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Public Health Assessment for

LAVA CAP MINE
NEVADA CITY, NEVADA COUNTY, CALIFORNIA
EPA FACILITY ID: CAD983618893
MAY 3, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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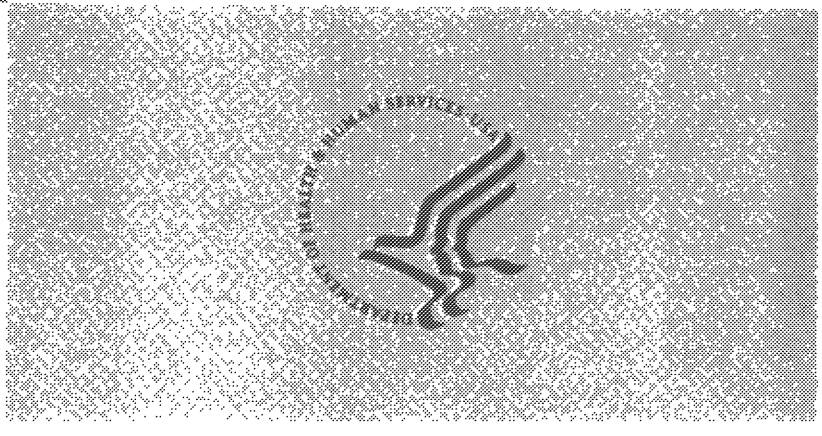

PUBLIC HEALTH ASSESSMENT

Evaluation of Off-Site Contamination from the Lava Cap Mine Site

LAVA CAP MINE

NEVADA CITY, NEVADA COUNTY, CALIFORNIA

EPA FACILITY ID: CAD983618893

Prepared by:

California Department of Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, fullscale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E56), Atlanta, GA 30333.

TABLE OF CONTENTS PAGE

SUMMARY

The Environmental Health Investigations Branch (EHIB) of the California Department of Health Services (CDHS), under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), has completed a public health assessment for the Lava Cap Mine Site. The purpose of the public health assessment is to evaluate potential off-site exposure to arsenic contamination from the site and to determine if it poses a threat to public health. Federal legislation requires public health assessments to be completed one year from the time a site is proposed for "Superfund" listing. Due to this requirement, the public health assessment was able to examine only data collected between the winter of 1997 and the fall of 1998. If additional data collected since that time indicate a need to re-evaluate risk, CDHS-EHIB will do so in a separate health consultation. At the time of this writing private well data were not available; once these data are available, CDHS will evaluate the health risk in a health consultation.

In 1997, a severe winter storm caused a dam failure which released mine tailings into Little Clipper Creek, Lost Lake and the Little Clipper watershed. Tailings from the Lava Cap Mine have caused significant arsenic contamination of the Little Clipper and Clipper Creek watersheds.

CDHS evaluated whether exposure to contaminants, primarily arsenic, which has migrated from the Lava Cap Mine Site poses a public health hazard. We determined that people and animals will be exposed to arsenic if they swim or wade in the impacted creeks or in Lost Lake, eat fish from Lost Lake, or inhale or ingest dust and dirt near the mine site. Inhaling or ingesting dust and dirt in homes in the affected area, and drinking water from contaminated wells are also potential sources of exposure to arsenic. In sufficient doses, exposures occurring over many years could result in an increased risk of certain skin problems, as well as, in a low to moderate increased risk of skin, liver, bladder, and lung cancer. For this reason, CDHS has classified the Lava Cap Mine Site as a Public Health Hazard, and advises against wading or swimming in Lost Lake or Little Clipper and Clipper Creek watersheds. CDHS also advises residents to avoid contact with mine tailings in areas of known deposition.

STATEMENT OF ISSUE

The Environmental Health Investigations Branch (EHIB), within the California Department of Health Services (CDHS), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), is conducting public health assessment activities at the Lava Cap Mine Site in Nevada County, California. The Lava Cap Mine Site was nominated to the U.S. Environmental Protection Agency (USEPA) National Priorities List in February of 1999. This public health assessment is constructed to adhere to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) legislation requiring release of the public health assessment within one year from the time the site was proposed for "Superfund" listing.

Specifically, this public health assessment examines contaminants that migrated from the Lava Cap Mine Site after a severe winter storm in 1997 caused a dam failure, which released mine tailings into Little Clipper Creek, Lost Lake and the Little Clipper watershed. Data collected between the winter of 1997 and fall of 1998, were used to prepare this public health assessment.

BACKGROUND

Lava Cap Mine is located on about 30 acres in the Sierra Nevada foothills at 14501 Lava Cap Road, Nevada City, Nevada County, California. Gold and silver mining activities occurred during the periods of 1861-1918 and 1933-1943. The mining operations created two waste piles at the site; a pile of coarse, gravel-sized material, called waste rock, and a mill tailings pile. The mill tailings pile (estimated at 200,000 cubic yards) is of primary concern because it is an extremely fine grain material (a "flour-like" material) that is easily suspended in air or water and carried off the site. Analyses of the tailings pile have shown arsenic levels over 1,000 parts per million (ppm). The mill tailings were held behind a 60-foot high log dam until a major winter storm resulted in a partial failure of the dam (1,2).

On January 1, 1997, after a three day storm, a breech of the dam released more than 10,000 cubic yards of tailings downstream into Little Clipper Creek. After the dam failure, the storm water carried the mine tailings from Little Clipper Creek to the confluence of Little Clipper Creek and Clipper Creeks, and from there into Lost Lake, a small reservoir approximately 1.5 miles downstream. Prior to the dam failure, Lost Lake was used by shoreline residents for swimming, boating, and fishing (1,2).

Within days of the dam failure, the California Department of Toxic Substance Control (DTSC) conducted initial assessments of the environmental damage. Analyses of soil and sediments impacted by the tailings release showed that the Lost Lake shoreline soils contained arsenic at levels above 1,000 ppm. In addition, the water in Lost Lake contained arsenic at 28 parts per billion (ppb). Subsequent analyses found arsenic in a variety of environmental samples at higher levels. Those analyses also found that most of the arsenic-laden tailings were located in the creek and lake sediments. The arsenic-contaminated sediments extended up to the high water level left by the winter storms. DTSC released fact sheets that recommended the area residents should avoid swimming, boating, and fishing in Lost Lake, and that contact with the shoreline

soil and sediments should be avoided. During the fall of 1997, the USEPA Emergency Response Office supervised activities that were designed to stabilize the remaining mine tailings and prevent further off-site migration of contaminants. These activities included grading and covering exposed tailings, improving the site drainage, and creating stream diversions around the tailings pile (1).

