Public Health Assessment

Final Release

KLAU AND BUENA VISTA MINES

SAN LUIS OBISPO COUNTY, CALIFORNIA

EPA FACILITY ID: CA1141190578

Prepared by the
California Department of Public Health

APRIL 1, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner 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's Cooperative Agreement Partner 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's Cooperative Agreement Partner 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's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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List of Acronyms

A description of some of these terms can be found in Appendix D.

μg—microgram, or one-millionth of a gram (0.000001 gram)
μg/dL—microgram per deciliter
μg/m^3—microgram per cubic meter
AMD—Acid Mine Drainage
ATSDR—Agency for Toxic Substances and Disease Registry
BLM—Bureau of Land Management
Cal/EPA—California Environmental Protection Agency
CalPoly-California Polytechnic Institute
CDPH—California Department of Public Health
COCs—contaminants of concern
CREG—Cancer Risk Evaluation Guide for one in a million excess cancer risk
DHHS—Department of Health and Human Services
DTSC—California Department of Toxic Substances Control
EMEG—Environmental Media Evaluation Guide (ATSDR)
EPA—U.S. Environmental Protection Agency
IARC—International Agency for Research on Cancer
kg—kilogram
LOAEL—Lowest-Observable-Adverse-Effect Level
MCL—Maximum Contaminant Level for drinking water (state and federal)
mg—milligram
mg/kg/day—milligram per kilogram per day
MRL—Minimal Risk Level (ATSDR)
NA—not analyzed
NAPL—non-aqueous phase liquid
ND—not detected
NOAEL—No-Observed-Adverse-Effect Level
NPDES—National Pollutant Discharge Elimination System
NPL—National Priorities List (EPA)
pCi—picocuries
PHA—public health assessment
ppm—parts per million
ppb—parts per billion
PRGs—preliminary remediation goals (EPA)
RfC—Reference Concentration (EPA)
RfD—Reference Dose (EPA)
REL—Reference Exposure Level
RMEG—Reference Dose Media Evaluation Guide (ATSDR)
RWQCB—Regional Water Quality Control Board

Summary

The California Department of Public Health (CDPH), under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), prepared a Public Health Assessment (PHA) for the Klau and Buena Vista Mines, San Luis Obispo County, California. The Klau and Buena Vista Mines are located about 12 miles west of Paso Robles, at the intersection of Cypress Mountain Road and Klau Mine Road. The mines cover about 250 acres, including 5 miles of underground workings, approximately 300,000 tons of mine tailings, overburden, waste rock, and several rundown buildings.

> **What is a Public Health Assessment?**
>
> A public health assessment is a report that gives information on hazardous waste sites and their estimated effect on the health of surrounding communities. In the process of writing the report, we look at environmental data and at the ways (or exposure pathways) people may come in contact with chemicals from a waste site or an industrial facility. We analyze the data to see if those chemicals could potentially cause health problems in people living near the facility. Another important part of the public health assessment is responding to community health concerns.

This PHA has three parts:

- A review of environmental data to evaluate the potential health impact from exposures to contaminants found at the Klau and Buena Vista Mines. The review addresses the following:
  - Metal contamination in on-site soils.
  - Exposure to contaminants from resuspension of soils from dirt roads.
  - Exposure to mercury vapor in ambient air.
  - Exposure to surface water in streams and creeks near the mines.
  - Exposure to groundwater.
  - Consumption of contaminated fish from Lake Nacimiento, Bureau of Land Management Reservoir and Harcourt Reservoir.
  - Exposure to mercury in dust when water levels in Lake Nacimiento are low.
- A description of health concerns collected from community members.
- An evaluation of these health concerns based on the environmental data review.

Background

Between the years 1868 and 1970, when the Klau and Buena Vista Mines were in operation, approximately 6.4 million pounds of elemental mercury were produced. Mining operations were shut down in 1971. Elevated concentrations of metals have been detected in soil, sediment, and/or surface water at the Klau and Buena Vista Mines. Contaminants of particular concern are arsenic, manganese, mercury, and thallium.

