCEPTUAL DESIGN DRAWINGS ONLY - NOT INTENDED FOR CONSTRUCTION

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Bat Gate Details
Kromona Mine

B2473M	fig8.dwg	11/03/09	Figure 8

APPENDIX A

SITE PHOTOGRAPHS

Photo 1: First washed out culvert

Photo 2: Second washed out culvert


Photo 3: Third washed out culvert


Photo 4: Heavy downfall along access road (FR 6110)

Photo 5: 60-foot unstable bridge from west side

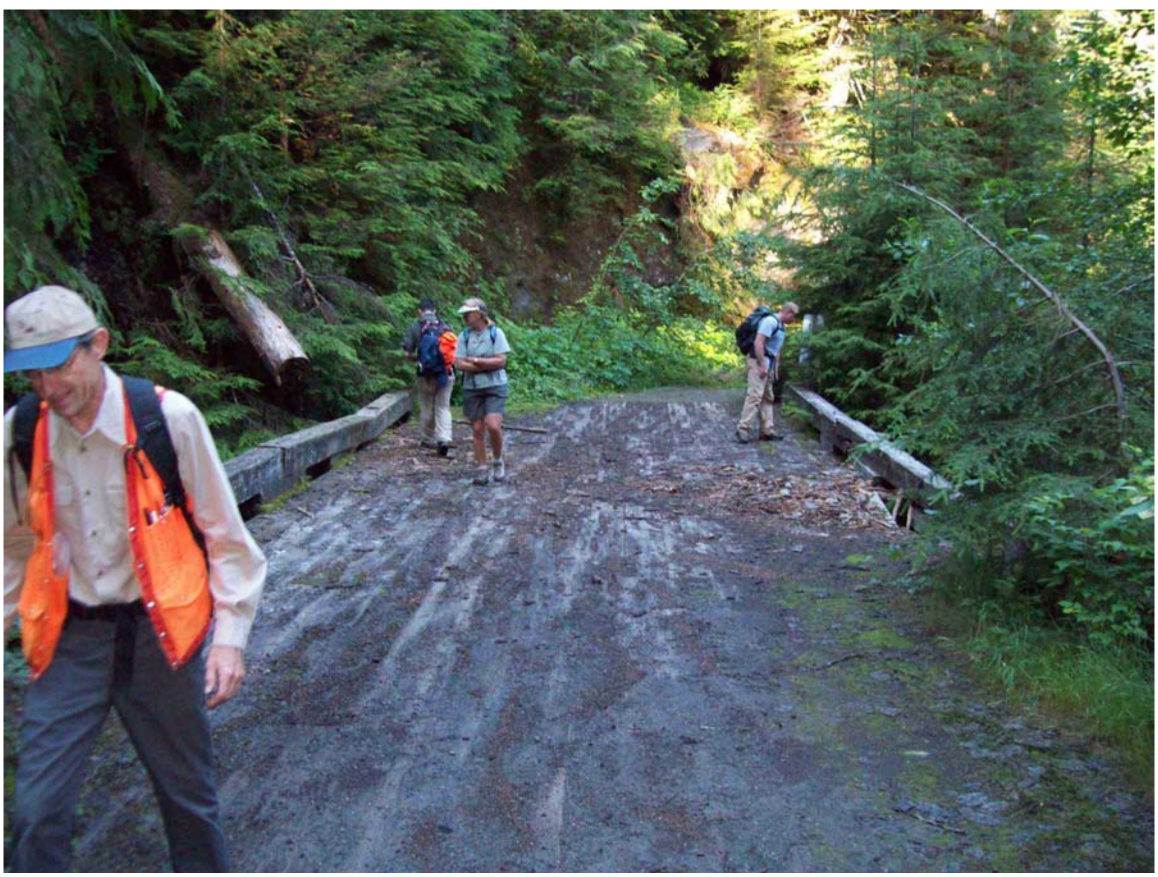

Photo 6: 60-foot unstable bridge from east side

Photo 7: Collapsed bridge across MFSF at Site from south side


Photo 8: Collapsed bridge across MFSF at Site from north side


Photo 9: Bench at millsite


Photo 10: Remains of terraced mill foundation


Photo 11: Unprocessed coarse ore on middle terraces of mill foundation


Photo 12: Unprocessed fine ore on lower terraces of mill foundation


Photo 13: Millsite from terraced mill foundation

Photo 14: Sump drain in mill foundation

Photo 15: Underground storage tank at millsite


Photo 16: Tailings impoundment near mill foundation


Photo 17: Upper workings from southeast end of terrace


Photo 18: Upper workings from northwest end of terrace


Photo 19: Main Adit portal at upper workings


Photo 20: Post and beam shoring inside Main Adit portal


Photo 21: Asbestos tile at upper workings


Photo 22: Aboveground storage tank at upper workings


Photo 23: Culvert discharging flow from Main Adit


Photo 24: Culvert discharging flow from hillside above terrace


Photo 25: Tram terminal and waste rock pile at upper workings

Photo 26: Looking down waste rock slope from terrace at upper workings

Photo 27: Looking up waste rock slope at tram terminal

Photo 28: Potential repository location at Millsite

Photo 29: Potential repository location along access road (FR 6110)

APPENDIX B

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Chemical-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Safe Drinking Water Act (SDWA)	40 USC § 300		
