SECTION 1

Introduction

The U.S. Environmental Protection Agency (EPA)—under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA)—is conducting a remedial investigation (RI) and feasibility study (FS) to address contamination associated with the Lava Cap Mine Superfund Site. The Lava Cap Mine is located southeast of Nevada City, California, as shown on Figure 1-1. The Lava Cap Mine Superfund Site (also referred to as the Site or Lava Cap Mine Site in this report) was listed on the National Priorities List (NPL) in February 1999. The Site encompasses the mine property itself and all downgradient areas impacted by contamination from the mine. This RI report has been developed, according to EPA guidance document, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

This RI report documents results of data collection efforts conducted to characterize site conditions, to determine the nature and extent of contamination, and to support informed risk-management decisions regarding potential risks to human health and the environment.

Following evaluation of the information gathered during the RI, potential remedial options will be addressed in the FS. The FS will use information generated during the RI to develop, screen, and provide detailed evaluations of alternative remedial actions. The RI/FS process at the Lava Cap Mine Site will lead to a Record of Decision (ROD). In the ROD, EPA will describe the environmental cleanup actions necessary to mitigate risks to human health and the environment from Lava Cap Mine Site contamination.

This RI report summarizes the geologic, hydrogeologic, air, and ecological investigations involving collection of soil, sediment, surface water, groundwater, air, and biota samples at the Lava Cap Mine Site. Samples were collected in the following general areas: reference areas, source areas, the mine, and downgradient of the mine. The area downgradient of the mine includes the area between the mine and Lost Lake, the Lost Lake area, and the area downgradient of Lost Lake.

1.1 Site Background

The following sections provide a description of the Site and a brief history of the Lava Cap Mine. In addition, this section summarizes investigations performed prior to EPA initiating this RI.

1.1.1 Site Description

Lava Cap Mine occupies approximately 30 acres in a rural residential area of the Sierra Nevada foothills. The mine is approximately 5 miles southeast of Nevada City and 6 miles east of Grass Valley (Figure 1-1) at 14501 Lava Cap Mine Road, Nevada City, California. The geographical coordinates are latitude 39°13’41.0” north and longitude

120°58'11.5" west, Township 16 North, Range 9 East, Section 28 of the Mount Diablo baseline and meridian (EPA, 1994a). The area is shown on Figure 1-2.

The mine property is bordered on all four sides by forest and low-density residential areas. There are several structures at the mine, including the former mill building, the former cyanide treatment building, a number of other old mine buildings, and several residences.

1.1.2 Site History

Gold and silver mining activities were initiated at the Lava Cap Mine (formerly known as the Central Mine) in 1861. The Banner Mine began operation in 1860. The Banner Mine is approximately 1.5 miles north of the Lava Cap Mine (Figure 1-3). These two mines were later operated by the Lava Cap Gold Mining Corporation (starting in 1934), and at that time, the Central Mine became known as the Lava Cap Mine. Various groups intermittently operated the Central and Banner Mines between 1860 and 1943, and a history of operations over that time period follows.

The initial operating period at the mines was from 1860 to 1918. Relatively small-scale mining operations occurred then. Approximately 20,000 tons of ore were mined from the Banner Mine / Central Mine between 1865 and 1890 (California Department of Toxic Substances Control [DTSC], 1991).

In the early years, the Central Mine was mined primarily for silver. During this period, amalgamation was used to process the ore. This process uses mercury to recover the silver and gold from the ore. The process was not highly effective on Central Mine ore, because of its high sulfide content. Between 1861 and 1918, the mining rate was higher at the Banner Mine. Hence, the majority of the ore processing, disposal of waste rock, and tailings (tailings are the waste products generated during the processing of ore to recover the gold and silver) reportedly occurred at the Banner Mine.

The Banner and Central Mines were inactive from 1918 until 1934, when mining activities resumed under the Lava Cap Gold Mining Corp. Prior to resumption of mining, a flotation plant was built to process the ore at the renamed Lava Cap Mine property. At some point after 1934, when the mines were reopened, the Banner and Lava Cap Mines were connected underground by means of a 5000-foot drift. The subsurface mine workings of the Lava Cap and Banner Mines are shown on Figure 1-3. Ore from the Banner portion of the mine was transported to the Central shaft and transported to the surface, where it was processed in the Lava Cap mill (California Division of Mines and Geology, 1941).

After operations resumed, Lava Cap Mine was one of the largest gold mines operating in California. The mine ranged from approximately 300 to 400 tons of ore a day during this period (Vector Engineering, Inc., 1991). In 1941, about 310 men were employed at the mine. The primary mining method was cut and fill (California Division of Mines and Geology, 1941). In this method, the open stope formed by mining was filled with waste rock after the ore was removed. This provided a more stable method than leaving the stope open under weak rock conditions.