In 1969, the Regional Water Quality Control Board (RWQCB) first observed waste discharges originating from the Klau and Buena Vista Mines. Between 1987 and 1990, the RWQCB issued two Cease and Desist Orders to the owners of the Klau and Buena Vista Mines for violating waste discharge requirements. In 1995, the RWQCB observed illegal discharges of acid mine drainage to Las Tablas Creek. The long history of discharges of mine wastes into Las Tablas

Creek, combined with documented impacts to the watershed, prompted the RWQCB to ask the U.S. Environmental Protection Agency (EPA) for assistance in controlling the continued release of mercury-contaminated soil/sediment from the mines.

In 2005, EPA prepared an Action Memorandum recommending time-critical activities on the Buena Vista Mine to abate imminent and substantial endangerment posed by hazardous substances at the mine (most notably mercury). Since that time, investigations and several remedial actions have occurred at the mines.

In June 2006, EPA completed an emergency removal of the mercury processing buildings and associated contaminated soils. Over 900 tons of mercury-contaminated soil and building debris were removed, and over 100 pounds of free elemental mercury were recovered and recycled during the emergency removal action [1]. These activities were initiated based on a request from CDPH, after staff visited the mines and observed a number of physical hazards and liquid elemental mercury pooled on surface soils.

In 2007, San Luis Obispo County secured funds to pave 3.3 miles of Cypress Mountain Road, in order to eliminate the mobilization of contaminated soils/mine tailings originally used to construct the road. The roadside investigation and capping was completed in 2008.

In July 2009, a public comment draft of the public health assessment was released to the public and other stakeholders for review and comment. The comments and CDPH responses are provided in Appendix G.

Community Concerns

CDPH conducted a number of outreach activities to collect and understand the health concerns that community members believe are related to contamination at the Klau and Buena Vista Mines. The majority of concerns expressed were related to mercury exposure in surface water, groundwater, and from eating fish. Some community members were concerned about exposure to site-related contaminants in dust generated while driving on roads that were built using mine tailings. In the PHA, we respond to the concerns expressed by community members, based on a review of the environmental data.

Using environmental data collected from the Klau and Buena Vista Mines, CDPH evaluated the potential ways people could be exposed to contaminants from the mines. The conclusions of this evaluation are presented below.

Activities Presenting No Health Concern

CDPH concludes that the following exposure situations and activities would not be expected to harm people's health:

❖ Past, current, and future exposure to the caretaker or teenage trespassers from incidentally swallowing, skin contact, and breathing on-site surface soils containing site-related metals.

- The measured levels of metals in on-site surface soil were lower than the levels found in studies of people and/or animals that have been shown to harm health.

- Past, current, and future exposure to adults and children from ingestion and skin contact with site-related contaminants in surface water, streams, or creeks near the mines.

    - The levels of site-related contaminants measured in surface water, streams and creeks is lower than levels found in studies of people and/or animals that have been shown to harm health.

- Past, current, and future exposure to adults and children from drinking and skin contact with site-related contaminants in drinking water served by local water purveyors, including those that draw water from Lake Nacimiento.

    - The water purveyors regularly test the water served to their customers. Site-related contaminants have not been detected in drinking water served by local water purveyors.

- Past, current, and future exposure to adults and children from incidentally swallowing and breathing site-related contaminants in roadway dust on Cypress Mountain Drive, north of Klau Mine Road.

    - Cypress Mountain Drive, north of Klau Mine Road has been paved, eliminating direct contact with roadway soils and dust generation. The amount of exposure a person might have received from roadway soils, prior to the road being paved, was not at a level expected to harm health.

Activities Presenting a Potential Health Concern

CDPH could not determine whether the following exposure situations could have harmed people's health:

- Past exposure to workers from breathing mercury vapor in ambient air while the mines were operational.

    - In order to determine if workers were exposed to harmful levels of mercury vapor while the mines were operating, air sampling showing the levels of mercury in ambient air is needed. CDPH is unaware of any air sampling being conducted while the mines were operating.