Site Visit

In March of 1999, a CDHS representative participated in a site visit hosted by representatives of the USEPA. The site visit consisted of a walking tour of the actual mine site, the log dam, the Lost Lake dam, and Lost Lake and vicinity (Appendix A: Figure 1). Also participating in the site visit were representatives of a USEPA contractor and representatives of the DTSC.

The mine area is located in an area characterized by wooded foothills with steep ravines and creek banks. On the mine site, numerous old mine buildings are standing in various states of disrepair, and refuse piles are numerous. Much of the surrounding area is not inhabited, however there are two residences adjacent to the mine site, and approximately 20 homes are located within 0.25 miles of Little Clipper Creek, Lost Lake, and a small wetland upstream of the lake. In 1994, approximately 1,700 people lived within one mile of the mine and approximately 24,000 people lived within 4 miles of the mine (1).

Gravel or dirt roads provide access to the homes and the mine site. Automobile access to the mine site is restricted by locked gates. Most of the homes in the Lost Lake region are located approximately 50-100 feet above the elevation of lake.

Prior to the dam failure, the area residents and occasional trespassers used Lost Lake for swimming, boating and fishing. Lost Lake contains bass and bluegill, and the area creeks provide habitat for trout and other aquatic organisms. Most of the affected length of Little Clipper and Clipper Creeks are relatively small and in rugged terrain. Information obtained at the site visit indicated that fishing in the area is generally limited to Lost Lake.

While the water from Lost Lake is not used for drinking water, the DTSC representatives also reported that many of the area residents used drinking water from private wells. Approximately three miles down stream, the outflow of Lost Lake (Clipper Creek) flows into Rollins Reservoir, a recreational water body and a drinking water source.

COMMUNITY HEALTH CONCERNS

The history of community concerns dates back to 1979 when residents adjacent to the site reported to the Central Valley Regional Water Control Board (RWQCB) about sediments from the Lava Cap Mine property running into Little Clipper Creek (3). As a result, RWQCB issued a Cleanup and Abatement Order (CAO) requiring the owners of the mine property to take measures to remove the mine tailings from Little Clipper Creek and to ensure that tailings from the mine did not enter the creek in the future. In addition, RWQCB required the property owners to divert the water runoff around the mine tailings to prevent arsenic from the mine tailings from

leaching into the water runoff (1). Finally, the RWQCB directed the property owners to have an engineer evaluate the integrity of the log dam constructed to hold the tailings pile in place (1,4). In fact, no improvements were made to the dam at that time (5).

In 1984, the mine owners attempted to have the mine reopened. Based on an Environmental Impact Report developed for the Nevada County Planning Department, the Nevada County Board of Supervisors approved use permits to open the Lava Cap Mine (3) . However, two local homeowners associations were successful in petitioning against the Board of Supervisors decision and the mine was never reopened. Similarly, a proposal to subdivide five areas including part of the site property into 69 residential lots never materialized because of pressure from the local community to prevent the development (3).

During the remainder of the 1980s and into the early 1990s, there is no documentation of community concerns. However, the collapse of the log dam in January 1997 renewed the residents' concerns about the tailings.

Because of the high level of arsenic ($\geq$ 1,000 ppm) in the tailings, DTSC distributed fact sheets in the spring of 1997 explaining the release. The March fact sheet advised residents to "avoid direct contact with the mine tailings", provided arsenic health effects information, and explained that further sampling would be done. The subsequent fact sheet in June 1997 provided more specific health precautions about exposure to arsenic. This fact sheet recommended that residents, especially children, should avoid contact with soils along Little Clipper Creek and Lost Lake, and that residents should refrain from swimming or boating in Lost Lake (6,7). Although Lost Lake was a popular recreational fishing area prior to the dam release, DTSC did not explicitly advise residents against eating fish because it was assumed that recommendations in the June 1997 fact sheet precluded fishing (7). In the earlier fact sheet, DTSC had stated that the agency was evaluating a protocol for testing fish and after approval of the protocol, fish tissue from Lost Lake fish would be evaluated for arsenic.

In August 1998, Ecology and the Environment, contractor to the USEPA, released a report which ranked the Lava Cap Mine Site with a score which placed it on the National Priorities List, a list of hazardous sites considered to potentially have the greatest impact on the health of the public. In the areas evaluating possible exposure to humans, the site received the maximum scores (4). The report noted that one individual lived on the site within 200 feet of known contamination and seven people occupying three residences at Lost Lake were also within 200 feet of known contamination.

Residents were disturbed about the NPL ranking since some residents were not even aware of the mine and the contamination caused by the tailings. Others were upset because they thought that
problems related to tailing releases had already been addressed. Those who had lived there a long time knew of the log dam inspection included in the RWQCB Cleanup and Abatement Order and assumed measures to strengthen the dam had occurred.

In March of 1999, USEPA interviewed residents who lived near or owned property near the Lava Cap Mine and Lost Lake. During these interviews, USEPA informed residents about the Superfund program, the listing of the site on the National Priorities List, and inquired about any questions or concerns of the residents. The primary concerns related to health were about the health effects of arsenic or other contaminants and the impact of arsenic or other contaminants on their private wells. There was no data on private wells available at the time of this writing. (See the Public Health Implications section of this document for a discussion about the effects of exposure to arsenic by living in residences on the site, swimming in Lost Lake, wading in sediments at the side of the lake, and eating fish from the lake.)

Most of the residents who were interviewed by USEPA use private wells for their drinking water needs. Many are concerned about the impact of arsenic on their drinking water and several residents have been drinking bottled water since the tailings release in 1997. There are concerns about the location of the wells in relation to Little Clipper Creek and Lost Lake, the depth and the condition of the wells. Until testing occurs, it is not possible to evaluate the impact of arsenic on the private drinking water wells.

Residents who lived near the site were also concerned about the access for trucks and equipment used during the sampling and cleanup of the site. Residents did not like the idea of contaminated materials being hauled through their neighborhood. The roads are not built to handle heavy traffic and they are maintained by a resident road fund rather than the county. These roads go through the residential area so there was concern about the safety of trucks traveling through the neighborhood where there are children and pets.

ENVIRONMENTAL CONTAMINATION

Use Of Comparison Values

In order to assess the potential adverse health effects of environmental contamination on a nearby population, one must first identify the pollutants that may be affecting that population. Next, those pollutants that are present at a high enough concentration to possibly cause adverse health effects must be identified. Those contaminants so identified are called contaminants of concern, and are identified as follows.