The Lava Cap mill consisted of crushing and grinding circuits to reduce the particle size of ore. The ground ore was then subjected to flotation, which separated the ore into a concentrate, which contained gold and silver values and the tailings (Engineering and

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(Figure 1-1) (Backside)

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Figure 1-3 (backside)

Mining Journal, Vol. 135, 1934). It is estimated that the gold recovery from the processing was 93.5 percent (Holmes, 1985). The gold and silver concentrates from the flotation plant were shipped to two smelters: the Shelby Smelter near San Francisco, and the other in Tacoma, Washington (Vector Engineering, Inc., 1991).

In 1940, a cyanide plant was built to recover gold from the concentrates onsite, but this operation was relatively ineffective. From 1941 to 1943, the cyanide plant handled only the middlings (a process intermediate that is normally recycled in the mill to recover residual values) and tailings from the flotation plant, and did not handle the higher grade flotation concentrates. The middlings and tailings were ground to a very fine size and vat-leached with cyanide to remove residual gold and silver. The gold and silver were recovered in the cyanide plant using the Merrill-Crowe zinc-precipitation process.

During the 1934 to 1943 period, Lava Cap Mine produced 270,000 ounces of gold and 2.3 million ounces of silver from approximately 1 million tons of ore (Holmes, 1985). It was estimated that about 5 percent of the ore was recovered in the concentrate; hence, the quantity of tailings would have been approximately 95 percent of the quantity of ore mined (Vector Engineering, Inc., 1991).

Tailings from flotation and cyanidation processes were deposited in a ravine on the Lava Cap Mine property. A log dam, approximately 30 feet high, was built to hold the tailings in place where the ravine steepened and narrowed. The construction date of the log dam is not known, but it likely occurred shortly after mining operations resumed in 1934. The waste rock and overburden were deposited in two piles between the mine shaft and tailings pond that formed above the log dam.

It was reported that a dam was built on “Greenhorn Creek” in 1938 to “stop tailings from polluting waters of Bear River” (The Engineering and Mining Journal, Vol. 139, 1938). It is possible that this is a reference to the dam at Lost Lake. A 1935 Lava Cap Gold Mining Corp. map shows the section of Clipper Creek (CC) from the confluence of Little Clipper Creek (LCC) to Little Greenhorn Creek as “ N. Fk. Little Greenhorn.”

The dam located at Lost Lake was reported to be a “rock-core, earth filled dam meeting the then current requirements of the California Debris Commission. Water was then decanted in the tailings pond before being discharged into lower Clipper Creek” (Vector Engineering, Inc., 1991). This dam is approximately 50 feet high and approximately 1.25 miles downstream of the Lava Cap Mine. This dam was constructed as a mine tailings impoundment and created Lost Lake. Lost Lake is a private lake with a surface area of approximately 5 acres (Figure 1-1; Figure 1-4). Mine tailings were reportedly released into LCC, where they were transported to Lost Lake.

In 1943, Lava Cap Mine was closed because the federal government prohibited the production of non-strategic metals during World War II. An attempt was made to re-open the mine in the mid-1980s, but community opposition prevented the opening.

During a major winter storm in January 1997, the upper half of the log dam collapsed, releasing over 10,000 cubic yards of tailings into LCC. In May 1997, staff from the DTSC, the California Department of Fish and Game (CDFG), and the Nevada County Department of Environmental Health inspected the mine and downgradient areas. Extensive deposits of tailings were observed in LCC, in CC below the confluence with LCC, and in Lost Lake. The tailings were also observed in wetland areas contiguous with these water bodies, in some cases, reportedly covering the vegetation.

DTSC issued an information sheet in June 1997 warning of potential hazards from contact with Lost Lake sediments. The issuance of this information sheet was based on March and April 1997 sampling results that indicated the presence of arsenic in Lost Lake water at concentrations up to 28.4 micrograms per liter (µg/L) and in shoreline soils at concentrations up to 1,130 milligrams per kilogram (mg/kg).

In October 1997, the EPA Region IX Emergency Response Office determined that conditions associated with the tailings release from the Lava Cap Mine met the National Contingency Plan (NCP) Section 300.415(b)(2) criteria for a removal action. The primary concern was the potential for additional releases of tailings from the tailings pile. This concern was based on the high arsenic concentrations and the mobility of the extremely fine-grain tailings, which are easily suspended and transported in surface water (EPA, 1997a).

