SECTION 3

Remedial Investigation Approach

This section provides objectives of the Lava Cap Mine RI field effort and describes fieldwork conducted during the RI at the Lava Cap Mine Site. The description of the fieldwork is separated into specific areas, including reference areas, the source area at the mine, the mine area, along LCC below the mine, the Deposition Area above Lost Lake and around Lost Lake, and along CC below Lost Lake. The fieldwork descriptions also address ecological investigations.

3.1 Remedial Investigation Field Program Objectives

Objectives of the Lava Cap Mine RI field program include:

- Characterizing site conditions
- Collecting sufficient data to determine the nature and extent of contamination
- Collecting sufficient data to support informed risk management decisions regarding human health and the environment
- Collecting sufficient data to support preparation of the FS

This field effort was conducted, according to CERCLA guidance. A phased approach to the Lava Cap Mine RI was employed to minimize collection of unnecessary data and maximize data quality. Initial data collection efforts provided a basic understanding of site conditions. As this first objective was achieved, subsequent data collection efforts focused on filling identified data gaps in the conceptual site model and gathering the information necessary to support risk management decisions and future evaluations of remedial alternatives in the FS. The following sections describe specific sampling activities, media sampled, and ecological investigations that were conducted to achieve the field objectives.

3.1.1 Data Quality Objectives

The DQO process was used to guide RI planning for the Lava Cap Mine Site. This process provides a framework to collect data to support defensible decisionmaking in a cost-effective manner.

The DQO process is a systematic planning process for data collection developed through EPA total quality management activities. The process represents an effort by EPA to balance the need to minimize the cost and time of data collection with the need to collect data of sufficient quality and quantity to support defensible decisionmaking. To balance these competing needs, the DQO process establishes an organized, scientific methodology to guide planning by:

- Focusing on the end uses of the data
- Making decisions on the basis of risk
- Employing statistical methods to plan for and interpret data
- Emphasizing collaboration among the decisionmakers during the planning process

The results of the DQO process are the DQOs themselves - a series of statements leading to a RI design that results from the application of seven DQO steps specified by the EPA. The specific DQOs for specific locations at the Lava Cap Mine Site are presented in the field sampling plan (FSP) (EPA, 1999b).

3.2 Field Activities

The Lave Cap RI field program included three rounds of data collection. In addition, selected surface water locations were sampled approximately monthly. Table 3-1 provides a summary of the number of environmental samples collected during each round by area and media. Descriptions of the specific media sampled and types of sampling conducted at each location are provided in following sections.

The initial round of RI activities (Round 1) was completed during October and November of 1999. Round 1 included sampling surface soil, subsurface soil, sediment (sediment is surface soil located within or adjacent to surface water bodies), air, surface water, and groundwater. In addition, other information critical to the ecological risk assessment was gathered. This included site-specific characterizations of terrestrial and aquatic habitats and potential ecological receptors.

The second round of RI activities (Round 2) was conducted during January 2000. Round 2 included resampling all surface water locations and monitoring wells and surface soil sampling.

The third round of RI activities (Round 3) was completed during May and June of 2000. Round 3 included collecting numerous bioassay and biota samples and resampling most surface water and monitoring and residential well locations.

At the end of each round, EPA and the RI field team met to evaluate the data, identify outstanding data gaps, and outline a plan for the next sampling round. The DQO process, described in Section 3.1.1, was used to guide RI planning. Field activities were conducted, according to the FSP (EPA, 1999b), including the addenda prepared to describe Rounds 2 and 3 (EPA, 2000a and 2000b).

3.2.1 Media Sampled

Surface soil, subsurface soil, groundwater, surface water, sediment, air, and biota samples were collected during the Lava Cap Mine RI. General field procedures for collecting samples for each media are discussed subsequently. The number of samples collected in each area, by media, are described in Sections 3.3 through 3.9.

Surface Soil

Surface soil samples were collected as discrete grab samples using a disposable scoop. Samples were collected from soil surface between the depths of approximately zero to

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Table 3-1 (page 1 backside)

Table 3-1 – page 2

Table 3-1 – page 2 backside

6 inches below ground surface (bgs). Vegetation, sticks, stones, and other debris were removed from the sample.

Subsurface Soil

Soil borings were installed using either the hollow-stem auger drilling technique or a combination of auger drilling and air rotary drilling. Most subsurface soil samples were collected during auger drilling. These samples were taken from relatively undisturbed core or drive samplers drilled or driven in advance of the augers. Samples taken during air rotary drilling were collected as the drill cuttings were discharged at the surface.

At least three subsurface soil samples were collected from each soil boring. Typically, samples were collected from the upper 10 feet bgs, a second sample from the upper 25 feet bgs, and one sample near the water table. The actual sampling depths were based on field observations of subsurface conditions and materials encountered.

Groundwater

Three types of groundwater samples were collected: in situ samples from soil borings, samples from monitoring wells, and samples from residential wells. For all groundwater sampling, field parameters were measured to provide information on groundwater characteristics and, in the wells, to determine when groundwater samples could be collected. The following parameters were recorded in groundwater samples: pH or hydrogen (ion) concentration, temperature, electrical conductivity, oxidation-reduction potential (Eh or redox), dissolved oxygen, and turbidity.

In Situ Groundwater Sampling

In situ groundwater samples were collected directly from soil borings using tools specifically designed for this task. The soil borings were advanced until soil cores or cuttings indicated that the water table had been reached. The auger plug or drill rod and drill bit were then removed from the boring. A disposable sampler (a section of plastic screen material connected to a solid drive point) was lowered to the bottom of the borehole and pushed 3 to 4 feet into the soil by the drill rig. The outer shell of the sampler was then retracted to expose the inner screened sample chamber. A water-level indicator lowered into the hole determined the height of the water column in the chamber. When an adequate volume of groundwater had flowed into the sample chamber, the water-level indicator was removed, and a decontaminated small-diameter bailer was lowered into the chamber to collect the groundwater sample.

In situ samples are typically very turbid. Accordingly, samples for metals analyses were field-filtered to remove particulates. A disposable 0.45-micron filter was used in conjunction with either a vacuum pump or peristaltic pump to filter the sample. The filtered sample was transferred directly to a sample bottle. Samples for the other analyses were collected directly into appropriate sample bottles.

Monitoring Well Sampling

Groundwater samples were collected from the seven monitoring wells installed as part of the RI field activities. Groundwater samples were collected using the low-flow, minimal drawdown procedure (also known as the micropurge technique) described by EPA

(EPA, 1996). Low-flow, minimal drawdown sampling techniques minimize disturbance of solids that have accumulated in the well and reduce oxygen exchange with the atmosphere. These are particularly important factors when collecting samples for metals analyses. Using the low-flow technique, the well is pumped at a low-flow rate (a rate that does not significantly lower the water level in the casing) using a pump or tubing placed directly in the screened interval. At the Lava Cap Mine Site, the low-flow sampling technique employed a pumping rate of less than 0.5 gallons/minute with drawdown of less than 0.5 feet during purging.

At each monitoring well, either a portable submersible pump or peristaltic pump tubing was lowered slowly into the well to the middle of the screened interval. Care was taken to minimize both disturbance of solids in the well and excessive mixing of the stagnant water in the casing above the screen. Pumping continued until the field parameters of pH, redox potential, electrical conductivity, dissolved oxygen, and turbidity stabilized to within specified criteria. The criteria for stabilized readings are ± 0.1 pH units; ± 3 percent for conductivity; ± 10 millivolts for redox potential; and ± 10 percent for turbidity and dissolved oxygen.