- Past, current, and future exposure from ingestion (drinking, cooking) and skin contact (bathing) with water from private wells that may contain site-related contaminants.

    - Private wells are not regulated or tested by the state. In order to determine whether contamination from the mines have impacted private wells, sampling/testing is needed. CDPH has recommended that EPA investigate whether private wells near the mines have been impacted by mine-related contaminants.

Activities Presenting a Health Concern

CDPH concludes that the following exposure pathways/activities could have harmed people's health:

- ❖ Past, current, and future ingestion of fish caught from Lake Nacimiento, Bureau of Land Management Reservoir, and the Harcourt Reservoir. (see box to the right)
  - ➢ In order to safely consume fish caught from Lake Nacimiento, it is important to follow fish consumption guidelines (see box to the right). The fish consumption guidelines are presented in Appendix E of this report and are posted at Lake Nacimiento.
- ❖ Current exposure from inhalation of mercury vapor in ambient air near former process and/or equipment areas on the mines.
  - ➢ It is possible that the caretaker or a trespasser could breathe harmful levels of mercury vapor near the former process/equipment areas on the mines. Mercury vapor measured in some ambient air samples was at levels shown to be harmful to health in studies of workers. CDPH has made recommendations to EPA to mitigate this exposure.

Is fish contamination a hazard to public health?

The pathway of greatest concern is eating fish contaminated with methylmercury (a toxic form of mercury). While not all the methylmercury in nearby water bodies can be explicitly linked to the Klau and Buena Vista Mines, a number of reports identify these mines as the primary source of mercury in the Harcourt Reservoir, Bureau of Land Management Reservoir, and Lake Nacimiento.

CDPH concludes that consumption of fish caught from the Bureau of Land Management Reservoir, Harcourt Reservoir, and Lake Nacimiento poses a public health hazard, and that fish consumption guidelines should be followed.

CDPH worked with San Luis Obispo County and the California Office of Environmental Health Hazard Assessment to post a fish advisory for Lake Nacimiento, which was completed in February 2007.

A CDPH report evaluating fish contamination in Lake Nacimiento is available online at www.ehib.org/project.jsp?project_key=KLAU01.

In conclusion, while the majority of the pathways evaluated would not be expected to harm people's health, there are highly contaminated areas remaining on the site. As such, interventions to prevent exposures to mine contaminants and remedial actions should continue, in order to reduce/eliminate the potential for current and future exposure.

Recommendations

On the basis of the evaluation of exposures to the contamination from the Klau and Buena Vista Mines, CDPH and ATSDR make the following recommendations:

1. EPA should continue to take steps eliminate or reduce exposure to contamination at the mines.
2. Public access to the Klau and Buena Vista Mines should be restricted where feasible, and signs posted warning people of the hazards present at the mines.
3. Personal protective equipment should be used by the resident/caretaker of the Klau and Buena Vista Mines when engaging in activities on the mines. CDPH conveyed this recommendation to the caretaker in a letter.

4. Enhanced house cleaning techniques (wet mopping, high efficiency particulate arresting (HEPA) vacuum, etc.) should be utilized by the resident/caretaker to keep dust abated indoors. CDPH conveyed this recommendation to the caretaker in a letter.
5. EPA should conduct sampling of roadway soil on the unpaved portion of Cypress Mountain Drive, south of Klau Mine Road.
6. EPA should conduct a well survey and sampling in the vicinity of the mines to ensure that private wells are not impacted by the mines.
7. EPA should collect samples of exposed sediment from Lake Nacimiento in areas where ATV riding occurs, if upstream sediment data collected as part of the Remedial Investigation for the Las Tablas Creek Watershed (Operable Unit 2) indicate contamination at levels of health concern.
8. Owners of the Harcourt Reservoir should reduce or eliminate consumption of fish caught from the reservoir. This could include posting signs warning people about fish contamination in the reservoir. CDPH conveyed this recommendation to the owners of the Harcourt Reservoir in a letter.

