2.0 SITE DESCRIPTION, OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

This section provides a summary of the Site location and operational history, and describes the wastes associated with the Site. The Preassessment Screen (PAS) (Environment International Ltd., 2002) and other documents provide detailed descriptions of the Site location and the operational history of the mine. Relevant information provided by these documents is summarized below.

2.1 Location

- The Site includes an inactive mine located approximately three miles south of the Oregon-California border, on privately-owned land within the Rogue River-Siskiyou National Forest, in Siskiyou County, California (Figure 1).
- The latitude/longitude coordinates of the Site are 41˚57'36" North Latitude/123˚05'60" West Longitude.
- The Site is found on the U.S. Geological Survey (USGS) 7 ½ Minute Quadrangle Map – Dutch Creek, California.
- To access the mine from the north, proceed south on Upper Applegate Road (Highway 10), continue south on USFS Road 1040 (Figure 1). USFS 1040 merges with USFS 1050 just south of the Oregon-California border. Turn right at the intersection of USFS 1060 crossing Elliott Creek in the small community of Joe Bar, California. Continue 3.5 miles south on USFS 1060 to the Site.
- The Joe Creek watershed includes four unnamed tributaries referred to previously and herein as Tributaries 1 through 4 (from north to south) as well a fifth tributary called Manzanita Gulch.
- The Site lies at the upper headwaters of the Joe Creek watershed, on a steep, generally north-facing hillslope above the confluence of Joe Creek and Tributary 4.
- The Site is composed of over two miles of underground excavations, at least six adits, and steep slopes covered by accumulations of waste rock that extend down the slope to Joe Creek and Tributary 4 (Figure 2).
- Patented claims at the Site cover approximately 500 acres.

2.2 Operational History

The PAS provides a detailed review of the operational history of the Blue Ledge Mine. The following is a summary of the operational history.

- The ore body was discovered in 1898 by miners panning on Joe Creek.
- Development of the mine started in 1904 and continued until 1930. Over the lifespan of the mine there were several periods of inactivity (mid-1909 until 1917 and 1920 through 1929) before all mining activity ceased in 1930.
- The mine was developed to recover sulfide deposits rich in copper, gold, silver and zinc. Most of the mine's economic value stemmed from the extraction of copper and zinc.
- Ore was not shipped from the Site until 1917 after which it was hauled by wagon to Elliott Creek where it was loaded onto trucks for transport to Medford, Oregon. The ore was then loaded onto railcars for delivery to the smelter in Tacoma, Washington, owned by the American Smelting and Refining Company (ASARCO). Receipts from the smelter show ore shipment from the mine totaled 11,151 tons.
- Waste rock from the mining operations was disposed of on the steep slopes of the Site, as well as within many mine workings.
- Previous estimates of waste rock volumes vary from 50,000 to 60,000 tons.
- The mine has been owned, leased, or operated by at least 14 parties. ASARCO and/or their subsidiaries have been financially involved with the Site since 1913 and throughout the period of ore production.

- Several exploration activities have occurred at the Site since mining operations ceased in 1930.

2.3 Site Description

- The mine Site spans an elevation range of about 4,000 to 4,800 feet above sea level.
- Average annual rainfall exceeds 40 inches, the majority of which falls during the winter months.
- A run-off channel with seasonal flows to Joe Creek cuts through the waste rock. Known sources contributing to the flow in this ravine include groundwater emerging from the lower north adit, AD-01, and the seep west of the Site, SP-02, in addition to precipitation/snowmelt run-off from the waste rock covered slopes. The water flows over a log waste rock dam prior to its discharge to Joe Creek.
- Vegetation in the mine vicinity is a mesic forest consisting of Douglas fir, ponderosa pine, incense-cedar and Oregon white oak. Other species such as sugar pine, yellow pine, and lodge-pole pine have also been reported in the area.
- The adits likely provide nesting and roosting habitat for many bat species.
- Other species within the habitat near the mine include amphibians, reptiles, birds and mammals. The northern goshawk is a U.S. Fish and Wildlife Service (USFWS) candidate species. The Siskiyou Mountain salamander is listed as a USFS sensitive species and a California-endangered species. The northern bald eagle and the northern spotted owl also reside in the area and are both federally listed threatened species.
- The watershed between the mine and Applegate Reservoir hosts resident rainbow and cutthroat trout populations; Pacific lamprey and reticulate sculpin may also inhabit the watershed. Historically, fish such as fall Chinook, Coho salmon, Pacific lamprey, and steelhead migrated to the watershed. Since the Applegate Dam was constructed these migrations have ceased. Currently no fish reside in Joe Creek.
- The small community of Joe Bar is located downstream of the Site just beyond the confluence of Joe Creek with Elliott Creek.