An electric sounder was used to take water-level measurements. The volume of water purged from the well was recorded whenever field parameters were measured. The samples were collected by filling sample bottles directly from the pump discharge tubing. For monitoring wells that did not yield sufficient water to maintain a continuous, low pumping rate, the wells were sampled using a bailer.

For bailer sampling, field filtering of dissolved metals samples was performed as described for in situ groundwater samples. If sample collection was performed with a pump, a disposable in-line filter (0.45-micron) was connected to the discharge tubing, and the sample bottle was filled directly from the pump discharge.

Residential Well Sampling

Wellhead samples were collected from 22 residential wells in the Lava Cap Mine Site vicinity. This included wells at the mine, along the Little Clipper Creek drainage below the mine, and on properties surrounding Lost Lake. These samples were collected as close to the wellhead as possible. If no spigot was available at the wellhead or the pressure tank, an outdoor water faucet were used for sampling.

At each residential well, the water was allowed to run for at least 10 minutes and until field parameters had stabilized. The sample bottles were filled directly from the spigot. Well construction (if available), flow rate, purge volume, sampling location, field parameters, and other pertinent information were recorded during residential well sampling.

Surface Water

Surface water samples were collected from several streams and Lost Lake, Deposition Area ponds, and accumulated water inside the abandoned mine buildings. Surface water sampling in streams progressed from the farthest downstream point to the farthest upstream point so that sampling activities would not disturb downstream sample locations.

Samples were collected either by dipping the appropriate sample bottles straight into the stream (for unpreserved samples) or by collecting water with an empty, unpreserved sample bottle and transferring that sample into a preserved sample bottle.

The sample bottle was submerged as close as possible (accounting for field safety) to the center of flow in the channel. The bottle was submerged with minimal surface disturbance. The mouth of the container faced downstream, allowing it to be filled slowly and continuously. If an empty bottle was used to transfer the surface water, the water was poured gently into the sample bottle with minimum entry disturbance. Filtered samples for dissolved metals analyses were poured directly into the disposable filter container as described for in situ groundwater samples.

After all sample bottles were filled, field parameters were recorded. Typically, the surface water flow rate (in cfs) was estimated at each sampling location by multiplying the estimated flow velocity with the estimated cross-sectional area of the stream at the sample location. The flow velocity was estimated using a float placed in the stream and measuring the time required for the float to traverse a known distance.

The procedure for collecting surface water samples in Lost Lake and ponds or ponded water areas was similar, except that surface water samples collected from Lost Lake were collected approximately 3 to 6 inches beneath the water surface.

Crest gauges were installed at four locations to assist with estimation of surface water flow rates from the mine and in the LCC and CC drainages. Crest gauges monitor peak water depths in surface water channels. The data on peak water depth is used with information on the channel slope and cross-sectional area to estimate peak flow rates. The crest gauges were installed in November 1999 at the caved adit; in LCC at the base of the log dam; in LCC immediately upgradient of the confluence with CC; and in CC immediately upgradient of the confluence with LCC. The crest gauges were checked monthly to record maximum depths of flow at each surface water location.

Sediment

Sediment samples were collected from the upper 3 inches of soil underlying and in contact with various surface water features, such as LCC, CC, Lost Lake, and various ponds/ponded water areas. Sediment samples are important for assessing potential impacts on ecological receptors, such as benthic invertebrates.

When both surface water and sediment samples were collected from the same location, the surface water sample was collected first. Sediment samples were collected with a disposable scoop, placed into a stainless steel bowl, and mixed thoroughly. Rocks, sticks, and other debris were removed, and then the sediment sample was transferred into the appropriate sample container using the disposable scoop.

Sediment samples from Lost Lake were collected using a dredge (Ponar). A dredge is a clamshell-type scoop device designed to be lowered to the bottom of a surface water body to collect sediment samples.

Ambient Air

Ambient air sampling was conducted during the Lava Cap Mine RI field program to assess whether fugitive dust released from tailings-impacted surface soil at the mine, in the Deposition Area, and near Lost Lake was contaminated with metals and/or cyanide. The sampling was conducted using a low volume ambient air sampler. The air sampler pulled a known quantity of air (5 liters/minute) through a glass-fiber mat filter to collect the suspended particulate matter. The air sampler ran for approximately 24 hours at each sample location; the filter was removed at the end of the 24-hour sampling period.

3.2.2 Field Methods

Installation of Soil Borings

Soil borings in unconsolidated soils (e.g., through the waste rock/tailings pile or in the Deposition Area above Lost Lake) were drilled using continuous flight hollow-stem augers or a hand auger. Except in the Deposition Area, all the borings extended into consolidated bedrock formations. Soil borings into consolidated materials were drilled with the hollow-stem augers until auger refusal was met. At that point, drilling switched over to the air rotary drilling technique.

Prior to initiating subsurface drilling activities, utility clearance was performed. In addition to complying with the required Underground Service Alert notification and clearances, a non-intrusive (geophysical) utility clearance was completed by a subcontractor. A subcontractor was used because the public utilities notified by USA have limited information concerning private properties, such as those where the drilling activities for this effort were installed.

During hollow-stem auger drilling, either continuous cores or drive samples were collected from all soil borings for lithologic description and soil samples. In situ groundwater samples were also collected from selected soil borings. After the borings were advanced to the planned depth and all necessary samples collected, the borings were either completed as monitoring wells or backfilled with grout. For the most part, the target depth of the borings was approximately 10 feet below the water table. In addition, borings in the waste rock/tailings pile extended at least 10 feet into the native formation.

A log of soil lithology was completed by the on-site geologist for each soil boring. The log includes descriptions of all subsurface materials encountered during drilling as well as information on the drilling company and drilling method, the name of the geologist preparing the log, and the boring location. The soils were classified and logged, according to the American Society for Testing and Materials (ASTM) Method D-2488. All soil boring logs were signed and dated by the on-site geologist preparing the log. Copies of the soil boring logs are attached in Appendix C1.

Monitoring Well Installation

Monitoring well construction was completed, according to California Department of Water Resources, California Department of Health Services, and Nevada County Department of Health Services requirements. The monitoring wells were constructed of either 2-inch-diameter or 4-inch-diameter, threaded, Schedule 40 PVC (polyvinyl chloride) casing and within 10- to 12-inch-diameter boreholes.

The blank well casing consisted of 10- or 20-foot sections of Schedule 40 PVC casing. Each monitoring well has either 10 or 20 feet of well screen that generally extends above and below the water table. The screen is Schedule 40 PVC, with a slot size of either 0.010 or 0.020 inch, depending on lithologic conditions. Well completion diagrams are provided in Appendix C2.

Gravel pack was tremmied around the screen interval, extending up from the bottom of the borehole to approximately 5 feet above the well screen. The gravel pack consists of thoroughly washed, hard, durable, siliceous sand. The size and gradation of the gravel pack, as well as the screen slot size, were assessed by the site geologist/hydrogeologist based on field examination of soil samples and drill cuttings.

Approximately three feet of fine-grain sand was placed above the gravel pack to prevent grout from penetrating the gravel pack. Approximately 3 feet of bentonite transition seal was placed above the transition sand.

An annular grout seal consisting of cement grout with a small amount of bentonite powder (to reduce shrinking and cracking) was placed from the top of the transition sand to the ground surface.

Well development was performed following well completion. Wells were developed as soon as practical after completion but no sooner than 24 hours after the concrete grout had been installed. Development included bailing, swabbing, and, for most wells, pumping. Well development continued until at least 10 well volumes were removed from the well; field parameters (including turbidity) stabilized; and the water was deemed clear by the field personnel.