During October and November 1997, 4,000 cubic yards of tailings were removed from just upstream of the damaged log dam and stockpiled on the waste rock pile immediately to the north of the tailings pile. The stockpiled tailings were placed on a liner and covered with a liner, then covered with a clay cap and waste rock to help protect the liner and cap. The oversteepened slopes of the tailings pile immediately behind the dam were graded, and the entire tailings pile was covered with waste rock. Stream diversions were also constructed around the waste rock and tailings piles. In February 1998, EPA conducted additional work at the site to stabilize another smaller tailings release and further improve drainage. In the summer of 1998, the emergency response action was completed. All work related to the action took place on the Lava Cap Mine property, at or above the log dam.

In 1998, EPA evaluated the Lava Cap Mine Site to approximate potential risks to human health and the environment posed by the site and to determine if it warranted listing on the NPL as a Superfund site. Based on this evaluation, EPA formally listed the Lava Cap Mine Site on the NPL in February 1999, allowing Superfund funding to be spent on investigation and cleanup of the Site.

1.1.3 Previous Investigations

This section provides a summary of historic arsenic concentrations detected at the Lava Cap Mine Site, including downgradient areas, such as Lost Lake. These data are compiled from a review of prior reports and associated analytical data.

In February 1978, Lava Cap Mine (owned at the time by Keystone Copper Corporation) submitted a National Pollutant Discharge Elimination System (NPDES) permit application to the California Regional Water Quality Control Board (RWQCB). Keystone Copper Company was seeking to discharge 63 million gallons of mine water to LCC as part of a project to de-water the mine workings. In response to this permit application, the RWQCB conducted a site inspection in May 1978 and requested additional information. The RWQCB did not issue a NPDES permit. During this site inspection, a mine discharge water sample had an arsenic concentration of 660 µg/L (EPA, 1994a).

In response to property owners' complaints of high volumes of sediments in LCC, the RWQCB and the CDFG collected water samples in September 1979. Analytical results

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Figure 1-4 (backside)

showed arsenic as high as 1,860 µg/L in LCC below the tailings dam (EPA, 1994a). Because of these results, the RWQCB issued a Cleanup and Abatement Order (CAO) to Keystone Copper Company for the Lava Cap Mine Site in October 1979.

In May and June 1982, the RWQCB collected water samples at Lava Cap Mine (the exact sample locations are unknown). The arsenic concentration near the property boundary was 26 µg/L in May 1982. The June 1982 results showed arsenic as high as 540 µg/L in the mine tailings area (EPA, 1994a).

Franco-Nevada Mining Corporation attempted to re-open the mine in 1984. Franco-Nevada contracted with Hydrosearch, Inc., to collect upstream, mine area, and downstream surface water samples in April, May, and June 1984. Arsenic was not detected in the upstream samples; however, concentrations in the mine discharge ranged from 490 to 660 µg/L (Hydrosearch, 1984). These concentrations decreased with downstream distance.

In 1985 and 1990, the site owner collected surface water samples from unspecified locations for arsenic analysis. Arsenic was present in surface water samples at concentrations ranging from 22 to 630 µg/L.

In January 1989, the mine owner had the waste rock and mine tailings analyzed for arsenic and lead. Both were detected in the waste rock at concentrations of 2,200 mg/kg and 4,100 mg/kg, respectively. They also were detected in mine tailings at concentrations of 1,100 mg/kg and 50 mg/kg, respectively.

As part of a preliminary site inspection, EPA conducted a field-sampling event at the Lava Cap Mine in May 1994. Sediment samples from onsite wetland areas had arsenic and lead present at concentrations up to 7,070 mg/kg and 1,140 mg/kg, respectively. These wetlands were wiped out during the 1997 storm event and EPA's subsequent removal action. Sediment samples collected upgradient of the site had arsenic and lead concentrations up to 20 mg/kg and 16.9 mg/kg, respectively. Soil samples from Lava Cap Mine waste rock and tailings had arsenic and lead at concentrations up to 1,900 mg/kg and 206 mg/kg, respectively. Soil samples collected upgradient of the site had arsenic and lead concentrations up to 373 mg/kg and 60.9 mg/kg, respectively (EPA, 1994a).

After the log dam failure, DTSC sampled surface water, sediment, and surface soil periodically between 1997 and 1999. Arsenic concentrations in LCC surface water were fairly steady during this time period, but concentrations in Lost Lake fluctuated considerably between sampling events. Samples from a small pond at the confluence of LCC and CC had arsenic concentrations ranging from 706 to 2,070 µg/L. Arsenic concentrations in soil samples collected around Lost Lake decreased with increasing distance away from the water's edge.