2.4 Summary of Previous Data Collection

- In January 1981 the USFS collected one surface water sample from Joe Creek at the confluence with Elliott Creek. The sample was analyzed for arsenic, chromium and copper. Only copper was detected.
- In 1983 Freeport Exploration Co. conducted a reconnaissance sampling program to explore for precious metal massive sulfide deposits.
- The USFS collected surface water samples from the mine drainage, Joe Creek, and Elliott Creek in April 1992. Samples were analyzed for pH, conductivity, metals, sulfates, fluoride, hardness, and alkalinity. The results confirmed that the mine drainage contained cadmium, copper, and zinc at levels exceeding EPA freshwater criteria. The sample of the mine drainage exhibited an acidic pH of 3.10.
- The USFS conducted three water quality monitoring events in September 2000, April 2001, and August 2001. Samples were collected from Elliott Creek, Joe Creek upstream and downstream of the Site, the run-off channel that flows through the Site, and Park Gulch (a tributary of Elliott Creek). Field parameters (pH, temperature, dissolved oxygen, and conductivity) were collected by field personnel. Water samples were submitted to a laboratory for analysis of total metals, sulfate, and total alkalinity. Results from these investigations demonstrated that concentrations of cadmium, copper, iron, lead, and zinc in Joe Creek increased significantly in surface water downstream of the Site, indicating that the Site was an ongoing and significant source of contamination to Joe Creek.
- A macroinvertebrate survey was conducted by Southern Oregon University (SOU) during the Fall of 2000 and Spring of 2001. The results of the survey documented that ongoing drainage from

the Site was impacting biota in Joe Creek. The survey also concluded that the impacts of the drainage increase during periods of high run-off from the Site.

- The USEPA Superfund Technical Assessment and Response Team (START) conducted a Site screening sampling event in May 2005 followed by a removal assessment. Sample results from the screening sampling event were used to identify contaminants of concern and sample population statistics. During the removal assessment, eight surface samples were collected and eight subsurface samples (1-1.5 feet deep) were collected. All samples were analyzed for the chemicals of concern (COCs) determined during the screening (lead and arsenic). Two of the subsurface samples were additionally analyzed for cadmium, copper, iron, manganese, mercury, and zinc. The sampling event demonstrated that metals concentrations significantly exceeded health-based benchmarks (Region 9 Preliminary Remediation Goals) as well as background concentrations.
- From May 2005 through November 2007 SOU students collected water samples from the Site, Joe Creek, Elliott Creek, and the Middle Fork of the Applegate River. Field parameters (pH, temperature, dissolved oxygen, and total dissolved solids) were measured. All samples were analyzed for total metals (arsenic, calcium, cadmium, copper, iron, sodium, lead, and zinc). The data collected as part of the SOU program indicated that there are slight seasonal trends in metal concentrations of water leaving the Site. Additionally, the data demonstrated that the EPA response actions at the Site were essentially ineffective at improving the quality of water discharging from the Site to Joe Creek.
- In summary, the previous investigations have demonstrated that the waste rock present within the abandoned workings and on the slopes of the Site are a significant historic and ongoing source of cadmium, copper, iron, lead, and zinc, and sulfuric acid to Joe Creek. Data from previous investigations demonstrate that cadmium, copper, iron, and zinc concentrations in surface water detected below the Site are significantly higher than background detections, further confirming that the Site is a significant source of these metals and is releasing these metals to the environment at significant concentration. Based on the work completed to date, releases have been confirmed to have severely impacted the aquatic life of Joe Creek, and Joe Creek would otherwise be a productive native fishery.