The concentration of the contaminant in a specific medium (soil, air, and water) is compared to a screening value for that contaminant in that medium. This screening value is the concentration of a specific chemical in a specific medium (soil, air, or water) at or below which a person could be exposed to that chemical without the expectation of adverse health effects occurring. These values are calculated using health protective assumptions regarding the body weight and ingestion rate of the receptor population, so that if the concentration of the contaminant is below the screening value, one should feel confident that adverse health effects should not occur. If the concentration of the contaminant exceeds the screening value, then it is called a contaminant of concern. However, adverse health effects do not automatically occur if the concentration of a chemical exceeds its comparison value. The chemical must be further evaluated on an individual basis to determine the likelihood of exposure and the possibility of adverse health effects.

Comparison values are available for evaluating both cancer and non-cancer health effects. The non-cancer health effects will be evaluated relative to the comparison values called Environmental Media Exposure Guidelines, or EMEG values (developed by ATSDR). If the contaminant levels are less than the non-cancer health comparison values, the EMEG values, then a non-cancer adverse health effect is not likely, and that contaminant is not considered further. On the other hand, if the contaminant concentration exceeds the non-cancer EMEG comparison value, the contaminant is considered a contaminant of concern, and a more rigorous toxicological evaluation is necessary.

Contaminants that may cause cancer can be evaluated in terms of an increase in the risk of developing cancer. Such an increased risk can be assessed by using comparisons with the Cancer Risk Evaluation Guide, or CREG, comparison values. These CREG comparison values use a decision point for screening purposes that is set at "one-in-a-million" (or 10^{-6}). In other words, if the concentration of a specific contaminant is less than the CREG, then exposure to the contaminant is not expected to increase the risk of cancer by more than one cancer case per one million people. If the contaminant concentration exceeds the CREG, the contaminant is considered a contaminant of concern, and it receives further toxicological evaluation.

Environmental Sampling

The data evaluated for this public health assessment were collected through a series of off-site sampling, conducted over a period between winter 1997 and fall 1998, by the DTSC (summarized in Table 1 in Appendix A). These sampling efforts provided a number of "biased" samples that were aimed at evaluating the contamination in areas of likely human contact.

The analyses used USEPA Methods to determine the concentrations of metals in water and soil/sediments. Samples were taken of soil/sediments along Little Clipper Creek, and Lost Lake, and of water from Little Clipper Creek and Lost Lake. Approximate sampling locations in the Lost Lake vicinity (March 3, 1998 sampling) are shown in Figure 2 in Appendix A. Data evaluated for fish consumption were taken from fish collected from Lost Lake. While the data from these analyses were not "validated" by traditional data review methods, they likely provide a reasonable estimate of the contaminant levels in the area.

Of the 77 off-site samples analyzed, 62 exceeded the soil comparison value for arsenic (EMEG for chronic exposure to a child = 20 mg/kg) (Appendix A: Table 1 Data Summary). No other contaminants were detected above the soil comparison values. Surface water samples showed arsenic levels that were routinely above drinking water standards (Appendix A: Table 1). Four fish samples (two bluegill, and two bass) were collected from Lost Lake and evaluated for arsenic contamination. The highest levels of total arsenic found in the fish was 1.79 ug/g.

In summary, the use of comparison values shows that arsenic found in the water of Lost Lake, in Little Clipper Creek past the confluence of Little Clipper Creek and Clipper Creeks, in Clipper Creek below the Lost Lake dam, and in the sediments associated with the creek and lake, is the only contaminant of concern. Therefore arsenic will be evaluated further with respect to cancer and non-cancer health effects.

PATHWAY ANALYSES

For a population to be exposed (receptor population) to environmental contamination, there must be a way (mechanism) by which that contamination comes into direct contact with the target population. An exposure pathway is the description of this mechanism. An exposure pathway consists of five parts: a source of contamination, an environmental medium and transport mechanism, a point of exposure, a route of exposure, and a receptor population (8).

Exposure pathways are classified as completed, potential, or eliminated. A completed exposure pathway is one in which all five elements of the pathway are present. A potential pathway is a pathway in which one or more elements of the pathway are missing, but might be present later. A pathway may also be described as a potential exposure pathway if information on one of the elements of the pathway is missing. An eliminated exposure pathway is one in which one or more of the elements is missing and will not be complete in the future. For a population to be exposed to an environmental contaminant, a completed exposure pathway (all five elements) must be present (8). If any one or more of these elements are missing, then there is no exposure, though the presence of contamination may still be significant and require remediation. This is especially true if there is a possibility of an incomplete exposure pathway becoming complete in the future.

The source of the contaminants in all pathways is the mine tailings at the Lava Cap Mine Site. These mine tailings have migrated off the mine site resulting in substantial depositions in the Lost Lake vicinity. The medium in all of the pathways is water (creek or lake), the soil/sediments (from creek or lake), or dirt and dust derived from the mine tailings. The point of exposure is at or in the lake or creek, or in homes near Little Clipper Creek, Lost Lake or the Lava Cap Mine. The identified exposure routes are inhalation, ingestion and dermal contact. The "receptors" are identified as the residents of the area and the occasional trespasser.

It should be noted that the Little Clipper Creek and Lost Lake are not used for drinking water. While eliminated as a likely drinking water exposure, the exposures to arsenic from these waters will be evaluated based on incidental ingestion and dermal contact while swimming or wading.

The CDHS has identified four completed pathways and three potential pathways at the Lava Cap Mine Site. The potential pathways are summarized in Table 3 of Appendix A and are described below. The completed pathways are summarized in Table 2, briefly described below and evaluated further in the Public Health Implications section.

The Completed Exposure Pathways

The "**mine site residence**" pathway involves ingestion and inhalation of dirt and dust contaminated with arsenic. This pathway is specific for the four residences on the mine site property.

The "**swimming**" pathway is used to evaluate the exposures to adults and children swimming in Lost Lake.

The "**wading**" pathway is used to evaluate the exposures to adults and children wading in Lost Lake, Little Clipper Creek, and the area after the confluence of Little Clipper Creek and Clipper Creeks.

The Potential Exposure Pathways

The **"dust/dirt"** pathway involves the potential exposure that may be associated with breathing contaminated dust and incidental ingestion of dust and dirt in homes near Lost Lake (Appendix A: Table 3). Analyses of the "dust and dirt" inhalation pathway are limited by the absence of data describing the arsenic levels in air and dust in and around the area homes in the Lost Lake area. Without that data it is unreasonable to speculate on the exposures that could result from ingestion and inhalation of arsenic-contaminated dust and soil. It should be pointed out that such exposures might be expected as the small particle size of the mine and mill tailings will facilitate their becoming airborne. Wind-carried dusts could settle in the homes of the area residents and be inhaled and/or ingested. In addition, pets are likely to wade and/or walk in the contaminated sediments and "track-in" those contaminated sediments when returning to the owners' homes. A recent report indicates that human and pet "track-in" can add significant quantities of an outdoor contaminant to the indoor living space of residential homes (9).