3.2.3 Analytical Methods

To meet the overall RI objectives and the DQOs presented in the FSP (EPA, 1999b), soil and sediment samples from the Lava Cap RI were analyzed for metals, mercury, and cyanide. Water samples were analyzed for metals, mercury, cyanide, and general chemistry (alkalinity, anions, hardness, and total dissolved solids [TDS]). The list of metals analyzed for in each sample included:

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Calcium
- Chromium (total)
- Cobalt
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Mercury

- Nickel
- Potassium
- Selenium
- Silver
- Sodium
- Thallium
- Vanadium
- Zinc

Several bunkers are present at the mine that were historically used to store explosives. Soil samples were collected at several of these bunkers and analyzed for explosives and total organic carbon (TOC). Specific discussions of the analytical methods used during the field effort are provided in the Lava Cap Mine Quality Assurance Project Plan (EPA, 1999a).

All the samples, except screening-level samples, were sent to Columbia Analytical Services (CAS) laboratory in Kelso, Washington, for analyses.

3.2.4 Quality Assurance/Quality Control (QA/QC)

An extensive QA/QC program was implemented during the RI field effort to ensure that samples collected were representative of field conditions and to assist with determining data reliability. The QC samples collected include field duplicates, field and equipment blank samples, performance evaluation (PE) samples, and laboratory QC samples (for matrix spike [MS] and matrix spike duplicate [MSD] analyses). QC samples were collected immediately after, and using the same procedures as the target or normal samples.

Field Duplicate Samples

A field duplicate is an independent sample that is collocated with or collected as close as possible to the original sample and from the same source. Field duplicates are used to assess the precision of the sample results by looking at the reproducibility of the data. Duplicates are labeled and packaged in the same manner as normal samples so that the laboratory would not be able to distinguish between normal samples and duplicates. Field duplicates for water samples were collected by alternately filling sample and sample duplicate containers at a location of known or suspected contamination. Each duplicate was taken using the same sampling and preservation method as the collocated normal sample. Field duplicates were collected at minimum frequency of 1 in every 10 normal environmental samples.

Blank Samples

One field blank sample was submitted each day that water sampling was conducted. At least one equipment blank sample per media was collected each week that soil or water sampling was performed. Blank samples were collected to verify that contamination was not introduced to samples during collecting, handling, or shipping. Blanks were prepared and labeled in the same manner as the field samples and sent "blind" to the laboratory. Equipment blank samples were collected when sampling equipment was decontaminated and reused in the field or when a sample collection vessel (e.g., a bailer or beaker) was used. Otherwise, a field blank (also called a field bottle blank) was collected. Metal-free (deionized or distilled) water was used for preparing blank samples.

Performance Evaluation Samples

PE samples are samples of known concentration that are used to assess the performance of a laboratory. As part of the RI field effort, PE samples of water and soil were analyzed for metals and cyanide. Environmental Resource Associates provided the PE samples and the certified concentrations. The samples were sent directly to the field crew at Lava Cap Mine so they could be submitted blind to the laboratory along with the other samples. The samples were sent to CAS laboratory in Kelso, Washington, on January 27, 2000.

Laboratory QC Samples

Laboratory QC samples were collected to perform MS and MSD analyses. An MS is an aliquot of a sample spiked with a known concentration of target analytes. An MS analysis provides a measure of the method accuracy for the laboratory at that time. The MSD is a laboratory split sample of the MS and is used to determine the precision of the method.

Twice the normal sample volume was collected for laboratory QC samples. Laboratory QC samples were labeled as such on sample bottles and paperwork and were collected at a frequency of 1 in every 20 samples (or one a week, whichever is greater) for each matrix.

3.3 Reference Areas Fieldwork

The contaminants of concern for the Lava Cap Mine site are all inorganic constituents that occur naturally in the environment. Accordingly, data need to be collected on area background conditions to be able to distinguish between areas impacted by releases from the mine and areas that contain naturally occurring levels, not inorganic constituents. Because there has been considerable human activity throughout the mine vicinity, it is not easy to identify specific areas that are truly representative of background conditions in the area, while also being representative of the specific soil and rock types found at the mine. Rather than attempting to identity true background areas, the RI has selected reference areas that can be used to help delineated mine-related impacts. Reference areas were selected that appeared to be upstream or upgradient of areas potentially impacted by the Lava Cap Mine. However, because mining activities occurred over a long period of time (1860 to 1943) and on both sides of the ridge (Banner Mine and the Lava Cap Mine), it is not possible to know for sure that reference areas have not experienced some impacts from the mine. It is possible that true background conditions in the general area could be lower than concentrations measured in reference areas used for the RI. Reference area sample results are used in risk assessments to estimate the background chemical exposure experienced by human and ecological receptors at the Site.

Samples were collected in three separate reference areas assumed not to have been influenced by Lava Cap Mine operations or releases. One area is upgradient from the mine (at locations in and adjacent to LCC and locations north and west of the mine). The second reference area is in and along CC, upgradient of the confluence with LCC. The third reference area is in Little Greenhorn Creek upgradient of the confluence with CC. Sample locations are shown on Figures 3-1 through 3-4 (and on Plates 1 through 4). During RI field activities, reference areas were visually assessed, and samples were collected for the following media: surface soil, subsurface soil, surface water, sediment, groundwater, air, and biota. The biota sampling is discussed in Section 3.9, Ecological Investigations.

3.3.1 Soils and Vadose Zone

Surface soil samples were collected from two of the three background areas:

- Reference Area 1: 12 locations (1B, 1C, 1D, 1E, 1F, 1K, 1L, 1M, 1N, 1O, 1P, and 1Q) upgradient of the mine. See Figures 3-1 and 3-2 for sample locations.
- Reference Area 2: 5 locations along CC (2D, 2E, 2F, 2I, and 2K) upgradient of the confluence with LCC. See Figure 3-3 for sample locations.

Each surface soil location was sampled once and analyzed for metals, mercury, and cyanide. Soils, from locations 1M, 1N, 2E, 2I, and 2K were also used for soil bioassay testing. Bioassay tests were performed to support the ecological investigation. The tests help evaluate the potential effects of soil, sediment, and water media on the survival and growth of representative species.

In the reference area borings, three subsurface soil samples were collected in the location closest to the mine (1A on Figure 3-2), and six samples were collected in the upgradient location near Lava Cap Mine Road (1B on Figure 3-1).

3.3.2 Surface Water and Sediment

Surface water and sediment samples were collected from all three reference areas.

- Reference Area 1: Three locations (1H, 1I, and 1J on Figure 3-2) on LCC upgradient of the mine. Surface water samples were collected during Rounds 2 and 3. Reference Area 1 was dry during Round 1.
- Reference Area 2: Five locations on CC (2A, 2B, 2C, 2G, and 2H on Figure 3-3) upgradient of the confluence with LCC. Surface water samples were collected in all three rounds.
- Reference Area 3: One location on Little Greenhorn Creek (20 on Figure 3-4) upgradient of the confluence with CC. The location was sampled in Round 3 only.

Surface water was sampled three times at most locations to detect seasonal variation in constituent concentrations. Surface water samples were analyzed for metals, mercury, cyanide, and general chemistry parameters. Sediment samples were analyzed for metals, mercury, and cyanide. Surface water and sediment from locations 1H, 1I, 1J, 2B, 2G, and 2H were also used for bioassay testing during Round 3.