2.5 Description of Waste Characteristics

- Previous waste rock volume estimates at the Site range from 50,000 to 60,000 tons.
- The waste rock material is predominately silty gravel with sand and is moderately weathered. Previous investigations, such as the PA/SI (Weston, 2004), documented the presence of ferricrete (a sand and gravel mass that is cemented by iron oxide) at the Site.
- The sulfide deposits, for which the area was developed, are a continuing source of AMD, which results from weathering that oxidizes the mineralized sulfide deposits resulting in sulfate and acidity (including sulfuric acid). The mine workings created during the development of the mine (winzes, adits, and drifts) supply natural ventilation throughout the mine, providing an environment for the continued oxidation of exposed minerals (Hundhausen, 1947).
- Previous investigations have documented increased sulfate concentrations and acidity in water emerging from the mine adits. The AMD is flushed from the adits during periods of higher precipitation where it infiltrates through the waste rock and leaches metals. The finer the waste particle, the more surface area is available for the AMD to leach metals from. It is assumed that the majority of the infiltrated water emerges into the run-off channel and discharges into Joe Creek; infiltrated water that does not leave the Site via the channel is assumed to discharge to Joe Creek as groundwater base flow.
- Periods of high precipitation and surface runoff erode the waste rock and transport waste material as sediment to Joe Creek. In 2006, remediation efforts by USEPA at the Site included grading of waste rock piles below the lowermost adit, redirecting AMD into a marble-lined run-

off channel and creating a settling pond above a log dam to capture sediment eroded from the waste piles. By May 2007, an approximately 90-cm-thick deposit of sediment had accumulated in the pond, nearly filling the capacity of the pond (SOU, undated).

2.6 Summary of SI Data Collection

- The SI field work and data collection were carried out from June 23 to June 28, 2008. A macro-invertebrate survey was also conducted on September 9, 2008. Drinking water samples were collected from sources in Joe Bar on November 8, 2008.
- URS collected solid samples of waste rock, river sediment, and riparian soil. Water samples were collected from seeps, adits, the log dam, tributaries to Joe Creek (Tributary 3, Tributary 4, and Manzanita Gulch), Joe Creek, Elliott Creek, the Middle Fork Applegate River, and Applegate Reservoir. A total of four macroinvertebrate samples were collected from Joe and Elliott Creeks. Fish tissue samples were collected from Elliott Creek, the Middle Fork Applegate River, and Applegate Reservoir. Drinking water samples were collected from three sources in Joe Bar, two wells and one spring.
- Sample locations and types, with the exception of drinking water samples, are shown on Figures 3, 4, 5 and 6.
- Water samples were collected from 32 locations shown on Figures 3 through 5. Field duplicate samples were collected from two locations, EC-04 and JC-07.
    - Surface water samples were collected using clean, disposable, dedicated bailers.
    - Clean, disposable 0.45-micron filters were used to collect field filtered samples analyzed for dissolved metal. Filters were connected directly to a bailer during sampling.
    - In-situ water quality measurements at each water sample location included pH, temperature, and specific conductivity.
    - Water samples from the seeps and the log dam could not be collected directly with a bailer. These samples were collected directly into lab-provided bottles and jars for analyses not requiring field filtering. Samples requiring filtering were collected in an unpreserved 1-liter bottle and transferred to a clean, dedicated bailer with a clean, disposable 0.45-micron filter attached to its outlet, from which sample containers were filled.
    - Of the seven adits observed at the Site, only adit # 1 and adit #2 were discharging groundwater during the field investigation. A water sample was collected from each of these two adits.
    - Two seeps were observed during the field investigation. One, SP-02, is near the former Eileen town site and the other, SP-01, is on the hillside to the west of the main waste rock area, as shown on Figure 5. A water sample was collected from each seep.
    - Water was observed flowing over the log dam from the settling pond created as part of the 2006 EPA removal action. A single water sample, DAM-01, was collected from below the log dam.
    - Two of the tributaries of Joe Creek, Tributary 1 and Tributary 2, were found to be dry during the investigation.
    - Two planned sampling locations within Joe Creek, JC-05 and JC-06, were inaccessible and therefore not sampled.
    - Six of the sample locations on Joe Creek and two sample locations on Elliott Creek have been sampled during previous investigations (JC-01, JC-04, JC-06, JC-07, JC-08, JC-09, EC-06, and EC-07).
    - All water and drinking water samples were analyzed for dissolved metals (arsenic, cadmium, copper, iron, lead, and zinc), sulfate, total suspended solids (TSS), total dissolved solids (TDS), alkalinity, and hardness.