The **"well water"** pathway refers to potential exposures due to drinking water from a well that has been contaminated with the arsenic from the mine site. This pathway is listed as "potential" because there are no data describing arsenic levels in the private wells in the areas near the Lava Cap Mine Site or Lost lake. However, the USEPA has included well sampling in their "Sampling and Analysis Plan for the Remedial Investigation/Feasibility Study: Lava Cap Mine Superfund Site". That sampling is expected to be available in the spring of 2001, and those data will allow an evaluation of any exposure dose associated with drinking contaminated well water.

The "**fish eating**" pathway involves potential exposures received when eating fish from Lost Lake. This pathway is listed as "potential" due to limitations with the data, which prohibit an adequate evaluation. CDHS recommends that a survey be conducted to determine the extent of fish consumption in the area and additional fish sampling and analysis be conducted.

The **"Rollins Reservoir"** pathway refers to the potential for the migration of contaminants from Lost Lake to Rollins Reservoir, a drinking water source. The reservoir is monitored on a regular basis. However, a more extensive evaluation of this "potential" pathway will require analyses of

the water and sediments downstream from Lost Lake. Those analyses and an evaluation of the structural integrity of the Lost Lake dam have been planned by the USEPA ("Sampling and Analysis Plan for the Remedial Investigation/Feasibility Study: Lava Cap Mine Superfund Site"), and are expected to be completed by the spring of 2001. Data from those studies will permit an evaluation of any exposure dose associated with the drinking water taken from Rollins Reservoir.

PUBLIC HEALTH IMPLICATIONS

Health Effects Associated With Exposure To Arsenic

Arsenic is a naturally occurring element that is commonly found in surface soil and surface water in California. Long-term exposures of lower levels of arsenic through drinking water (170-800 ppb) can lead to a condition known as "blackfoot disease". This disease is characterized by a progressive loss of circulation to the hands and feet that can lead to necrosis and gangrene (10). Other effects of arsenic ingestion include gastrointestinal irritation, and contact with skin can cause discoloration (hypo-or hyper-pigmentation), wart-like growths and skin cancer. The USEPA has classified arsenic as a "known human carcinogen" due to its ability to cause skin cancer, with oral exposures increasing the risks of liver, bladder and lung cancer.

USEPA has calculated a Reference Dose (RfD) for long term oral exposure to arsenic. This value represents an estimate of daily exposure to the human population (including sensitive subgroups), below which non-cancer adverse health effects are unlikely to occur. The RfD is based primarily on two epidemiological studies. One study looked at the effects and dose-response relationships of skin cancer and blackfoot disease with arsenic-contaminated water. The other study looked at prevalence of skin cancer and increased incidences of hyper-pigmentation and keratosis in areas with chronic arsenic exposure (10,11). Based on these studies, the NOAEL (no-observable-adverse-effect-level) for the exposed populations was determined to be 0.0008 mg arsenic/kg/day (11). The LOAEL (lowest-observable-adverse-effect-level) was determined to be 0.014 mg arsenic/kg/day. To account for the uncertainty and to protect particularly sensitive people, USEPA divided the "no-observable-adverse-effect-level' by an uncertainty factor (or safety factor) of 3, resulting in a RfD of 0.0003 mg arsenic/kg/day (11).

ATSDR has calculated an acute Minimal Risk Level (MRL) for short term (1-14 days) exposure The MRL is based primarily on a study which looked at an episode of arsenic-contaminated soy sauce in Japan, which resulted in 220 poisonings (10). The LOAEL was determined to be 0.05 mg arsenic/kg/day. To account for the uncertainty and sensitive populations, ATSDR divided the LOAEL level an uncertainty factor (or safety factor) of 10, resulting in an MRL of 0.005 mg arsenic/kg/day (10).

Evaluation Strategy

It is the intention of the authors to use 'high end" estimates and assumptions to ensure that any potential health hazards from arsenic exposures are recognized. For evaluation of the complete exposure pathways in this public health assessment, the exposure assessment will assume (Appendix A: Table 4 lists additional parameters/values used in the evaluation):

1) acute and chronic exposures;
2) that the exposed populations are exposed to the average of the highest arsenic values from each sampling event, found in the water and sediment of Lost Lake;
3) that trespassers are exposed at the same rate as area residents;
4) that the "total arsenic" values reported for the soil and sediment, represent a quantity of completely bioavailable, inorganic arsenic;
5) complete absorption of arsenic from dermal contact exposures.

While ATSDR does not provide comparison values for evaluating exposures through dermal contact, dermal contact exposures represent a significant avenue for internalization of arsenic. Therefore, the exposure assessments in this public health assessment evaluate dermal contact with the lake water and sediments using the general guidance from the ATSDR. These procedures are similar to those used by used by the DTSC in previous evaluations of dermal contact exposures at the Lava Cap Mine Site (2).

Children's Health Issues

ATSDR's Child Health Initiative is designed to emphasize both recognition of, and response to, the special needs of infants and children. This additional emphasis is given children because they are at greater risk for certain exposures than are adults. The greater risks faced by children are related to several differences between children and adults. For example children are smaller, and therefore can be exposed to higher levels of contaminant per body weight. Also, permanent damage to children can result from exposures that occur during critical developmental and growth periods. In this public health assessment, exposure doses to children are evaluated as a portion of the analyses for each completed exposure pathway.

Toxicological Evaluation of the Completed Exposure Pathways

The pathway analyses found four completed exposure pathways (Appendix A: Table 2). Analyses using comparison values showed that arsenic is the only contaminant of concern. Therefore, the cancer and the non-cancer health effects of exposure to arsenic are evaluated.

Non-Cancer Health Effects

The approach used to evaluate the potential for adverse health effects, other than cancer, to occur in an individual or population assumes that there is a level of exposure below which non-cancer, adverse health effects are unlikely to occur. That level is called the threshold level or toxicity value. This approach compares a dose estimate with the toxicity value. The dose estimate is a

calculated estimate of the amount of contaminant in contact with or taken up by the exposed person and is expressed as milligrams of contaminant per kilogram body weight per day or mg/kg/day. When the dose estimate for a contaminant exceeds the toxicity value (e.g., ATSDR's Minimal Risk Level, MRL or USEPA's Reference Dose, RfD) for that contaminant, there may be concern for potential non-cancer, adverse health effects as a result of exposure to that contaminant.