3.3.3 Groundwater

To establish reference concentrations in groundwater, one monitoring well (1B) was installed upgradient from the mine and sampled during three rounds (November 1999 and January and May 2000). Monitoring well construction details are provided in Table 3-2. A groundwater grab sample from a soil boring (1A) was analyzed to provide data from a second reference location. The elevations of both groundwater samples are hydraulically upgradient from the mine site.

Examination of the boring logs for 1A and 1B indicates that sampled groundwater was derived from different formations. Monitoring Well 1B was completed north of the site in

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Figure 3-1 (backside)

Insert Figure 3-2 (11x17- color)

Figure 3-2 (backside)

Insert Figure 3-3 (8.5x11- color)

Figure 3-3 (backside)

Insert Figure 3-4 (8.5x11- color)

Figure 3-4 (backside)

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the Volcanic Breccia (the Tvb or lava) formation, which is not present from the mine southward. Soil Boring 1A was drilled in an upgradient location to the west of the mine, and penetrated the Metasedimentary Rock (Pms, see Section 2.5). All domestic water supply wells in the study area are completed in the Pms formation. The degree of hydraulic communication between the Tvb and Pms formations is not well established (Section 2.6). Thus, the data from the upgradient Monitoring Well 1B may not be representative of reference concentrations for residential wells in the Site vicinity.

The groundwater sample was collected from 103 to 109 feet bgs at location 1A. Groundwater samples from Monitoring Well 1B come from the screened interval, which extends from 130 to 150 feet bgs. Field parameters were recorded during sampling, and samples were collected for metals, mercury, cyanide, and general chemistry analyses.

3.3.4 Air

A 24-hour composite ambient air particulate sample was collected uphill from the mine during Round 1 to establish reference fugitive dust metal concentrations. The low-flow air sampler was placed on a tree (location 1G) near upgradient Monitoring Well (1B). The sample was analyzed for metals and mercury.

3.4 Source Area Fieldwork

The source areas at the Lava Cap Mine are those areas that contain wastes from historic mining activities. These include historic buildings at the mine (e.g., the Former Mill Building and Cyanide Building) that contain by-products from the mining operations. These buildings are currently open to the environment, with accumulated soil and ponded water inside the buildings. The waste rock and tailing pile areas of the site comprise the remaining source area.

Field activities were performed in the source area at Lava Cap Mine to characterize potential sources of contamination. The source area was characterized during the RI by:

- Summarizing site history and previous investigation data
- Evaluating the potential for and magnitude of continuing releases from the mine
- Estimating the volume and extent of sources (e.g., the waste rock/tailings pile and the continuous mine discharge)
- Evaluating source area concentrations and contaminants of potential ecological concern (COPECs)/contaminants of potential concern (COPCs)

During RI field activities, the source area was visually assessed, and samples were collected for the following media: surface soil, subsurface soil, surface water, sediment, groundwater, air, and biota. The biota sampling is discussed in Section 3.9, Ecological Investigations. All sample locations in the source area at the mine are shown on Figure 3-2 (and on Plate 2). In addition, a visual assessment of the condition of the log dam stability was performed.

3.4.1 Soils and Vadose Zone

Six surface soil samples were collected from inside the two largest historic mine buildings. These included three from the Mill Building (locations 6A, 6B, and 6C) and the Cyanide Building (locations 6D, 6E, and 6F). Each soil sample was analyzed for metals, mercury, and cyanide. Soil from location 6E was also used for soil bioassay testing.

Seven soil borings (5A, 5B, 5C, 5D, 5E, 5H, and 5I) were drilled through the waste rock/tailings piles to provide information on subsurface lithology and thickness of waste materials and to help characterize subsurface conditions. Surface soil, subsurface soil, and groundwater samples were collected from the soil borings. These soil borings were used to help estimate the volume and extent of waste rock and tailings at the mine. Laboratory analysis of waste rock/tailings samples also provided information on source material concentrations. Each soil sample was analyzed for metals, mercury, and cyanide. The intent was to collect a surface soil sample and subsurface soil samples at three depths in each boring (one in the tailings; one near the interface with native soil; and one in the underlying native soil). The subsurface soil sample depths in each boring are summarized in Table 3-3.

TABLE 3-3
Summary of Source Area Subsurface Soil Sample Depths
Lava Cap Mine, Nevada County California

Location	Number of Subsurface Samples	Sample Depths (feet bgs)		
5A	3	3 - 8	9 - 10	15 – 15.5
5B	3	18 - 19	22 - 23	24 – 25
5C	3	6 - 8	73 – 73.5	76 – 76.5
5D	3	10 - 11	27 - 28	33 – 34
5E	3	15 - 16	25.5 – 26.5	37.5 – 38.5
5H	3	20.5 – 21.5	22.5 - 23	26 – 26.5
5I	3	34 - 35	67 - 68	86 – 87

3.4.2 Surface Water and Sediment

Surface water and sediment samples were collected in the source areas at the mine, including the mine adit discharge, seeps in the waste rock/tailings area, at the base of the log dam, and inside the mine buildings. These sample results were used to characterize the magnitude and concentration of ongoing surface water discharge from the mine and through the waste piles and to help define the COPECs/COPCs for the Lava Cap Mine RI.

Surface water samples were collected approximately monthly for 12 months from the caved-in adit discharge (location 3A); the tailings pile seep, when present, (location 3B); and the base of the log dam (location 4A). Seasonal variability in discharge rates and contaminant concentrations was assessed using the monthly sampling results for these locations (see Section 4.3). Surface water was also collected once (during January 2000) at

location 3C, a secondary seep in the waste rock/tailings area. Field parameters and approximate flow rates were recorded during each sampling event at these surface water locations and samples were collected for metals, mercury, cyanide, and general chemistry analyses. The Round 3 sample from location 4A was also used for surface water bioassay testing.

Ponded surface water was collected in the Mine Building at location 6I during October 1999 and January 2000. Ponded surface water was collected in the Cyanide Building at locations 6K (October 1999 and May 2000) and 6L (January 2000). Samples were analyzed for metals, mercury, cyanide, and general chemistry parameters. The May 2000 sample from location 6K was also used for surface water bioassay testing.

Sediment samples were collected from the base of the log dam (location 4A2) in October 1999; the waste rock/tailings pile seep (location 3B) during November 1999; and in both January and May 2000 from the adit discharge area (location 3A). Samples were analyzed for metals, mercury, and cyanide. In addition, the May 2000 sediment sample from 3A was used for sediment bioassay testing.

3.4.3 Groundwater

Monitoring Wells 5A, 5D, 5E, and 5I were completed beneath the waste rock/tailings piles to assess impacts to groundwater in the bedrock aquifer directly under the waste piles. All wells were sampled during three rounds (November 1999, and January and May 2000), except 5I, which was installed and sampled during Round 3 (May 2000). In situ groundwater samples were collected from Soil Borings 5B and 5C. Field parameters were recorded during each sampling event, and samples were collected for metals, mercury, cyanide, and general chemistry analyses.

Well 5A was installed in the shallow bedrock in proximity to the mine adit discharge to compare water quality from the adit (location 3A) with underlying groundwater. The screen interval in well 5A is 10 to 30 feet bgs. Wells 5D, 5E, and 5I were completed and screened in the bedrock just beneath the waste rock/tailings area to examine potential impact to underlying groundwater. The screen interval in well 5D is 32 to 42 feet bgs and in well 5E, it is 31 to 41 feet bgs. Well 5I is located near wells 5D and 5E, but was completed deeper into the bedrock aquifer than the others are. The screen interval in well 5I is 65 to 85 feet bgs. Well construction details are provided in Table 3-2.