National Toxics Rule	40 CFR Part 131	Establishes water quality standards for protection of human health and aquatic organisms for states that fail to fully comply with Clean Water Act (CWA) Section 303(c)(2)(C).	Not Applicable—the State of Washington has been delegated this program.
National Primary Drinking Water Regulations	40 CFR Part 141	Establishes health-based standards, maximum contaminant levels (MCL) and maximum contaminant level goals (MCLG), for public water systems.	Potentially Relevant and Appropriate to potable surface water at the site; however, Removal Action does not involve a public water supply.
Clean Water Act (CWA)	33 USC §§ 1314		
National Recommended Water Quality Criteria (NWQC)	33 USC § 1251 et seq., Section 304(a), 40 CFR Part 131	Establishes non-enforceable criteria for water quality based on toxicity to aquatic organisms and human health.	Not Applicable—the State of Washington has been delegated this program. Recommended but not enforceable criteria.
Clean Air Act (CAA)	40 USC § 7409		
National Primary and Secondary Ambient Air Quality Standards (NAAQS)	42 USC §§ 7401 et seq.	Establishes air quality levels that protect public health.	Not Applicable—only "major" sources are subject to requirements related to NAAQS, defer to state regulation of fugitive dust emissions.
National Standards for Hazardous Air Pollutants (NESHAP)	40 CFR Part 61, Subpart M	Establishes work practices to minimize the release of asbestos fibers during activities involving processing, handling and disposal of asbestos.	Applicable Requirement
Resource Conservation and Recovery Act (RCRA)	40 USC § 6901-6992k		
Hazardous Wastes	40 CFR Part 261, Subpart D and C	Defines those solids wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271.	Potentially Applicable or Relevant and Appropriate. Washington has not adopted the Bevill Amendment for mining waste. See action-specific ARARs for further discussion.