- Sediment samples were collected from 24 locations as shown on Figures 3 through 5. Two field duplicates were collected from sample locations EC-04 and EC-05.
    - Sediment samples were collected from Joe Creek, Elliott Creek, the Applegate Reservoir, and the Middle Fork Applegate River.
    - Sediment was not present at the proposed Joe Creek tributary locations (T1JC, T2JC, T3JC, T4JC and MG), and therefore no sediment samples were collected from these locations.
    - Sediment was collected from stream channels using a shovel. Sediment that did not contact the shovel was then placed in sample jars manually while wearing clean, disposable nitrile gloves.
    - Personnel stood downstream during sampling, and sediment sampling was performed after collection of water samples.
    - Samples from Applegate Reservoir were collected using a hand-held trident box core sampler deployed from an inflatable raft. Sediment was then placed in sample jars manually as above while wearing clean, disposable nitrile gloves.
    - All sediment samples were analyzed for total metals (arsenic, cadmium, copper, iron, lead, and zinc) and particle size.

- Riparian soil samples were collected from 10 locations as shown on Figures 3 through 5. One field duplicate was collected at sample location EC-05.
    - Riparian soil was collected from above the normal high water line alongside Joe and Elliott Creeks and the Middle Fork Applegate River.
    - Samples were collected from the top 12 inches of soil after removal of organic debris present on the ground surface. A stainless steel shovel was used to perform "in-situ homogenization" (i.e., loosening and then mixing the soil in place) prior to placing the homogenized material into the laboratory provided containers. This was performed manually while wearing clean nitrile gloves.
    - An example of shoveled riparian soil before being placed in a sample jar is shown in Appendix A, Photo 25.
    - All riparian soil samples were analyzed for total metals and particle size.

- Fish tissue samples were collected from five locations as shown on Figure 3. A field duplicate was collected from the AR-02 sample location.
    - Fish were collected through electro-fishing and netting, under the supervision of a California Department of Fish & Game representative.
    - Reticulated sculpin, juvenile to 2 years old, were collected in Middle Fork Applegate River and Elliott Creek.
    - A rainbow trout was collected from Applegate Reservoir.
    - Fish collection was attempted in Joe Creek at location JC-01. No fish were observed or collected in Joe Creek.
    - All fish tissue samples were analyzed for total metals (arsenic, cadmium, copper, iron, lead and zinc).