In situ groundwater samples were collected from Soil Borings 5B and 5C. These grab samples at 5B and 5C represent shallow groundwater just beneath the waste rock/tailings pile. The groundwater was collected from 26 to 27 feet bgs at location 5B and 32 to 47 feet bgs at location 5C. Field parameters were recorded during sampling, and samples were collected for metals, mercury, cyanide, and general chemistry analyses.

3.4.4 Air

Twenty-four hour, composite, ambient air particulate samples were collected from three locations in the source areas during the Lava Cap Mine RI. These included inside the Mill Building (6G), inside the Cyanide Building (6H), and on the waste rock pile (5G). Location 6G was sampled during both October 1999 and May 2000 and analyzed for metals and mercury. Location 6H was sampled during October 1999 and analyzed for cyanide. Location

5G was sampled during November 1999 and May 2000 and analyzed for metals and mercury.

3.4.5 Log Dam Evaluation

To assess the potential for future significant releases caused by further dam failures, a visual evaluation of the condition of the Lava Cap Mine log dam was conducted. The assessment was performed by a California registered civil and geotechnical engineer with experience in evaluating dam safety. Visual evaluation of the log dam occurred during two separate site visits (October 21, 1999, and July 10, 2000). The second visit was conducted to evaluate if there had been any changes in the condition of the log dam after another winter storm season. The engineer concluded that the log dam was not in good condition and that a significant storm event could potentially result in additional significant releases of tailings. In addition, the continuing erosion of the slopes on either side of the dam increases the chance of significant releases during major storm events. A more comprehensive evaluation of the log dam will be performed for the FS to assess potential options for repairing or replacing the log dam.

3.5 Mine Area Fieldwork

The mine area refers to all areas at the mine exclusive of the source areas (i.e., the historic mine buildings and the waste rock/tailings pile) described previously. Mine area sampling primarily focused on areas either adjacent to or in proximity to the source areas. Analytical testing conducted on samples collected outside the source areas provides an indication of lateral contaminant movement that may have occurred as a result of wind, water, and mechanical transport processes at the mine. These analytical results help define the extent of contamination at the mine. There are several abandoned bunkers near the waste rock piles that were likely used to store explosives during mining operations. Soil samples near the bunkers were used to assess if explosives or explosives breakdown products are present.

During RI field activities, the mine area was visually assessed and samples were collected for the following media: surface soil, surface water, sediment, groundwater, air, and biota. Sample locations for the mine area fieldwork are shown on Figure 3-2 (and on Plate 2). The biota sampling is discussed in Section 3.9, Ecological Investigations.

3.5.1 Surface Soil

Samples were collected from 34 surface soil locations in the mine area, but away from the identified source areas described previously.

- Six locations (7A, 7B, 7C, 7D, 7E, and 7F) around the mine buildings in surface runoff accumulation areas.
- Six randomly selected locations (8A, 8B, 8C, 8D, 8E, and 8F) around the mine buildings.
- Sixteen locations (9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I, 9J, 9K, 9L, 9M, 9N, 9O, and 9P) outside the waste rock/tailings areas. Four of these (9F through 9I) were located immediately adjacent to the waste rock/tailings areas and five (9A through 9E) were at the explosive storage bunkers.

- Six locations (10A, 10B, 10C1, 10D, 10E, and 10F) around the two residences located at the mine closest to the waste rock/tailings areas (three samples around each residence).

Each soil sample was analyzed for metals, mercury, and cyanide. In addition, samples from locations 9A through 9E were analyzed for TOC and explosives.

3.5.2 Surface Water and Sediment

One sediment and two surface water samples were collected in the mine area during the RI. Locations 4B (sediment) and 4D (surface water) are in the seasonally ponded portion of the LCC channel, where LCC first enters the northeast corner of the waste rock/tailings area. Location 4C is a surface water sample in the pond near the new residence northwest of the historic mining operations. During the surface water sampling, field parameters were recorded, and samples were collected for metals, mercury, cyanide, and general chemistry analyses. The sediment sample was analyzed for metals, mercury, and cyanide.

3.5.3 Groundwater

Groundwater samples were collected from four residential wells in the mine area (10G, 10H, 10I, and 10J). Well 10H (near the residence furthest south on the mine property) was sampled once. The other three wells were sampled twice each. Well 10G is near the residence on the west side of the mine property; this well provides drinking water to two residences at the mine. Well 10I is new, drilled in 1999 for the new residence northwest of the historic mining operations. Because of the high arsenic concentrations present in this well (over 500 µg/L), a replacement well (10J) was installed in late 1999 to provide drinking water for the northern residence. The 10I well was relatively shallow (less than 200 feet deep) and appears to have intersected the historic mine workings. Field parameters were recorded during sampling of all wells; samples were collected for metals, mercury, and cyanide analyses.

3.5.4 Air

Two 24-hour, composite, ambient air particulate samples were collected during the Lava Cap Mine RI in the mine area. The air sample was collected in the yard area of the southernmost residence (location 10C2) on the mine property. Samples were collected during Round 1 and Round 3. The air particulate samples were analyzed for metals and mercury.

3.6 Little Clipper Creek below Mine

The Little Clipper Creek drainage below the mine serves as the link between the contaminant source area and the primary downstream deposition and accumulation areas, including Lost Lake. Because of the steep gradient along most of LCC in this stretch, significant tailings deposition occurred only in isolated flatter areas. The portion of LCC between the log dam and the confluence with CC is approximately 1 mile long. During RI field activities, this area was visually assessed, and samples were collected for the following media: surface soil, surface water, sediment, groundwater, and biota. Sample locations in this area are shown on Figure 3-5 (and on Plates 3 and 4). The biota sampling is discussed in Section 3.9, Ecological Investigations.

Insert Figure 3-5 (8.5x11- color)

Figure 3-5 (backside)

3.6.1 Surface Soil

Surface soil samples were collected from seven locations (12A, 12B, 12C, 12D, 12E, 12K, and 12L) near LCC between the mine and the deposition area above Lost Lake. Two of these locations (12K and 12L) are in a smaller deposition area along LCC just south of the mine property. Surface soil samples were analyzed for metals, mercury, and cyanide. In addition, the May 2000 surface soil sample from 12K was used for soil bioassay testing.

3.6.2 Surface Water and Sediment

Surface water and sediment samples were collected from five locations (12F, 12G, 12H, 12I, and 12J) in LCC between the mine and the deposition area above Lost Lake. Surface water was sampled during all three rounds. Sediment was only sampled during Round 1. Surface water samples were analyzed for metals, mercury, cyanide, and general chemistry parameters. Sediment samples were analyzed for metals, mercury, and cyanide.

3.6.3 Groundwater

Seven residential wells located in the LCC and CC drainage areas between the mine and Lost Lake (11AF, 11AJ, 11AK, 11AL, 11AM, 11AN, and 11AR) were sampled to assess impacts, if any, to the bedrock aquifers serving as drinking water sources for area residents. All the wells were sampled at least twice, except Well 11AR (shown on Figure 3-3), which was sampled once. Field parameters were recorded during sampling and samples were collected for metals, mercury, and cyanide analyses. Though there is limited information on the construction of these wells (Table 3-2), it is assumed that all private wells are screened in the metasedimentary bedrock aquifer. There is too little alluvial material overlying the bedrock to provide a sufficient domestic water supply.

3.7 Deposition Area and Lost Lake

The Deposition Area encompasses the large, relatively flat floodplain area present between the confluence of LCC and CC and Lost Lake (Figure 3-6 and Plate 4). This area is termed the Deposition Area because of the large amount of tailings that have been deposited in this area. Lost Lake encompasses the two lobes (north and south) of Lost Lake and the adjacent lake shoreline.