Ongoing Activities

EPA is continuing with the remedial process at the Klau and Buena Vista Mines. In the fall of 2008, the Remedial Investigation report was completed, which documents the nature and extent of contamination at the mines. This information will be used in the development of the Feasibility Study, which outlines available cleanup options. Once the review and comment process for the Feasibility Study is completed, EPA will choose a cleanup method. The selected method will be formalized in a Record of Decision.

CDPH and San Luis Obispo County continue to provide outreach to the community about the contaminated fish caught from Lake Nacimiento and consumption guidelines for eating fish safely. San Luis Obispo County and CDPH provide this information on their websites (see http://www.slocounty.ca.gov/health/publichealth/healthissues/lakenacfish.htm and http://www.ehib.org/topic.jsp?topic_key=173&mode=Internet). CDPH recently conducted a ‘fish training’ for nurses, health educators, and dieticians who work in San Luis Obispo County.

Background and Statement of Issues

In this public health assessment (PHA), the California Department of Public Health (CDPH) and the Agency for Toxic Substances and Disease Registry (ATSDR) will determine whether health effects are likely to occur because of past, current, or future exposure to site contaminants, and will recommend actions to reduce or prevent potential exposures. ATSDR, located in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 to conduct PHAs at hazardous waste sites. The conclusions of this PHA for the Klau and Buena Vista Mines are based on a review of available environmental data, various environmental reports, community concerns, information obtained from site visits, and consultations with involved parties and the public. A glossary of terms can be found in Appendix A.

In September 1997, the site was identified as a potential hazardous waste site and entered into the Comprehensive Environmental Response, Compensation, and Liability Act Information System [2]. The U.S. Environmental Protection Agency (EPA) proposed that the Klau and Buena Vista Mines be added to the National Priorities List (NPL) in the September 2004 Federal Register. The site was officially placed on the NPL in April 2007. The NPL is a list of hazardous waste sites eligible for federal funds to carry out extensive long-term cleanup. The NPL is part of the EPA's Superfund Program. EPA investigates NPL sites to determine if they pose risks to public health or the environment and to eliminate those risks, whenever possible.

Site Description

The Klau and Buena Vista Mines are located at 780 Klau Mine Road, approximately 12 miles west of Paso Robles, California (Appendix B, Figure B1). The mines are located at the intersection of Cypress Mountain Road and Klau Mine Road on adjacent properties on a ridge of the Santa Lucia Range in the California coastal mountains. The geographic coordinates of the mines are 35 degrees 37' 33.89" North latitude and 120 degrees 53' 44.05" West longitude [3]. Topography around the site is variable, including some steep slopes with elevation ranging from 1,000 to 1,600 feet above sea level.

The mines encompass approximately 250 acres, including 5 miles of underground workings, approximately 300,000 tons of mine tailings, overburden, and waste rock [4]. Most of the underground workings are plugged or collapsed at the surface and are inaccessible. Liquids flowing from the waste piles and tunnels at the Klau and Buena Vista Mines are best described as Acid Mine Drainage (AMD). AMD is generally acidic and contains elevated metal concentrations.

Site History

Mercury mining and ore processing operations occurred at the Buena Vista Mine and adjacent Klau Mine between approximately 1868 and 1971, when the mines were shut down. Early activities at the mines consisted of underground excavations (tunnels and adits) in search of mercury-containing cinnabar ore. The Buena Vista Mine was an open pit operation from 1957 to 1963 and a combined open pit and underground operation until 1964 [5]. From 1964 until the mine closed in 1971, operations were entirely underground. Buena Vista Mines, Inc. has owned the Buena Vista Mine since at least 1957, and the Klau Mine since at least 1964 [4].

In 1969, a Regional Water Quality Control Board (RWQCB) representative observed orange-colored sludge from the Buena Vista Mine, deposited in the Las Tablas floodplain channel, up to 5 miles downstream of the mine.