Chemical-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON			
Hazardous Waste Removal Reduction Act	WAC 173-350, Revised Code of Washington (RCW) 70.95C	Establishes state policies and goals that encourage the reduction of hazardous substance use and the generation of hazardous waste. Requires certain hazardous waste generators and hazardous substance users to prepare plans for voluntarily reducing hazardous substance use and hazardous waste generation.	Potentially Relevant and Appropriate
Persistent Bioaccumulative Toxins Rule	WAC Chapter 173-333	Establishes criteria to identify persistent bioaccumulative toxins that pose human health or environmental threats, defines chemical action plans preparation, and defines the processes ecology will use to coordinate the implementation of this chapter with the department of health and other agencies.	Potentially Relevant and Appropriate
Surface Water Beneficial Uses	WAC Chapter 173-201A-200 and –600, RCW 90.48	Requires that surface water bodies be protected for their designated beneficial uses	Potentially Relevant and Appropriate
Dangerous Waste Regulations	WAC Chapter 173-303, RCW 70.105	(1) Designates solid wastes that are dangerous or extremely hazardous to the public health and environment; (2) provides for surveillance and monitoring of dangerous and extremely hazardous wastes; (3) establishes a system for manifesting, tracking, reporting, monitoring, recordkeeping, sampling, and labeling dangerous and extremely hazardous wastes; (4) establishes siting, design, operation, closure, postclosure, financial, and monitoring requirements for dangerous and extremely hazardous waste transfer, treatment, storage, and disposal facilities; (5) establishes design, operation, and monitoring requirements for managing the state's extremely hazardous waste disposal facility; (6) establishes a program for permitting dangerous and extremely hazardous waste management facilities; and (7) encourages recycling, reuse, reclamation, and recovery to the maximum extent possible.	Potentially Relevant and Appropriate
Washington Industrial Safety and Health Act (WISHA)	Chapters 296-62 and 296-65	Establishes occupational health and safety standards for asbestos removal and handling. Requires a survey by an accredited inspector prior to demolition	Applicable Requirement
Puget Sound Clean Air Agency	Regulation III, Article 4	Establishes local (Snohomish County) regulations for asbestos handling and disposal.	Applicable Requirement

Chemical-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON (continued)			
Drinking Water Standards	RCW 70.119A, WAC Chapter 246-290	Established health-based MCLs for public water supplies.	Potentially Relevant and Appropriate to surface water drinking sources at the site.
Water Quality Standards for Surface Water	RCW 90.48, WAC Chapter 173-201A	Establishes aquatic life criteria for hazardous substances in freshwater.	Potentially Applicable. State of Washington is authorized by EPA to implement CWA.
Model Toxics Control Act (MTCA)	RCW 70.105D, WAC Chapter 173-340	Specifies that surface water cleanup standards be based on estimates of the highest beneficial use and the reasonable maximum potential exposure under current and future site uses. Establishes administrative processes and standards to identify, investigate, and clean up facilities where hazardous substances have come to be located. It defines the role of the department and encourages public involvement in decision making.	Potentially Relevant and Appropriate
	WAC Chapter 173-340-7490	Specifies procedures for a Terrestrial Ecological Evaluation (TEE) to determine if the existence of hazardous substances at a site could harm terrestrial plants or animals, and to establish cleanup levels to protect biota.	Potentially Relevant and Appropriate
Natural Background Soil Metals Concentrations	WDOE Publication 94-115, October 1994	Defines region–specific natural background concentrations for metals in surficial soils throughout the state.	To Be Considered
Sediment Management Standards	WAC Chapter 173-204	Establishes freshwater surface sediment management standards.	Potentially Relevant and Appropriate
Economic Impact Statement For Proposed Sediment Management Standards	WAC Chapter 173-204	The WDOE is proposing a management process for implementing sediment quality standards pursuant to requirements of the Model Toxics Control Act, the Water Pollution Control Act, and the Puget Sound Water Quality Authority Act.	To Be Considered