Toxicity values used to evaluate non-carcinogenic, adverse health effects from arsenic at the Lava Cap Mine Site include ATSDR's MRL and USEPA's RfD. This value (or health comparison value) estimates the daily exposure to the human population (including sensitive subgroups), below which non-cancer adverse health effects are unlikely to occur. The MRL and RfD only consider non-cancer effects. Because it is based only on information currently available, some uncertainty is always associated with the MRL and RfD. Uncertainty factors are used to account for the uncertainty in our knowledge about their danger. The greater the uncertainty, the greater the uncertainty factor and the lower the MRL or RfD.

Dose estimates may be calculated for oral or inhalation exposures to arsenic. However, there is no MRL or RfD for inhalation of airborne arsenic. Therefore, the oral RfD (0.0003 mg/kg/day) and MRL (acute 0.005 mg/kg/day: chronic 0.0003 mg/kg/day) were used as the health based guidelines in cases where inhalation was the exposure route. MRLs and RfDs are classified as either acute, intermediate, or chronic. Acute MRLs and RfDs are developed for exposures of up to 14 days; intermediate exposures are between 15 and 364 days; and chronic exposures are greater than 365 days.

In addition to oral intake, the direct contact of a chemical with the skin (dermal contact, dermal exposure) can also lead to exposure to that chemical. The ability of a chemical to penetrate the skin is measured by the permeability constant, K_p. The ability of a chemical to penetrate the skin is also a function of the concentration of the chemical in the medium of interest, the surface area of the body which is exposed to the chemical, the part of the body exposed, and the length of time that the chemical is in contact with the skin.

Carcinogenic Health Effects

To evaluate the cancer risk posed by some chemicals, the increased lifetime cancer risk was calculated. This risk is called an increased risk because the value that is calculated represents an increase in the number of expected cases of cancer over and above the normal background cancer rate in the general population of 1 in 4 (25%, or 250,000 cancers per 1,000,000 people). Thus, an increased lifetime cancer risk of 1 in one million (or 1×10^{-6}) means that in 1,000,000 people, 250,001 cases of cancer would be expected, with only 1 case potentially caused by the chemical exposure.

The increased lifetime cancer risk is calculated from the oral slope factor (OSF) for that chemical. A slope factor is an estimate of a chemical's potential for causing cancer. The OSF, in turn, is calculated from the slope of the dose-response curve for the chemical in question. The increased lifetime cancer risk from exposure to a given chemical is calculated by multiplying the

daily dose of the chemical by the OSF. The total increased lifetime cancer risk is calculated by adding together the cancer risk for the individual chemicals. If the total increased lifetime cancer risk is less than 1×10^{-6}, then it is considered to be an insignificant increased risk, and will not be considered further.

The cancer and non-cancer toxicological evaluations of the completed pathways are described as follows (Appendix A: Table 5, Summary of Estimated Exposure Doses). It should be noted that due to the limited amount of available data this toxicological evaluation should be considered a screening process.

Exposure Dose Estimates and Health Effects Evaluation

The "**mine site residence**" pathway involves exposures from contaminated dust and dirt to the occupants homes adjacent to the mine site. These homes are within 200 feet of the mine site waste rock piles, and it is likely that arsenic-contaminated dust and dirt, becomes airborne, and may be deposited in these homes. This pathway considers an inhalation exposure, and was evaluated using assumptions that the contaminated dust in the air is at a concentration of 0.05 mg/m^3 (12), and that all of that dust is composed of the highest average arsenic soil level found on residential property (i.e., 733 mg/kg; Appendix A: Table 1).

Dust and dirt in homes also represent an ingestion hazard as incidental ingestion of that dust and dirt is expected, especially in children. For example, children may come into contact with and ingest soil particles at higher rates than adults (also, some children possess a behavior trait known as "pica", which is a tendency to ingest soil and other non-food items). Therefore, incidental ingestion of the dust and dirt in the homes near the mine site was also evaluated.

For the "mine site residence" pathway, the inhalation and the incidental ingestion exposures are summed for a total exposure dose of 0.0120 mg/kg/day in children, and an exposure dose of 0.0010 mg/kg/day in adults. The total exposure dose for children exceeds the acute (1-14 days of exposure) "minimal risk level" (acute oral MRL = 0.005 mg/kg/day) for non-cancer health effects. The exposure dose estimated for adults exceeds the chronic oral MRL (0.0003 mg/kg/day) for non-cancer health effects. Therefore, exposure to such doses could cause non-cancer health effects to the skin, in children (1-14 days of exposure) and adults (30 years of exposure). A one time acute exposure to a child with pica behavior (ingestion of 1000-5000 mg soil/day) could result in an acute health threat. The increased cancer risks for these exposures (calculated as dose multiplied by the cancer slope factor of 1.5) are: 1.5 in 1,000 for exposed children and 1 in 1,000 for exposed adults. (This means that there could be one or two additional skin cancer cases in a population of 1,000 exposed children and approximately one additional cancer case per 1,000 adults, from a lifetime of exposure.) These cancer risks are considered "moderate increased risk".

The "**swimming**" pathway involves dermal contact exposures from the contaminated water in Lost Lake and incidental ingestion of the lake water while swimming. CDHS assumed that incidental ingestion and dermal contact would take place during the summer, and thus we used the highest average concentration of arsenic detected in Lost Lake water during the summer

months, when people would be most likely to swim. This pathway was evaluated using assumptions that the contaminated water in Lost Lake is at a concentration of 513 ug/L (Appendix A: Table1). The estimated exposure dose for the children swimming in Lost Lake is 0.00023 mg/kg/day (sum of dermal contact with water plus incidental ingestion). Exposure doses estimated for children do not exceed the MRL for non-cancer health effects associated with chronic exposures through incidental ingestion and dermal contact. The estimated exposure dose (0.00018 mg/kg/day) for the adults swimming in Lost Lake does not exceed the MRL (0.0003 mg/kg/day). Thus, non-cancer health effects to the skin are not likely to occur in children or adults swimming in Lost Lake, with arsenic levels averaging 513 ug/L.

The increased cancer risk associated with the estimated exposure dose (dose multiplied by the oral cancer slope factor of 1.5) is 2.5 in 100,000 for exposed children and 1.2 in 100,000 for exposed adults. These risks of cancer are both described as "a very low increased risk of cancer".