The Deposition Area is currently vegetated with both woody and herbaceous plants, with plants growing directly in the tailings. This area provides considerable wildlife habitat (e.g., deer tracks, frogs, and birds observed in the area). Evidence of human activity (e.g., a small fire ring and trails) is also present.

Lost Lake, which was originally created as a tailings impoundment, is currently less than 10 feet deep. Multiple residences are located around the lake. In addition, Lost Lake provides habitat for fish, wildlife, plants, and invertebrates. There is also considerable evidence of human activity, including trails, small boats, and rafts.

During RI field activities, the deposition and Lost Lake area, including the Lost Lake Dam, was visually assessed, and samples were collected for the following media: surface soil, subsurface soil, surface water, sediment, groundwater, air, and biota. Sample locations are

shown on Figure 3-6 (and on Plate 4). The biota sampling is discussed in Section 3.9, Ecological Investigations.

3.7.1 Soils and Vadose Zone

Soil samples were collected from the following areas.

- During the beginning of Round 1, surface soil samples were collected at 40 locations (11-1 through 11-40) around the shoreline of Lost Lake. These samples were analyzed for arsenic only, using an accelerated laboratory turn around time. These 40 samples were intended to provide an initial screening of conditions around Lost Lake and to guide collection of additional samples for complete laboratory analyses. Generally, the 40 samples were collected in pairs; the first sample was collected just below the high water mark, and the second sample was collected approximately 5 to 10 feet further uphill.
- Surface soil samples were collected at 24 locations (11-A through 11-X) around the shoreline of Lost Lake during Round 1. Sample locations were selected, based on the surface soil screening sample results described previously. Generally, these samples were collected at a higher elevation than the screening samples or along the lakeshore to fill in gaps between pairs of screening surface soil sample locations. The samples were analyzed for metals, mercury, and cyanide.
- Surface soil samples were collected from 4 additional locations (11BA, 11BB, 11BC, and 11BD) around Lost Lake during Round 2 to fill in remaining data gaps after Round 1. These samples were analyzed for metals, mercury, and cyanide.
- Similar to the initial 40 samples around Lost Lake, 20 surface soil samples (13-1 through 13-20) were collected in the Deposition Area above Lost Lake early in Round 1 to provide an initial screening of conditions. These samples were analyzed for arsenic only, with an expedited laboratory turn around time.
- Surface soil samples were collected at 6 locations (13I through 13N) approximately 15 feet uphill from the perimeter of the Deposition Area.
- Surface and subsurface soil samples were collected at 6 hand-auger boring locations in the Deposition Area (13A, 13B, 13C, 13D, 13E, and 13F).
- Subsurface soil samples were collected from 2 deeper borings in the Deposition Area (13Q and 13R). These locations were completed as monitoring wells.

In addition, the May 2000 surface soil samples from locations 13N (above the Deposition Area) and 13O and 13P (in the Deposition Area) were used for soil bioassay testing.

3.7.2 Surface Water and Sediment

Surface water and sediment samples were collected from 4 areas.

- Three collocated surface water and sediment locations (14A, 14B, and 14C) from CC downstream of the confluence with LCC (this is the combined flow of LCC and CC above Lost Lake).

Insert Figure 3-6 (11x17 color)

Figure 3-6 (backside)

- Six locations in seasonal surface water pools in the tailing Deposition Area (15A, 15B, 15C, 15D, 15E, and 15F). Sediment samples were collected from five of the locations (all except 15F). Surface water samples were collected from locations 15A, 15C, 15D, and 15F.
- Three collocated surface water and sediment locations (16A / 18A, 16B / 18B, and 16C / 18C) in Lost Lake. Locations 16A / 18A and 16B / 18B are in the northern lobe, while location 16C / 18C is the southern lobe of Lost Lake.
- Four sediment locations (17A, 17B, 17C, and 17D) along the edge of Lost Lake. Locations 17A, 17B, and 17C are in the northern lobe; location 17D is in the southern lobe of Lost Lake.

Surface water locations were sampled three times to detect seasonal variability in concentrations. Surface water samples were analyzed for metals, mercury, cyanide, and general chemistry parameters. Sediment samples were analyzed for metals, mercury, and cyanide. Surface water from locations 14A, 15A, 16A, 16B, and 16C and sediment from locations 14C, 17A, 17B, 17D, 18A, 18B, and 18C were used for bioassay testing.

3.7.3 Groundwater

Eleven residential wells in the Lost Lake vicinity (11AA, 11AB, 11AC, 11AD, 11AE, 11AG, 11AH, 11AI, 11AO, 11AP, and 11AQ [well 11AQ is shown on Plate 4 only]) were sampled to assess impacts, if any, to the bedrock aquifers serving as drinking water sources for area residents. All wells were sampled twice (during Rounds 1 and 3). Field parameters were recorded during sampling, and samples were collected for metals, mercury, and cyanide analyses. Though there is limited information on the construction of these wells, it is assumed that all the residential wells are screened in the bedrock aquifer, because there is too little overlying alluvial material to provide a sufficient domestic water supply.

Monitoring Wells 13Q and 13R were installed in the Deposition Area to measure shallow groundwater concentrations. These wells are screened in shallow unconsolidated material dominated by tailings. The bottom of the screen interval is in contact with the underlying bedrock. Drilling, completing, and sampling took place in May 2000. The screen interval in well 13Q is 18 to 28 feet bgs. The screen interval in well 13R is 12.5 to 22.5 feet bgs. Well construction information is provided in Table 3-2. Field parameters were recorded, and samples were collected for metals, mercury, cyanide, and general chemistry analyses.

Shallow, in situ groundwater samples were collected from hand-auger boring locations 13A and 13B in the Deposition Area. These samples are representative of shallow groundwater in the tailings. Total depth of the 13A and 13B borings were 7 and 10 feet bgs, respectively. Field parameters were recorded, and samples were collected for metals, mercury, cyanide, and general chemistry analyses.

3.7.4 Air

Twenty-four hour, composite, ambient air particulate samples were collected at two locations in the Deposition Area and one location at Lost Lake. The air samples were collected at the north end of the Deposition Area (13G), at the south end of the Deposition Area (13H), and on Lost Lake Dam (19D). Locations 13G and 13H were sampled during

both November 1999 and May 2000 for metals and mercury analyses. Location 19D was sampled during October 1999 for metals and mercury analyses.

3.7.5 Lost Lake Dam Evaluation

A California registered civil and geotechnical engineer with experience in evaluating dams reviewed the condition of the Lost Lake Dam during two separate site visits (October 21, 1999, and July 10, 2000). The Lost Lake dam evaluation consisted of physical observations of the exterior condition and construction of the dam. Based on the size and capacity of Lost Lake Dam, it could potentially be a jurisdictional dam that would be regulated by the California Division of Dam Safety. The engineer noted several maintenance activities that would be required to bring the Lost Lake Dam into compliance with California Division of Dam Safety requirements. These include removing of trees and bushes from the top of the dam, repairs to the spillway, and reducing of the slope of the dam face, which is currently too steep.

3.8 Downgradient of Lost Lake

The area investigated below Lost Lake includes the CC drainage down to the confluence with Little Greenhorn Creek and extends a short distance down Little Greenhorn Creek. Samples were collected from along the CC drainage downgradient of Lost Lake to evaluate the magnitude of contaminant migration beyond Lost Lake. These data were also used to evaluate the potential contaminant loading from Lava Cap Mine through CC into Little Greenhorn Creek.