- Waste rock samples were collected from four locations shown on Figure 5. One field duplicate was collected from the WRS-1 location. Results of waste rock analyses are shown in Table 7.
    - All waste rock samples were collected on the north face of the Site.
    - Samples were placed directly into Ziploc plastic bags by hand while wearing clean, disposable nitrile gloves.
    - All waste rock samples were analyzed by the Synthetic Precipitation Leaching Procedure (SPLP) for arsenic, cadmium, copper, iron, lead and zinc, and by the Toxicity

Characteristic Leaching Procedure (TCLP) for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

- A total of two bulk waste rock samples were collected for geotechnical analyses from the waste rock area shown on Figure 5.
    - All waste rock samples were collected on the lower half of the north face of the Site.
    - Samples were placed directly into clean 5-gallon buckets with a shovel.
    - Geotechnical analyses performed on the waste rock included grain size analysis and mechanical testing in general accordance with ASTM Test Methods D 422 and D 1140. Results of these analyses are included in Appendix E.

- A total of 28 bulk soil samples were collected for geotechnical analyses from nine test pits excavated at the three potential repository areas shown on Figure 6.
    - All test pits were excavated with a Case 580 backhoe.
    - 21 samples were collected from six test pits (test pits TP 1 through 6) excavated at the northern repository area.
    - Five samples were collected from two test pits (test pits TP 7 and 8) excavated at the southern repository area.
    - Two samples were collected from a single test pit (TP 9) excavated at the potential repository area at the former Eileen town site.
    - 23 of the 28 samples were placed in Ziploc bags immediately after excavation to maintain in-situ moisture content.
    - Five samples were placed directly into clean 5-gallon buckets with a shovel to perform bulk geotechnical tests.
    - Laboratory testing of the soils included soil classification (ASTM D 2487), moisture content (ASTM D 2216), grain size (ASTM D 422 and D 1140), Atterberg limits (ASTM D 4318), and laboratory compaction characteristics of soil using standard effort (ASTM D 698). Results of the laboratory analyses are not included in this report, the results will be used in the EE/CA.

- A total of four samples were collected for macroinvertebrate inventory from the areas shown on Figure 4.
    - All samples were collected in the reaches of stream near the sample locations shown on the figure.
    - Samples were collected in accordance with the EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition (Barbour, et al, 1999).
    - Each sample was comprised of the composite of five subsamples (or "kicks"). Kicks were collected in suitable riffle, rapid, or cascade stream habitat types; two kicks each were collected from areas near the right and left streambanks and one subsample was collected from a mid-channel location. The five kicks were combined into a single "composite" sample representing the entire sample location.
    - All samples were captured in a 12-inch diameter, 500-micron mesh size D-net and transferred to sterile 1-liter poly containers. Samples were immediately preserved with 90% ethanol.
    - The laboratory typed specimens to the highest taxonomic classification possible and constructed a Benthic Index of Biotic Integrity (B-IBI) to analyze sample locations against each other and expected conditions, based on watershed disturbance

- Macroinvertebrate Inventory Results
    - The results of the survey indicate that macroinvertebrate communities in Joe Creek downstream of the waste rock piles are significantly degraded, as compared to the upstream control sample. Differences in community are largely between species that are susceptible to metals toxicity and water temperature. Because water temperature was similar between the sample locations, the results indicate that metals contamination from the Site is adversely impacting the macroinvertebrate community in Joe Creek.
    - Macroinvertebrate communities in Elliott Creek varied slightly between samples collected downstream of the confluence with Joe Creek and the control located upstream. Community response gives no clear indication that assemblages were responding to the presence of metals. While this does not rule out an influence from metals, metrics were not sensitive enough to make such a correlation.
- Macroinvertebrate Inventory Conclusions
    - The aquatic macroinvertebrate survey clearly indicates that discharges from the mine (i.e., sediment erosion, surface water discharge, and/or groundwater discharge) are impacting aquatic biota assemblages in Joe Creek. Species composition, total numbers of a species, trophic distribution, and diversity of species all show a response to water quality impairment. Impacts to Elliott Creek are uncertain. Variations within Elliott Creek aquatic macroinvertebrate assemblages were not statistically significant; as such, analytical models were unable to discern if aquatic macroinvertebrate assemblages were responding to water quality contributed by Joe Creek.