During its operation, the Buena Vista Mine reportedly produced 30 tons of mercury-containing ore a day, at 5-30 pounds of mercury per ton. By 1970, the total amount of mercury removed was estimated at 84,300 flasks, or 6.4 million pounds of elemental mercury [2]. Over the approximately 100 years of operation, the Buena Vista Mine produced about $25 million dollars in revenue from mercury [6].

In 1961, Buena Vista Mines, Inc. built a dam just south of the Buena Vista Mine, using waste rock/tailings. The dam and half of the reservoir is located on Bureau of Land Management (BLM) property (hence forth referred to as the BLM Reservoir).

In 1987, Buena Vista Mines, Inc. applied to the RWQCB for a National Pollutant Discharge Elimination System (NPDES) permit for the Klau and Buena Vista Mines. The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. In 1988, RWQCB issued Cease and Desist Order No. 88-93, because discharges from the Klau Mine did not meet conditions of the NPDES permit. In 1990, RWQCB issued Cease and Desist Order No. 90-104 because discharges from the Buena Vista Mine did not meet the conditions of the NPDES permit [2].

Through the 1990s a large amount of environmental data was collected on the Klau and Buena Vista Mines or in the immediate area (Appendix C, Tables 2-5). The majority of this data was for surface water and sediment collected in association with Buena Vista Mines, Inc.'s NPDES permit.

In 1994, researchers from the Coastal Resources Institute (CRI) at California Polytechnic Institute released the Clean Lakes Assistance Program report for Lake Nacimiento. The study was funded by the State Water Resources Control Board. This report included background about sources of contamination to the lake and fish. The California Polytechnic Institute collected 120 fish samples representing 10 species and analyzed their tissue for total mercury. Largemouth Bass, smallmouth bass, white bass, threadfin shad, common carp, channel catfish, green sunfish, blue-gill sunfish, Sacramento suckers, and brown bullhead were all sampled during the 1994 Clean Lakes study. This study concluded that elevated mercury levels exist in fish in the Las Tablas Creek drainage [7]. The Clean Lakes study identifies the Buena Vista Mine and the Klau Mine as the two leading sources of mercury contamination of Lake Nacimiento.

On March 24, 1995, RWQCB staff observed a substantial quantity of AMD being illegally and purposely discharged from the Buena Vista Mine to Las Tablas Creek. RWQCB staff observed liquid being pumped from a holding pond to the regulated NPDES discharge point at greater than

100 gallons per minute. Field pH[1] was measured at about 3.0-3.5 (acidic) at two locations, the NPDES culvert discharge point, and in the conveyance channel just above the confluences with Las Tablas Creek [8].

In June 1999, the RWCQB released a study evaluating the water and sediment entering Lake Nacimiento. The study documented the erosion of sediments containing elevated levels of mercury into the North and South Forks of Las Tablas Creek, providing additional support showing Klau and Buena Vista Mines as the primary source of contamination of the Las Tablas watershed and Lake Nacimiento [9].

In May 1999, RWQCB requested that EPA Region IX's Emergency Response Office assist in preventing the continued release of mercury-laden sediments from the site. In July 1999, the Emergency Response Office determined that conditions at the site presented an imminent and substantial threat, and issued legal orders requiring Buena Vista Mines, Inc. to conduct removal activities [4]. In July 1999, EPA issued a Comprehensive Environmental Response, Compensation, and Liability Act Section 106 Unilateral Administrative Order to the owner of the Klau and Buena Vista Mines.

Between July and November 2000, EPA contractors conducted a variety of activities to reduce risks at the Klau and Buena Vista Mines. EPA constructed two mining waste repositories, removed 120,000 cubic yards of material from the Buena Vista Mine main ore dump to the newly constructed repositories, capped the filled repositories with 2 feet of clay, upgraded a temporary AMD treatment system, capped the Buena Vista Mine western overburden pile, re-graded and filled the collapsed Klau Mine underground workings, and implemented erosion control measures (i.e., hydro seeding) [4].