Location-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
RCRA	40 USC § 7601		
Hazardous and Solid Waste Regulations	40 CFR Part 264.18	Location standards and restrictions for hazardous waste treatment, storage, and disposal (TSD) facilities.	Potentially Relevant and Appropriate
	40 CFR §§ 257.3-1 through 257.3-4	Location standards and restrictions for municipal solid waste (MSW) facilities.	Potentially Relevant and Appropriate
Fish and Wildlife Coordination Act	16 USC §§ 661-667	Requires consultation with the USFWS when federal department or agency proposes or authorizes any modification of any stream or other water body to assure adequate protection of fish and wildlife resources.	Potentially Applicable
Fish and Wildlife Conservation Act	16 USC §§ 2901-2911	Promotes conservation of non-game fish and wildlife through assistance to states and use of federal authority.	Potentially Applicable
Protection of Wetlands Executive Order No. 11990	40 CFR Part 6; Appendix A, 40 CFR 6.302(a)	Established to avoid adverse impacts associated with the destruction or loss of wetlands and avoid support of new construction in wetlands if a practicable alternative exists.	Potentially Applicable
Floodplain Management Executive Order No. 11988	40 CFR Part 6, Appendix A 40 CFR 6.302(b)	Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain to the extent possible.	Potentially Applicable
Dredge and Fill Regulations	33 USC § 1344, 33 CFR 323.1 et seq.	Prohibits discharge of dredged or fill material into waters of the United States without a permit	Potentially Relevant and Appropriate
Bald Eagle Protection Act	16 USC §§ 668 et seq.	Requires continued consultation with the USFWS during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald or golden eagle.	Applicable Requirement
Endangered Species Act (ESA)	16 USC §§ 1531-1544	Outlines procedures for federal agencies to follow if actions may jeopardize listed species. Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat.	Potentially Applicable

Location-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL (continued)			
National Forest Management Act (NFMA), Mt. Baker Snoqualmie NF Land and Resource Management Plan (LRMP, 1989), as amended by Pacific Northwest Forest Plan (NWFP, 1994) and subsequent amendments (2001, 2004, and 2007)	16 USC §§ 1600-1614	NFMA requires land management based on multiple-use, sustained-use yields. The LRMP and NWFP establish guidelines and standards for design, construction, and use of various actions on USFS land.	Potentially Applicable or Relevant and Appropriate
National Historic Preservation Act (NHPA)	16 USC § 470; 36 CFR Part 800 40 CFR 6.301(b)	Requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on any property with historic, architectural, archeological, or cultural value that is included in or eligible for inclusion in the National Register of Historic Places.	Potentially Applicable
Archaeological Resources Protection Act	16 USC § 470	Specifies actions that must be taken to preserve archaeological resources.	Potentially Applicable
Archeological and Historic Preservation Act (AHPA)	16 USC § 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of significant scientific, prehistoric, historic, and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	Potentially Applicable
Historic Site, Buildings, Objects, and Antiquities Act	16 USC § 461-467	Requires preservation of historic sites, buildings, and objects of national significance.	Potentially Applicable
Native American Graves Protection and Reparation Act	25 USC § 3001 et seq.	Establishes protective requirements to be followed when graves or Native American burial sites are encountered.	Potentially Applicable
The American Indian Religious Freedom Act (AIRFA)	42 USC § 1996	Requires federal agencies to protect the right of Indian tribes to practice their traditional religions.	Potentially Applicable
Wilderness Act	16 USC §§ 1131-1136	Established the National Wilderness Preservation System, which concerns leaving lands unimpaired for future use as a wilderness.	Potentially Applicable