The "**wading**" pathway involves dermal contact exposures from the contaminated water in Lost Lake and incidental ingestion of sediments while wading. This pathway was evaluated using the assumption that the arsenic concentration in the sediments of Lost Lake is 470 mg/kg. (Other assumptions related to wading and calculations are provided in Table 4 of Appendix A). The estimated exposure dose for the children wading in Lost Lake is 0.00090 mg/kg/day (sum of dermal contact with sediments plus incidental ingestion). The estimated exposure dose for the adults swimming in Lost Lake is 0.00065 mg/kg/day. These exposures doses exceed the chronic MRL for non-cancer health effects associated with arsenic exposures. Therefore, arsenic exposure at these estimated doses may cause non-cancer health effects to the skin. The increased cancer risk associated with the estimated exposure dose (dose multiplied by the oral cancer slope factor of 1.5) is 2.3 in 10,000 for exposed children and 1.7 in 10,000 for exposed adults. Both of these increased risks of cancer are described as "low increased risk of cancer".

Additional Comments

As previously stated, the evaluations conducted for this public health assessment employed "high-end" assumptions and the average of the highest arsenic concentrations found, and therefore may overestimate the risks associated with arsenic exposures. In addition, the limited number of samples that were available for analysis in this public health assessment has resulted in limitations in carrying out a complete analysis of the health impact of the Lava Cap Mine Site.

DTSC representatives have stated that their community outreach program has been successful in reaching all of the area residents. Those educational efforts informed residents about the hazards associated with the mine tailings. The DTSC representatives were confident that area residents were accepting their recommendations, that area residents were not using the Lost Lake water, and they were also avoiding contact with the nearby sediments. This avoidance of the contaminated water and sediments should reduce present and future exposures to arsenic. It could be reasonably argued that the area residents do not swim or wade every day, and it is also

unlikely that they swim or wade in Lost Lake during the colder winter months. Such avoidance of the contaminated media is expected to further reduce actual exposures.

CDHS used both the acute and chronic MRL's in evaluating exposure doses. It might be argued that a comparison value for acute exposures would be more appropriate given the indications that area residents may be avoiding the contaminants in the Lost Lake vicinity. If such an argument is accepted, it must then be acknowledged that the wading pathways would not exceed the acute MRL.

Regardless of whether using the chronic MRL (0.0003 mg/kg/day) or the acute a MRL (0.005 mg/kg/day), the arsenic exposures estimated for a number of activities (ingestion and inhalation of soil for mine site residents) exceeds either comparison value for children. In addition, while estimated exposure doses for swimming in Lost Lake do not exceed health comparison values, it is difficult to enter the water and swim without first wading through the sediments along the edges of the lake. Thus, potential exposures received while swimming in Lost Lake may be compounded by exposure to arsenic containing sediments.

A comparison of the exposure doses indicates that ingestion of contaminated soil for mine site residences is associated with the highest risks (Appendix A: Table 5). With the intention of minimizing present and future exposures, this information should be included in the educational materials presented to the area residents.

Site Update

In November 2000, CDHS attended a public meeting held by USEPA to update residents on the status of the remedial activities at the site. CDHS has requested the sampling data collected by USEPA during the Fall of 1999 and 2000. The extent of potential downstream migration of contaminated tailings, and the potential impact to the Rollins Reservoir were not characterized during the 1999 and 2000 sampling efforts (D. Seter, USEPA, personal communication 1/24/01). As of January 2001, the data that has been collected were still undergoing USEPA's internal review process and were not available (D. Seter, USEPA, personal communication 1/24/01). Once these data are available, CDHS will determine if a re-evaluation of estimated risk is indicated. Additionally, we will evaluate the private well water data and determine whether a potential health risk exists.

CONCLUSIONS

The dam failure and subsequent off-site migration of arsenic-contaminated mine tailings from the Lava Cap Mine Site has resulted in significant arsenic contamination to residential properties on the mine site and adjacent to the site, in Lost Lake, Little Clipper and Clipper Creek watersheds. The arsenic-contaminated tailings are the source of four completed exposure pathways and three potential pathways. The completed pathways involve swimming and wading in the impacted creeks and Lost Lake, and inhalation and ingestion of dust and dirt by residents living near the mine site.

The potential pathways involve inhalation and ingestion of dust and dirt in homes off the mine property and Lost Lake, ingestion of fish from Lost Lake, drinking from arsenic-contaminated wells, and the possibility that contaminated tailings in Lost Lake could migrate downstream to a reservoir used for drinking water.

The limited data available for estimating exposure doses indicate that the completed pathways could result in non-cancer health effects. The estimated cancer risks for the exposure doses ranges from "very low increased risk" to "moderate increased risk". Avoiding contact with mine tailings, sediments in Lost Lake, Little Clipper Creek, Clipper Creek will reduce health risks associated with arsenic exposure. Based on these completed pathways and the estimated exposure doses, the Lava Cap Mine Site is evaluated as a Public Health Hazard.

PUBLIC HEALTH RECOMMENDATIONS AND ACTION PLAN

The Public Health Recommendations and Action Plan (PHRAP) for this site contains a description of actions taken, to be taken, or under consideration by ATSDR and CDHS at and near the site. The purpose of the PHRAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. CDHS and ATSDR will follow-up on this plan to ensure that actions are carried out.

Recommendations

1. CDHS/ATSDR recommends community members/residents avoid contact with sediments from wading and swimming in Lost Lake, and Little Clipper Creek between the Lava Cap Mine property and Lost Lake.

2. CDHS/ATSDR recommends community members/residents avoid contact with mine tailings in areas of known deposition (on the mine site property, and off-site above Lost Lake, past the confluence of Little Clipper Creek and Clipper Creek).

3. CDHS/ATSDR recommends that the community members/residents with private wells continue to use bottled water for potable purposes.

4. CDHS/ATSDR recommends that USEPA conduct additional sampling and characterization of fish contamination in Lost Lake, in order to better understand the risks associated with fish ingestion. Until this can be conducted, CDHS/ATSDR recommends community members/residents avoid ingesting fish caught in Lost Lake.

Actions Completed

1. In 1997, the California Department of Toxic Substance Control (DTSC) conducted community outreach and education on activities to reduce exposure to arsenic containing soil, sediments, and water.

2. In 1999, CDHS met with regulatory agencies to review the current state of knowledge of contaminants at the Lava Cap Mine Site.

3. In 1999, CDHS met with regulatory agencies and county and city officials to coordinate future activities at the Lava Cap Mine Site.

4. In 1999, CDHS reviewed data collected by DTSC and initiated a Public Health Assessment that addressed questions relevant to arsenic contamination at the site.