In October 2001, EPA contractors prepared a Preliminary Assessment/Site Inspection Report for EPA that concluded further assessment was needed under the Comprehensive Environmental Response, Compensation, and Liability Act. In the report, the following observations were made: elevated levels of mercury in processed ores remain on the sites; sampling data from 1991 and 1992 suggest that a release to the Las Tablas arm of the Nacimiento Reservoir may have occurred; a release to Las Tablas Creek and its tributaries can be established; and Bureau of Land Management (BLM) Reservoir, Nacimiento Reservoir, and Las Tablas Creek and its tributaries are all used for fishing [2].

On June 14, 2005, the On-Scene Coordinator for EPA prepared an action memorandum recommending time-critical activities on the Buena Vista Mine to abate imminent and substantial endangerment posed by hazardous substances at the site (most notably mercury) [10]. This action memorandum recommended a variety of actions, including site grading and stabilization, repairing a breach in the treatment pond, cleaning out sedimentation basins, re-vegetation, installing a fence around the mercury processing buildings, and posting warning signs. These activities were completed in the summer of 2005.

[1] pH is a measure of the acidity or basicity of a solution. Pure water is said to be neutral. The pH for pure water is close to 7. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are said to be basic or alkaline.

In June 2005, after staff visited the mines, CDPH wrote a letter to EPA recommending actions be taken to reduce the potential health risk from a number of physical hazards and liquid mercury pooled on the surface soils [11]. As a result, in June 2006, EPA completed an emergency removal of the mercury processing buildings and associated contaminated soils. Over 900 tons of mercury contaminated soil and building debris were removed, and over 100 pounds of elemental mercury were recovered and recycled during the emergency removal action [1].

In 2007, EPA initiated a Remedial Investigation (RI) at the Klau and Buena Vista Mines [12]. The site has been divided into two operable units. Operable Unit 1 is comprised of 320 acres, encompassing the mine property and some adjacent land. Operable Unit 2 encompasses the Las Tablas Creek Watershed, extending from the confluence of the South and North Forks of Las Tablas Creek downstream, ending at the dam between the Harcourt Reservoir and Lake Nacimiento. CH2M Hill, contractor for EPA, collected soil, sediment, surface water, and biological samples. Results of these data prompted EPA to conduct additional removal activities to address ongoing seepage of AMD into the drainage system from the mines [13]. Additional remedial work was also done in the sedimentation basins. These actions were completed in 2008. CDPH wrote a letter of support for the funding of this project.

In 2007, San Luis Obispo County secured funds to pave 3.3 miles of Cypress Mountain Road, in order to eliminate the mobilization of contaminated soils/mine tailings that had been used for construction of the road. The roadside investigation and capping were completed in 2008 [14]. In July 2009, a public comment draft of the public health assessment was released to the public and other stakeholders for review and comment. The comments and CDPH responses are provided in Appendix G.

Extraction/Processing

The Klau and Buena Vista Mines both had mill buildings on-site to process cinnabar ore extracted from the mines. Mill buildings consisted of ore furnaces and condensers, ore sheds, mine shops, ore cart trestles, and assay buildings. While both mines had buildings to process ore materials, the Buena Vista Mine had more buildings and those buildings were generally larger. The only building shown on historical maps of the Klau Mine is a processing plant identified as “Former Mill Site,” originally presented in the 2001 Preliminary Assessment/Site Investigation [2].

While most of the structures have been removed or demolished on the Klau Mine site, there are still several mill buildings located on the Buena Vista Mine (Appendix B, Figure B2). Roasting of cinnabar ore occurred in a rotary kiln, sometimes referred to as the retort, located in the Buena Vista Mine mill building. It was there that cinnabar ore was heated to temperatures up to 1,300 degrees Fahrenheit to vaporize the mercury sulfide. The vapors were then passed through a condenser made up of a system of U-shaped pipes where the gases cooled and condensed as elemental mercury (also called quicksilver) [2]. Processed ore, primarily in the form of mercury-bearing dust and soot from the retort, as well as free elemental mercury, is present beneath the Buena Vista Mine mill building. Abundant beads of free mercury were viewed at several Buena Vista Mine retort locations, prior to EPA’s emergency response activities in June 2006 (discussed above) [8].