Comparison of the Previous Investigation Results to the Current RI Results

Results of the current RI are described in detail in Section 4. However, a brief comparison of these results to data from previous investigations is presented here. Variations between the current and previous analytical results can be caused by several factors, including: natural variability within the matrix of the environmental media, seasonal variability in site conditions, differences in sampling and analytical techniques, and differing site conditions (e.g., the tailings being capped versus exposed). Even with these potential sources of variability, the analytical results from EPA's RI are consistent with the data generated previously.

Surface Water. The mine discharge from the adit was sampled on 10 dates covering 11 months during the EPA RI. Arsenic concentrations detected ranged from 199 to 668 µg/L. This range is consistent with mine discharge sample results presented previously for the historical investigations. The historic samples of mine discharge ranged from 34 to 660 µg/L.

One of the water samples collected from about 50 feet below the log dam in 1979 reportedly contained arsenic at 1,860 µg/L. This arsenic concentration is much higher than anything detected in LCC below the log dam during the RI. The peak concentration during the RI was 532 µg/L.

Historic arsenic concentrations measured in LCC between the mine and Lost Lake during periodic sampling events from 1984 through 1999 ranged from less than 5 µg/L to 130 µg/L. These concentrations are slightly lower than those detected during the RI, which ranged from 19 µg/L to 285 µg/L.

In Lost Lake, samples collected during the RI contained arsenic, ranging from 5.8 µg/L to 70.6 µg/L. This range is consistent with most of the samples that had been collected by DTSC. However, in July and August 1997 (the first summer after the log dam failure), DTSC measured arsenic concentrations in Lost Lake, ranging from 574 µg/L to 849 µg/L. Samples were not collected during the summer as part of the EPA RI.

Surface Soil and Sediment. All previous samples of the mine tailings and waste rock contained high concentrations of arsenic, ranging from 669 to 1,180 mg/kg and 1,670 to 3,190 mg/kg, respectively. The samples of waste rock/tailings collected during the RI contained arsenic in a similar range, with an average of 1,340 mg/kg and a maximum of 2,070 mg/kg.

The highest surface soil concentration detected historically, 15,400 mg/kg, was from the Cyanide Building. Samples collected from the Cyanide Building during the RI were also very high in arsenic, ranging from 1,620 to 31,200 mg/kg.

In 1997, DTSC collected a number of samples around the perimeter of Lost Lake, starting near the water's edge and, in some cases, stepping out more than 100 feet from the lake. The highest concentrations were found within 15 feet of the lake and ranged up to 1,130 mg/kg. The EPA RI samples from these same areas averaged over 400 mg/kg, with a peak of 818 mg/kg. Higher elevation samples from around Lost Lake had much lower concentrations in the historic and RI data, averaging 10.5 and 12.8 mg/kg, respectively.

DTSC collected sediment samples from LCC below the mine and Lost Lake. Arsenic concentrations in these samples ranged from 391 to 552 mg/kg. The EPA RI samples in these areas were similar but slightly higher averaging 655 mg/kg, with a peak of 1,150 mg/kg.

1.2 Report Organization

This RI report is organized as follows.

1.2.1 Text

- **Section 1.0 – Introduction:** Purpose, site background, and report organization
- **Section 2.0 – Physical and Ecological Characteristics:** Demography and land use, topography, surface water, soils, geology, hydrogeology, air, climate, and ecological setting at Lava Cap Mine
- **Section 3.0 – Remedial Investigation Approach:** RI objectives, sampling activities, media sampled, and ecological investigations
- **Section 4.0 – Nature and Extent of Contamination:** Nature and extent of contamination in the reference areas, at the mine, between the mine and Lost Lake, and downgradient of Lost Lake
- **Section 5.0 – Contaminant Fate and Transport:** Potential routes of exposure and contaminant migration
- **Section 6.0 – Baseline Risk Assessment:** Risk assessment approach, human health and ecological evaluation / assessment, and risk characterization
- **Section 7.0 – Summary and Conclusions:** Summary and conclusions of nature and extent, and fate and transport evaluations, and risk assessments
- **Section 8.0 – References:** List of documents referenced in this report

1.2.2 Appendices

Appendix A Analytical Data Summary

Appendix B Field Parameter Data Summary

Appendix C1 Soil Boring Logs

Appendix C2 Well Construction Diagrams

Appendix C3 Soil Descriptions

Appendix D Survey Data

Appendix E Human Health Risk Assessment

Appendix F Ecological Risk Assessment