5. In 1999, CDHS recommended that ATSDR establish comparison values for concentrations of arsenic for usage in evaluating acute exposures. Fall 2000, ATSDR developed an oral acute comparison value of 0.005 mg/kg/day for arsenic.

6. On August 25, 2000, CDHS released the Lave Cap Mine Site public health assessment for public comment.

Recommendations for Further Actions

1. If subsequent data collected by USEPA indicate re-evaluation of the estimated risks, CDHS will prepare a health consultation that evaluates that data.

2. CDHS will meet with community members to communicate the findings of this Public Health Assessment. Specific goals should be to increase the understanding of the technical aspects of the area contaminants and their fate and transport, and to educate the community about potential health impacts of arsenic exposure.

3. CDHS will evaluate private well data when available, and prepare a health consultation.

4. CDHS/ATSDR will continue to keep community members aware of the public health activities at the Lava Cap Mine Site.

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APPENDIX A

Table 1. Summary of Arsenic Data from Sampling Events at the Lava Cap Mine

Sample Date	Number of Samples	Highest Arsenic Creek Water (µ/L)	Highest Arsenic Soil (mg/kg)	Highest Arsenic Residential Soil (mg/kg)	Highest Arsenic Lost Lake Water (µ/L)	Highest Arsenic Lost Lake Sediment (mg/kg)
1/31/97	8	<1	511	ns	<1	444
3/14/97	20	706	571	571	28.4	681
4/17/97	19	ns	1130	1130	49.7	261
7/8/97	5	ns	ns	ns	591	ns
8/12/97	3	ns	ns	ns	849	ns
10/29/97	8	826	ns	ns	146	ns
3/9/98	5	125	ns	ns	18.9	ns
9/2/98	9	114	494	497	99.3	ns
Average Arsenic Concentration of Highest Values		354	677	733	223	462
Average Arsenic Concentration of Lake and Creek Samples Collected During the Summer Months		470	not applicable	not applicable	513	not applicable

(µ/L): micorgrams per liter
(mg/kg): milligrams per kilogram
ns: not sampled

Table 2. Summary of Completed Exposure Pathways at the Lava Cap Mine

Name	Source	Media	Exposure Point	Exposure Route	Receptor	Time
mine site residents	mine tailings	air	homes	inhalation	residents	past
			ingestion			present
					future	
swimming	mine tailings	water	creek lake	dermal ingestion	area residents	past
					present	
					future	
wading	mine tailings	sediments	creek lake	dermal ingestion	area residents	past
					present	
					future	
fish eating	mine tailings	food	homes	ingestion	area residents	past
					present	
					future	

Table 3. Summary of Potential Exposure Pathways at the Lava Cap Mine

Name	Source	Media	Exposure Point	Exposure Route	Receptor	Time
dust/dirt	mine tailings	air	homes	inhalation ingestion	residentspast	present future
well water	mine tailings	water	wells	dermal ingestion	area residentspresent	past future
fish	Lost Lake fish	fish	home/fish	ingestion	residentspast	present future
Rollins Reservoir	mine tailings	water	homes	dermal ingestion	water customers	past present future

Table 4. Parameters and Values Chosen for Evaluating the Exposure Pathways

	Receptor	
Parameter	Children	Adults
body weight	16,35,60 kg	70kg
exposed skin surface		
total (swimming)	8750 cm2	19400 cm2
wading	2672 cm2	4700 cm2
exposure duration		
swimming	1 hr/day	1 hr/day
wading	1 hr/day	1 hr/day
water		
arsenic concentration	513 ug/L	513 ug/L
incidental ingestion	0.05 L/hr	0.05 L/hr
dermal permeability	0.001 cm/hr	0.001 cm/hr
dermal adsorption factor	0.03	0.03
sediment/soil		
arsenic concentration	462/733 mg/kg	462/733 mg/kg
incidental ingestion	100 mg/day 200 mg/day	100 mg/day
"pica behavior"	1000-5000 mg/day	
sediment adherence to skin	20 mg/cm2	20 mg/cm2
dust		
arsenic concentration (soil)	733 mg/kg	733 mg/kg
breathing volume	15 m^3/day	23 m^3/day
concentration of dust in air	0.05 mg/m^3	0.05 mg/m^3

Table 5. Summary of Exposure Dose Estimates for Completed Pathways

Exposure Pathway	Exposure Media	Exposure Route	Exposure Dose (mg/kg/day) Children	Adults
Mine Site Residence	Dust/Dirt	Inhalation	0.000018	0.000012
		Ingestion	0.012	0.001
Swimming	Water	Ingestion	0.000084	0.000036
		Dermal Contact	0.00015	0.00014
Wading	Sediment	Ingestion	0.000084	0.000036
		Dermal Contact	0.00081	0.0018