Waste Characteristics

Liquids flowing from the waste piles and adits at the Klau and Buena Vista Mines are best described as AMD. AMD generally has a very low pH (2-3/acidic) and elevated metal concentrations. AMD is the result of sulfur in the ore materials being exposed to oxygen in the air and water. When water washes over the exposed sulfur rocks it takes some of the sulfur with it. The sulfur in the runoff lowers the pH of the water. The acidic/low pH of the runoff makes metals in the soil and rock more soluble. As low pH water passes over rock, through cracks and seeps in the rock and through soils, it leaches metals into solution and results in elevated metal concentrations in the runoff. This may be in the form of surface water runoff or as a seep that discharges directly out of the ground through cracks and fissures in the bedrock. AMD has been documented flowing from the subsurface into the Klau Branch of Las Tables Creek at several locations [2,3].

The largest waste source on the mines consists of the 114,053 cubic yards of tailings that were deposited in a pile on the Buena Vista Mine property [2]. Mine tailings at the site generate AMD at varied flow rates depending on the season [4]. Combined AMD flow rates at the Klau and Buena Vista Mines typically range from approximately 5 gallons per minute in the late summer months, up to 20 gallons per minute in the late winter/early spring months [5]

Watershed

The Klau and Buena Vista Mines are located within the Las Tablas Creek watershed. The Las Tablas watershed is part of the larger watershed for the Nacimiento Reservoir (Appendix B, Figure B3). The Nacimiento Reservoir watershed encompasses approximately 82 square miles (52,480 acres). The two leading sediment mercury sources in the Nacimiento Reservoir watershed identified in the Clean Lakes Report include the Buena Vista Mine and the Klau Mine [7]. While the Klau and Buena Vista Mines appear to have caused the most significant impacts on Las Tablas Creek, there are several other mines that are located in the South Fork of Las Tablas Creek Watershed, including the Cypress Mountain Mines, the Kismet Mines, and the Little Bonanza Mines (Appendix B, Figure B3).

Prior to remedial work done by EPA on the Klau and Buena Vista Mines, surface water seeps from the Klau Mine discharged into the Klau Branch of Las Tablas Creek. The Klau Branch flows into the South Fork of Las Tablas Creek for approximately ½ mile, then merges with the North Fork of Las Tablas Creek and becomes Las Tablas Creek proper.

Las Tablas Creek flows for about 5 ½ miles and into the Harcourt Reservoir. The Harcourt Reservoir was constructed to provide irrigation water for some adjacent lands [6]. Harcourt Reservoir spills back into Las Tablas Creek and flows into the Las Tablas Creek arm of the Nacimiento Reservoir. Surface water runoff from the mines drains into the Las Tablas Creek watershed, which drains into the Nacimiento Reservoir, located approximately 8.5 miles downstream of the mines.

The Buena Vista Mine point source watershed is an enclosed bedrock valley surrounded by bedrock ridges. The main drainage for the Buena Mine drains to Dodd’s Ditch through a single point at a culvert under Klau Mine Road (just east of the intersection of Klau Mine Road and Cypress Mountain Road) (Appendix B, Figure B2) [6]. Buena Vista Mine's runoff flows through about 900 feet of this drainage ditch between Buena Vista Mines, Inc. point source (at the culvert) and the North Fork of Las Tablas Creek [6]. Dodd's Ditch, the North Fork, South Fork, and Klau Branch of Las Tablas Creek, and Las Tablas Creek proper are intermittent (i.e., dry at certain times of the year) [2].

AMD-contaminated water from the mines has caused significant contamination and ecological impacts to the North and South Forks of Las Tablas Creek. Elevated concentrations of aluminum, barium, chromium, cobalt, copper, iron, manganese, mercury, nickel, thallium, vanadium, and zinc have been detected in surface water downstream from the mines.