Action-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL			
Clean Water Act	33 USC § 1342		
National Pollutant Discharge Elimination System	40 CFR Part 122.26	In general, Part 122 provides permit requirements for the discharge of pollutants from any point source into waters of the United States. Part 122.26 requires permits for storm-water discharges.	Potentially Applicable
CWA – Water Pollution Control Act (WPCA), Water Quality Certification	33 USC § 1341, Section 401	Requires certification from the state (WDOE) that discharges into navigable waters comply with applicable water quality standards.	Potentially Applicable
CWA/WPCA – National Pollution Discharge Elimination System (NPDES)	33 USC § 1342, Section 402	Establishes requirements for point source discharges and stormwater runoff.	Potentially Applicable
CWA/WPCA – Discharge of Dredge and Fill Materials	33 USC § 1344, Section 404	Regulates the discharge of dredge and fill into waters of the United States, including wetlands.	Potentially Applicable
Clean Air Act	42 USC § 7401 et seq., 40 CFR Part 50	Establishes limits for air emissions.	Potentially Applicable
National Standards for Hazardous Air Pollutants (NESHAP)	40 CFR Part 61, Subpart M	Establishes work practices to minimize the release of asbestos fibers during activities involving processing, handling and disposal of asbestos.	Applicable Requirement
Land Disposal Restrictions (LDRs)	40 CFR Part 268	LDRs place specific restrictions (conc. or trmt) on RCRA hazardous wastes prior to their placement in a land disposal unit. Relevant and appropriate LDR requirements will be met if any material accumulations are treated *ex situ*.	Applicable Requirement
RCRA Subtitle C – Hazardous Waste Management	42 USC § 6901, 40 CFR Parts 260 to 279	Specifies hazardous waste identification, management, and disposal requirements.	Potentially Applicable
Subtitle D – Managing Municipal and Solid Waste	42 USC § 6901, 40 CFR Parts 257 and 258	Establishes guidelines for the management of non-hazardous solid waste.	Potentially Applicable
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities	40 CFR Part 264.13.14	Requirements for proper handling, treatment, storage, and disposal of hazardous wastes.	Potentially Applicable
Disposal of Solid Waste	42 U.S.C. § 6901 et seq; 40 CFR 257	Facility or practices in floodplains will not restrict flow of basic flood, reduce the temporary water storage capacity of the floodplain or otherwise result in a wash-out of solid waste.	Potentially Applicable

Action-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL (continued)			
Closure Requirements	RCRA/HWMA 40 CFR & 264, Subpart G	Closure of hazardous waste repositories must meet protective standards. Regulations to minimize contaminant migration, provide leachate collection and prevent contaminant exposure will be met.	Potentially Applicable
Landfill Design and Construction	RCRA/HWMA 40 CFR & 264, Subpart N	Hazardous waste landfills must meet minimum design standards. Protectiveness will be achieved through capping and institutional controls.	Potentially Applicable
Groundwater Monitoring	RCRA/HWMA 40 CFR & 264, Subpart F 40 CFR & 264, Subpart X	Establishes standards for detection and compliance monitoring. Site wide monitoring will accommodate specific groundwater monitoring requirements.	Not Applicable or Relevant and Appropriate. Treatment of groundwater is outside the Removal Action scope.
Occupational Exposure to Asbestos	29 CFR Parts 1910 and 1926.	Establishes OSHA requirements for asbestos-related work in the construction and demolition industry. Requirements on exposure limits, work practices and engineering controls to provide worker safety in handling, removal, disposal, or other workplace exposure to asbestos.	Potentially Relevant and Appropriate
Superfund Remedial Design and Remedial Action Guidance	EPA OSWER Directive 9355.0-4A, June 1986	Provides guidance for site remediation and the design of remedial action components.	To Be Considered
Hazardous Materials Transportation Act	49 USC §§ 1801-1813 49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials.	Potentially Applicable
Surface Mining Control and Reclamation Act	30 USC §§ 1201-1328	Performance standards for surface mining activities.	Potentially Relevant and Appropriate
Indian Sacred Sites	Executive Order 13007	Requires federal agencies to avoid physical damage to Indian sacred sites and to avoid interfering with access to such sites.	To Be Considered
Protection and Enhancement of the Cultural Environment	Executive Order 11593	Directs federal agencies to nominate historic properties to the NRHP and treat properties that are eligible for the NRHP as though they were listed.	To Be Considered

Action-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
FEDERAL (continued)			
Invasive Species	Executive Order 13112	Requires federal agencies to prevent the introduction of invasive species.	To Be Considered
Migratory Bird Treaty Act (MBTA)	16 USC §§ 703 et seq.	Establishes federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	Potentially Relevant and Appropriate
Responsibilities of Federal Agencies to Protect Migratory Birds	Executive Order 13186	Requires federal agencies to avoid or minimize adverse impacts to migratory bird resources to the extent practical.	To Be Considered