During RI field activities, the area downgradient of Lost Lake was visually assessed, and samples were collected for the following media: surface soil, surface water, sediment, and biota. Sample locations in this area are shown on Figure 3-4 (and on Plate 4). The biota sampling is discussed in Section 3.9, Ecological Investigations.

3.8.1 Surface Soil

Surface soil samples were collected from two locations (19H and 19I), both near the CC channel (Figure 3-4) in a relatively flat area near the confluence with Little Greenhorn Creek. Soil from location 19I was also collected for soil bioassay testing. The two soil samples were analyzed for metals, mercury, and cyanide.

3.8.2 Surface Water and Sediment

Surface water and sediment samples were collected from four locations below Lost Lake. Surface water samples were collected during all three rounds to provide information on the seasonal variability in concentrations.

During Round 1, surface water and sediment samples were collected from locations 19A, 19B, and 19C. Location 19B is in the seep area at the base of Lost Lake Dam, and locations 19A and 19C are in the CC channel (Figure 3-4).

During Round 2, surface water samples were collected from locations 19A, 19B, and 19C. A sediment sample was collected from location 19E in Little Greenhorn Creek, downgradient of the confluence with CC.

In Round 3, surface water samples were collected from locations 19A, 19B, 19C, and 19E. In addition, a new sediment location (19G), immediately downgradient of the location 19B seep area, was sampled for sediment bioassay testing. The Round 3 sample from location 19A was also used for surface water bioassay testing.

Sediment samples were analyzed for metals, mercury, and cyanide analyses. Surface water samples were analyzed for metals, mercury, cyanide, and general chemistry parameters.

3.9 Ecological Investigations

Several different approaches were adopted for conducting ecological investigations to support RI and ecological risk assessment (ERA) studies. The areas assessed include the reference areas, the mine property, including both the mine area and source area, and areas downgradient of the mine. The areas downgradient of the mine include LCC and the adjacent corridor, the Deposition Area above Lost Lake, Lost Lake and surrounding areas, and CC, including the adjacent corridor from the confluence with LCC down to Little Greenhorn Creek below Lost Lake.

3.9.1 Habitat Assessment

The dominant vegetation type was recorded in all areas included in the Lava Cap Mine RI field program. These observations were used to characterize habitat types using the system presented in Mayer and Laudenslayer (1988). The habitat types found throughout the entire study areas were then used to query the Wildlife Habitat Relationship System database (CDFG, 1999a). The database provides a list of potentially occurring wildlife species that could be associated with observed habitats. Because specific evaluations of terrestrial habitat quality were not completed as part of this study, the database query was structured to be the most inclusive possible. The query assumed that represented habitats are of the highest quality (i.e., all habitat elements are present, and there are no seasonal restrictions). The California Natural Diversity database (CDFG, 2000) information for the Site vicinity was also reviewed to determine whether occurrences of special-status plant and animal species had been documented in proximity to the Lava Cap Mine Site.

The general habitat conditions developed in this manner were supplemented with wildlife observations noted during biological surveys (described subsequently) conducted as part of the RI field program.

3.9.2 Biological Surveys

Direct observations of wildlife (including birds and mammals) and indirect signs of wildlife (such as tracks or scat) were recorded throughout the RI field program. CH2M HILL conducted a biological survey in May 2000.

Specific evaluations of aquatic habitat quality in flowing creeks were made in select areas, using the modified Rapid Bioassessment Protocol (RBP) methodology described in *California Stream Bioassessment Procedure* (CDFG, 1999b). RBP analyses were performed at two potentially impacted locations downgradient of the mine and two reference locations. RBP analyses were performed using the point source sampling design protocols outlined in CDFG (1999b). Descriptions of physical creek environments were made, including rill

length, rill width, and substrate characteristics. Samples of the benthic substrate were also collected as part of the RPB. These samples were sent to a qualified laboratory for complete characterization of the benthic community structure.

Biota sampling was conducted as part of the RI process to assess the potential for bioaccumulation of site-related contaminants. The sample collection also yielded supplemental information for description of ecological elements in the study area. Sampled terrestrial biota included plants, invertebrates, and small mammals. Plant samples were collected to assess the potential for uptake of site-related contaminants. Sampled aquatic biota included benthic invertebrates and fish (where available). Benthic invertebrates were collected with kick nets in the flowing stream, while fish were collected by a combination of electrofishing techniques and seine nets. Invertebrate samples were collected to assess the potential for uptake by birds and mammals through diet. The following sections provide more detail on the types of biota samples collected and the ecological sample locations.

3.9.3 Types of Ecological Samples

Terrestrial Plants

Given the scope of the planned sampling, terrestrial plant samples were limited to a single genus, *Salix* spp., commonly known as the willow family. The sampling was focused primarily on red willow (*S. laevigata*), although Gooding's willow (*S. gooddingii* var. *variabilis*) and yellow tree willow (*S. lasiandra*) were also sampled in locations where red willow was not present.

The willow was chosen as the target plant, because it is represented throughout the area investigated, from the mine down through the area downgradient of Lost Lake. It is also closely associated with the margins of LCC and Lost Lake that were likely impacted during contaminant releases from the mine. Willow is present in reference areas so that reference conditions can be compared to impacted areas. The willow serves as a common food source for vertebrate and invertebrate receptors.

Plant samples were collected by hand from the new year's growth of several plants in the area of concern and then field composited into a resealable bag. Leaf and new shoot samples were collected by hand (wearing latex gloves) from individual plants. Where possible, the plants were chosen around existing surface soil sample locations, so estimates of bioaccumulation could be developed.

Mammals

Deer mice (*Peromyscus maniculatus*) and California voles (*Microtus californicus*) were chosen for sampling, because they are common inhabitants in the Site vicinity and are common prey for carnivores likely to forage in the Site vicinity. Deer mice are omnivores and eat a variety of plant material and invertebrates, while California voles are herbivores and eat primarily green, growing vegetation.

Small mammals were live-trapped using Sherman live traps baited with peanut butter and wild birdseed and placed in areas with signs of small mammal activity. Trap lines consisted of either 10 or 20 traps placed along rodent runways or outside rodent burrows in the areas selected for small mammal sampling. Traps were set at dusk and checked each morning,

baited again, and reset, as necessary. Traps were used until three individuals of a species were captured, or for 3 nights. Only those species identified as target species (e.g., deer mice and California voles) were saved for chemical analysis. Target animals were killed by non-chemical methods. Stomach contents were removed from each animal, and animals were placed into clean plastic whirl-packs and frozen. All target animals were stored and shipped frozen. Each mammal sample consisted of a composite of three to five animals.

Terrestrial Invertebrates

Insects and other terrestrial invertebrates (such as earthworms, snails, spiders, or sow bugs) were collected from upland and wetland sites. The invertebrates were analyzed for whole-body tissue chemistry. Whenever possible, the invertebrates were collected from areas located in immediate proximity to locations from which soil, sediment, or surface water samples were also collected to allow for evaluation of bioaccumulation.

Significant difficulty was encountered in obtaining sufficient biomass of invertebrates for chemical analysis. To provide sufficient sample volume, broad taxonomic groups were included in individual samples for chemical analyses. Most of the other biota sampling included a single species. Attempts were made to obtain sufficient terrestrial invertebrate mass for composite samples of a particular taxonomic group (e.g., beetles). When sufficient biomass of an appropriate taxonomic group was not available, composite samples were collected and made up of mixed terrestrial invertebrates in the sample area. Composite samples were collected from three locations in each general upland and wetland cover type. Similar composite samples were also collected from designated reference locations (i.e., similar cover type in similar aspect, slope, and elevation, but in a reference location).