FIGURES

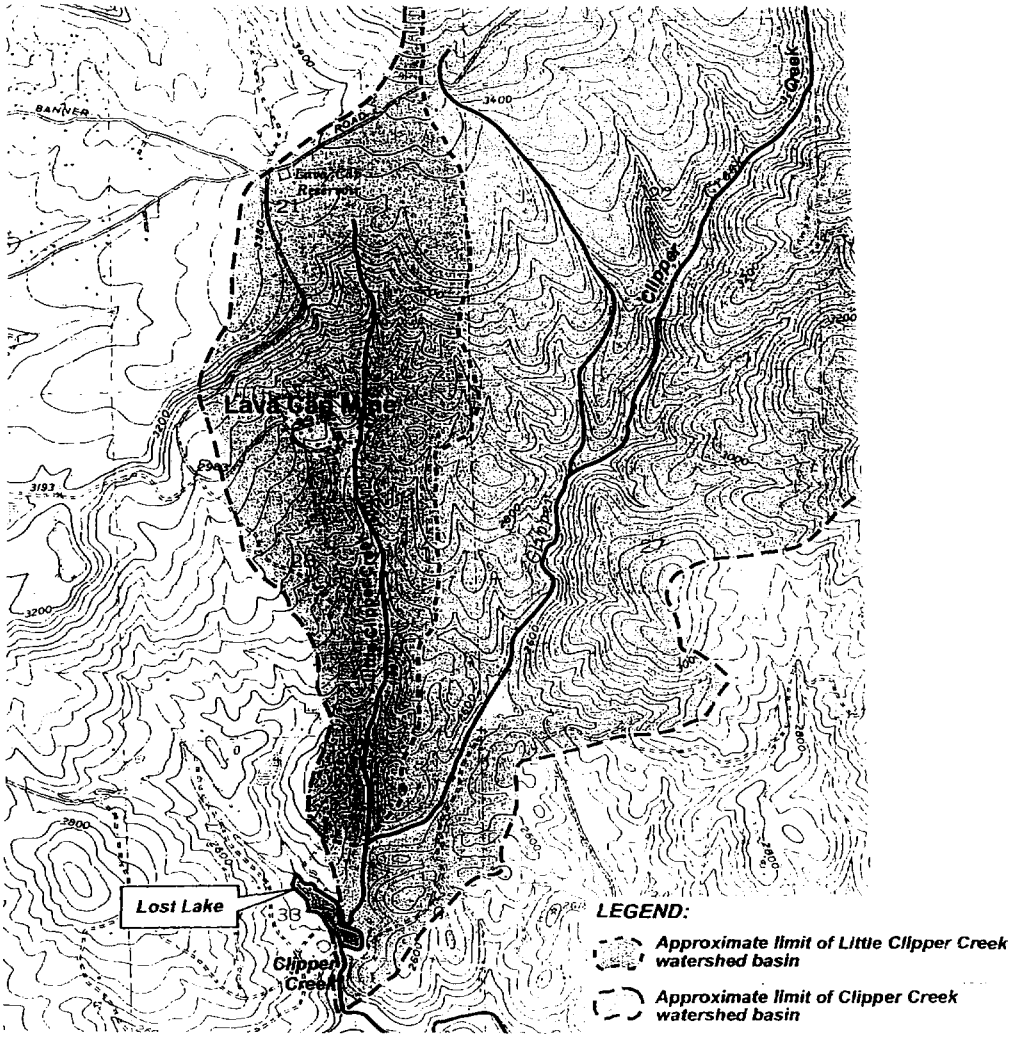

Figure 1. Map of the Lava Cap Mine Site and the Lost Lake Vicinity.

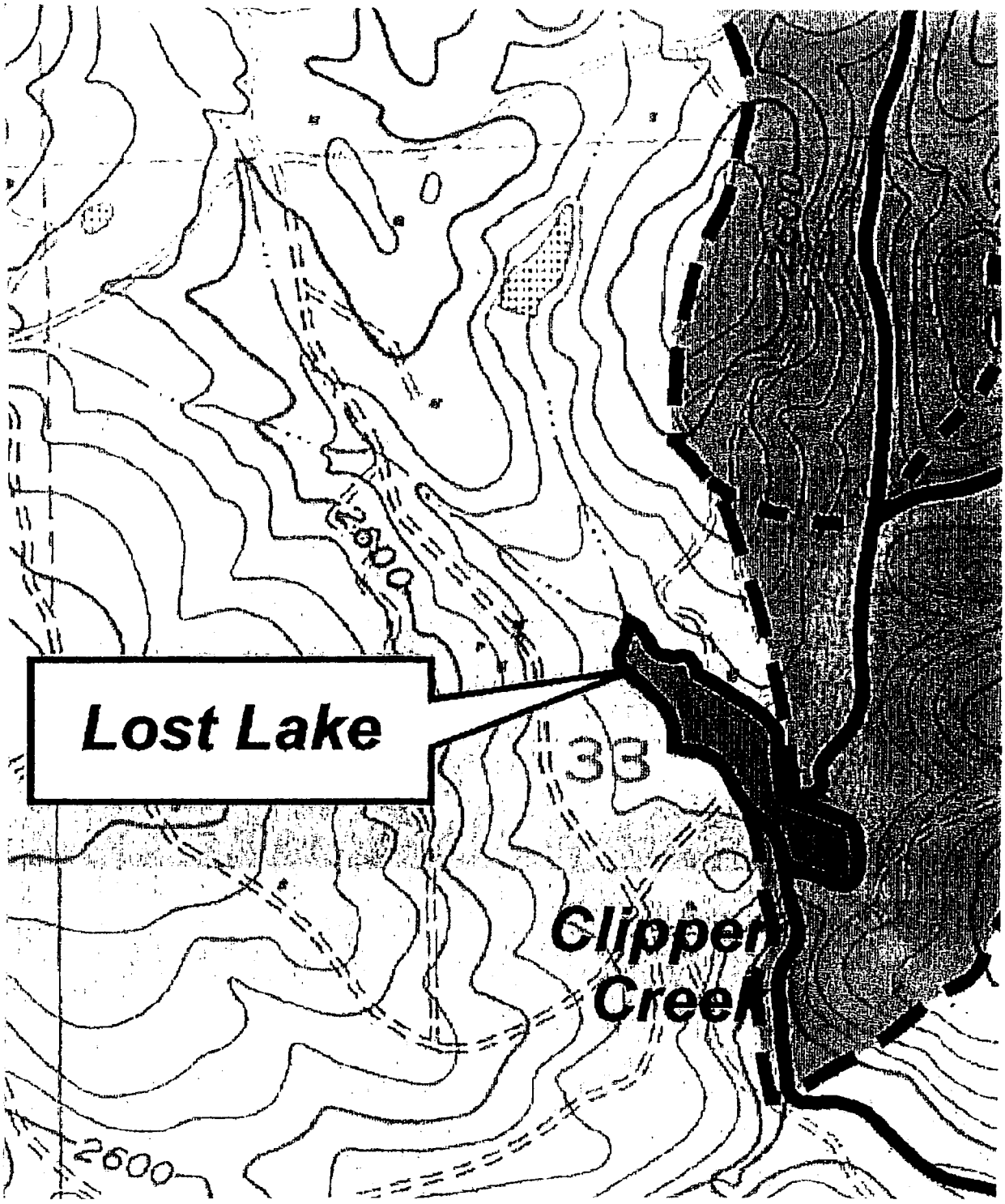

Figure 2. Approximate Locations of Samples Collected in the Lost Lake Vicinity on March 3, 1998.

APPENDIX B

Public Comments

On August 25, 2000, CDHS distributed copies of the Public Health Assessment, "Evaluation of Off-Site Contamination from the Lava Cap Mine Site," to Nevada County community members for review. Copies of this public health assessment were also placed in the Nevada County Public Library, the Grass Valley Public Library and on the Nevada County Department of Environmental Health's web site for all interested parties to review. Additional copies were sent to the Nevada County Public Health Department's Health Officer, Banner Mountain Homeowner's Association, South Yuba River Citizen's League, Greenhorn Road Association, and interested individuals. The major points of the public health assessment also appeared in the Nevada City Union newspaper on August 28, 2000, and the Sacramento Bee on August 31, 2000.

There were approximately 5 weeks (August 25, 2000 to October 1, 2000) allotted public comment on this document. CDHS did not receive any comments on the public health assessment.

Certification

This Lava Cap Mine Public Health Assessment was prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this, and concurs with its findings.

for RG

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