Action-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON			
MTCA	RCW 70.105D, WAC Chapter 173-340	Establishes procedures and standards for investigating and cleaning up sites with hazardous substances present.	Potentially Applicable
Sediment Management Standards	WAC Chapter 173-204	Establishes freshwater surface sediment management standards.	Potentially Relevant and Appropriate
Regulation and Licensing of Well Contractors and Operators	RCW 18.104, WAC Chapter 173-162	Establishes procedures for well contractors and operators.	Potentially Applicable
Minimum Standards for Construction and Maintenance of Water Wells	RCW 18.104, WAC Chapter 173-160	Sets minimum standards for the construction of water and monitoring wells, and well decommissioning.	Potentially Applicable
Hazardous Waste Management Act and Dangerous Waste Regulations	RCW 70.105, WAC Chapter 173-303	Establishes regulations for the handling and deposition of dangerous waste, including identification, accumulation, storage, transport, treatment, and disposal.	Potentially Applicable – Washington has not adopted the Bevill Amendment for mining wastes.
Solids Waste Handling Standards	RCW 70.95, WAC Chapter 173-350	Establishes standards for the proper handling and disposal of solid waste, and requirements for the design, construction, operation, and closure of solid waste handling facilities.	Potentially Applicable or Relevant and Appropriate
Hydraulic Code	RCW 77.55, WAC Chapter 220-110	Requires a Hydraulics Project Approval permit for construction activities that use, divert, obstruct, or change the bed or flow of state waters.	Substantive provisions potentially Applicable
Shoreline Management Act (SMA)	RCW 90.58, WAC Chapter 173-18, 173-22	Established to prevent harm to the state's shorelines, including streams with a mean annual flow greater than 20 cubic feet per second.	Applicable Requirement
Fugitive Dust Emissions	40 CFR Section 50.6	Establishes standards for PM-10	Applicable Requirement
Water Quality Standards for Surface Waters – Mixing Zones	RCW 90.48, WAC Chapter 173-201A-400	Establishes mixing zone effluent limits for discharges to surface water.	Potentially Applicable
Water Quality Standards for Surface Waters – Short-term Modifications	RCW 90.48, WAC Chapter 173-201A-410	Allows for short-term modification to water quality criteria for specific water bodies when necessary.	Potentially Applicable
Submission of Plans and Reports for Construction of Wastewater Treatment Facilities	RCW 90.48, WAC Chapter 173-240	Requires submission of wastewater treatment systems designs to the WDOE for review and approval.	Potentially Applicable

Action-Specific
Applicable or Relevant and Appropriate Requirements
Kromona Mine, Washington

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/Relevant and Appropriate?
STATE OF WASHINGTON (continued)			
Aquatic Lands Management	RCW 79.90, WAC Chapter 332-30	Establishes criteria for the management of state-owned aquatic lands to promote uses and protect resources.	Potentially Applicable
Water Code and Regulation of Public Groundwater – Surface Water and Groundwater Withdrawal	RCW 90-90.03 and 90.44	Specify criteria and procedures for appropriating surface water and groundwater for beneficial uses.	Potentially Applicable
Maximum Environmental Noise Levels	RCW 70.107, WAC Chapter 173-60	Establishes maximum permissible noise levels.	Potentially Applicable
Washington Clean Air Act and Implementing Regulations	WAC Chapter 173-400-040(8), 173-420	Requires reasonable precautions be taken to prevent the generation of fugitive dust.	Potentially Relevant and Appropriate
General Regulations for Air Pollution Sources	RCW 70.94, WAC Chapter 173-400	Regulates air pollution from contaminant sources, and establishes rules for the control and prevention of air contaminant emissions.	Potentially Applicable
Washington Industrial Safety and Health Act (WISHA)	Chapters 296-62 and 296-65	Establishes occupational health and safety standards for asbestos removal and handling. Requires a survey by an accredited inspector prior to demolition	Applicable Requirement
Puget Sound Clean Air Agency	Regulation III, Article 4	Establishes local (Snohomish County) regulations for asbestos handling and disposal.	Applicable Requirement