Soil and sediment-dwelling invertebrates were sorted using stainless steel forceps or trowels and placed in clean stainless steel pans. Collection was performed either by hand or by using an insect sweep-net in areas with vegetation where insectivores were likely to forage (especially birds and mammals). Collection techniques also included use of pitfall traps to ensure sufficient sample mass.

At each sampling location, five pitfall traps were setup for collection of ground invertebrates. The pitfall traps consisted of plastic one-quart containers buried so the lip of the container was level with the ground. A layer of dirt and plant material was placed in the bottom of the container and a lid was suspended about 5 centimeters over the opening to protect samples from inclimate weather and predators. Each location was also searched by hand, turning over leaves, rocks and logs, to collect invertebrate samples. Invertebrate samples from each location were pooled and placed in plastic bags.

Aquatic Invertebrates

Collection of aquatic invertebrates was performed using either kick nets or aquarium nets. Aquarium nets were used in Lost Lake among the emergent plants in the shallow, wadeable parts of the shoreline. Only the larger north lobe of Lost Lake was sampled. Once collected, debris was removed, and samples were placed in whirl-packs.

RBP samples were collected with kick nets at each location from three individual riffles. Each sample consisted of a composite of three sub-samples collected in a transect perpendicular to the riffle. Samples were preserved in 95-percent ethanol.

Field measurements for pH, dissolved oxygen, conductivity, temperature, turbidity, and redox were recorded at each riffle. Physical measurements and habitat characteristics were recorded, according to procedures included in the California bioassessment protocols.

Fish

Fish were collected using kick nets and electroshocking. Samples in Lost Lake were collected by electroshocking weed beds and brush piles and with the use of a 50-foot long, ¼ inch mesh beach seine in shallow weedy areas. In the south lobe of Lost Lake, a kick net was used for collecting mosquito fish through shallow weedy areas along the shore.

Bioassays

Bioassays serve as a direct measure of the toxicity of media from the field. Tests performed at reference locations provide an indication of background toxicity and bioavailability of chemicals. Results from these tests can be compared to those from the mine and downgradient locations to determine the relative increase, if any, in toxicity and bioavailability in mine area and downgradient media as compared to reference media. To allow bioassay results to be directly related to chemical concentrations in abiotic media, media for bioassays (soil, sediment, and surface water) were collected concurrently with media for chemical analyses during Round 3. In some locations, abiotic media from multiple sampling locations was composited for use in the bioassays. The abiotic media selected were those media (soils, surface water and sediment) to which ecological receptors (e.g., plants and invertebrates) could reasonably be exposed and for which there was available toxicity tests and reference data for evaluating the significance of the concentrations. *Ceriodaphnia* and fathead minnow, *Hyalella* spp., and earthworm and nutsedge bioassays were performed for surface water, sediment, and surface soil, respectively.

3.9.4 Ecological Sample Locations

The ecological investigations are summarized by areas. The number of samples in each area is provided in Table 3-1. Table 3-4 provides a correlation between biota samples and abiotic samples.

Reference Areas

Similar to the abiotic media, biota samples (terrestrial plants, terrestrial invertebrates, small mammals [mice], aquatic invertebrates, and fish [where found]) were collected in three separate reference areas that were assumed to have not been influenced by Lava Cap Mine operations or releases. Reference Area 1 is upgradient from the mine (at locations in and adjacent to LCC and northwest of the mine). Reference Area 2 is in and adjacent to CC upgradient of the confluence with LCC. Reference Area 3 is in Little Greenhorn Creek upgradient of the confluence with CC. General vegetation conditions were recorded in all three areas.

Biota samples were collected from the three reference areas as follows.

Reference Area 1 (Upgradient of the Mine)

- 3 terrestrial plant (willow) samples from along LCC
- 1 mixed terrestrial invertebrate sample from along LCC

Insert Table 3-4, page 1 (formerly Table 3-2)

Insert Table 3-4, page 2

Insert Table 3-4, page 3

- 5 small mammal (mice) samples
- 1 mixed aquatic invertebrate sample from LCC

Reference Area 2 (CC upstream of LCC)

- 1 terrestrial plant (willow) sample from along CC
- 2 terrestrial invertebrate samples (one mixed, one earthworms) from along CC
- 3 mixed aquatic invertebrate samples from CC

Reference Area 3 (Little Greenhorn Creek upstream of CC)

- 2 mixed aquatic invertebrate samples from Little Greenhorn Creek
- 2 fish (rainbow trout) samples from Little Greenhorn Creek

Source Area

In the source area at the mine, small mammal samples (mice) were collected in the waste rock / tailings area (3 composite samples) and historic mine buildings (4 composite samples). In addition, small frogs and pollywogs were collected from the shallow pool of mine discharge from the adit.

Mine Area

One mixed terrestrial invertebrate sample and three terrestrial plant (willow) samples were collected in the mine area. The terrestrial plant samples were collected near the mine shaft, near the Cyanide Building, and between the Cyanide and Mill Buildings. In addition, general vegetation conditions were recorded.

Little Clipper Creek below the Mine

The 1-mile segment of LCC between the log dam at the mine and the confluence with CC in the Deposition Area was walked during each round of the RI field program to record general vegetation and ecological conditions. The following biota samples were collected from LCC below the mine:

- 3 terrestrial plant (willow) samples from along LCC
- 1 mixed terrestrial invertebrates sample from along LCC
- 2 small mammal (mice) samples
- 3 mixed aquatic invertebrate samples from LCC
- Fish (rainbow trout) samples from LCC

Deposition Area and Lost Lake

In the Deposition Area (CC through the Deposition Area and Lost Lake), the following biota types were sampled: terrestrial plants, terrestrial invertebrates, small mammals, aquatic invertebrates, and fish. Significant effort was spent trying to collect frogs from the permanent pond in the Deposition Area and fish from CC in the Deposition Area, but the attempts were not successful. General vegetation conditions were recorded in all areas.

Biota samples were collected from the Deposition Area and Lost Lake as follows:

Deposition Area

- 3 terrestrial plant (willow) samples from along CC
- 1 mixed terrestrial invertebrate sample from along CC
- 4 small mammal (mice) samples
- 1 aquatic invertebrate (snails) sample from the permanent pond near the confluence of LCC and CC

Clipper Creek through Deposition Area

- 3 mixed aquatic invertebrate samples from CC

Lost Lake

- 3 terrestrial plant (willow) samples from around Lost Lake
- 1 mixed terrestrial invertebrate sample from around Lost Lake
- 3 aquatic invertebrate (snails, dragonfly / damselfly larvae, crayfish) samples from Lost Lake
- 5 whole body fish (3 blue gill and 1 bass composite from the northern lobe and 1 gambusia composite from the southern lobe) samples from Lost Lake
- 4 fish (1 blue gill and 3 bass from the northern lobe) filet samples from Lost Lake

Downgradient of Lost Lake

Portions of the segment of CC between Lost Lake dam and the confluence of CC and Little Greenhorn Creek were walked during each sampling round to record general vegetation and ecological conditions. Biota samples were collected from CC downgradient of Lost Lake as follows:

- 3 terrestrial plant (willow) samples from along CC
- 2 terrestrial invertebrate samples (1 mixed, 1 earthworms) from along CC
- 3 mixed aquatic invertebrate samples from CC
- 3 fish (2 samples of rainbow trout, 1 sample of bluegill) samples from LCC