Generally, mercury and other metals associated with mining activities are not soluble in water. However, these metals can be transported via surface water as they attach to the suspended sediment or particles in the water. When inorganic mercury comes into contact with microbial constituents in sediment, it can be transformed into organic or methylmercury, a more toxic form of mercury. Methylmercury bioaccumulates in biological organisms such as fish, and eventually people, who eat the contaminated fish.

Lake Nacimiento

Lake Nacimiento (also called Nacimiento Reservoir) is located approximately 8.5 miles downstream of the Klau and Buena Vista Mines and was built in the 1950s by Monterey County. There are over 42 mercury mines located within 10 miles of Lake Nacimiento (Appendix B, Figure B3). It was built for flood control and to provide farmers in the Salinas Valley summertime water. The reservoir is 18.6 miles long, has 5,727 surface acres and nearly 163 miles of shoreline [4]. The maximum depth of Lake Nacimiento is approximately 180 feet, with an average depth of 98 feet. Lake Nacimiento contains approximately 350,000 acre-feet of water [7].

RWQCB has identified Lake Nacimiento as a high-priority water source for the region, and the reservoir is a drinking water aquifer recharge source for the Salinas Valley [6]. The water quality of Lake Nacimiento is also very important to the region for recreational and aesthetic reasons. Lake Nacimiento is used as a direct source of drinking water by some lakeshore residents [2]. Lake Nacimiento water has been monitored for mercury since 1993; monitoring results indicate that lake water meets state and federal drinking water standards for mercury [15]. In 2007, construction began on the Nacimiento Water Project, a regional water transmission facility that will deliver water from Lake Nacimiento to communities within San Luis Obispo County [16].

Fish

Fishing is a popular recreational activity on Lake Nacimiento. Fish caught from Lake Nacimiento include largemouth bass, smallmouth bass, spotted bass, white bass, crappie, channel catfish, blue and white catfish, bluegill, redear sunfish, European carp, and threadfin shad. In 1994, researchers from the California Polytechnic Institute collected a total of 120 fish representing 10 species and analyzed their tissue for total tissue mercury [7]. The California

Polytechnic Institute concluded that elevated mercury levels exist in fish in the Las Tablas Creek drainage. The highest mercury concentrations were detected among the top predators such as Bass and the larger (older) fish. Results of the study revealed mercury in fish at levels of health concern, prompting San Luis Obispo County to post a health advisory at Lake Nacimiento and Las Tablas Creek area in July 1994.

In 2006, CDPH staff conducted an exposure investigation of fish in Lake Nacimiento to assess the current levels of mercury in fish [17]. CDPH staff, with the assistance of the California Department of Fish and Game, collected over 150 fish for analyses. Mercury levels were elevated in all species of fish sampled. The results of the exposure investigation will be summarized in this report and are presented in detail in a Health Consultation report that is available online at www.ehib.org/project.jsp?project_key=KLAU01.

Mercury-contaminated fish may also be caught in areas along Las Tablas Creek, in the Harcourt Reservoir, and the BLM Reservoir.

Site Visit

CDPH staff first visited the Klau and Buena Vista Mines and the immediate area on May 10, 2005. Staff was accompanied by EPA staff during the site visit to provide access and a verbal history of activities at the Klau and Buena Vista Mines. Personnel from the California Environmental Protection Agency (Cal/EPA), Department of Toxic Substance Control (DTSC), and the Central Coast office of RWQCB were also on the tour of the mines. During the tour, CDPH staff observed a number of areas where mine tailing wastes were leaching noticeable AMD and some areas where slopes of the mine tailings were either eroding or in bad condition. CDPH staff observed a Health Warning posted by San Luis Obispo County (Appendix D) at the junction of Klau Mine Road and Cypress Mountain Road, at the point where the runoff from the Buena Vista Mine discharges into the Buena Vista Mine Conveyance Channel. This warning is in the same location as the NPDES discharge sampling compliance point.

CDPH staff observed several remnant structures on the Buena Vista Mine property (Appendix B, Figure B2). These structures were generally in very bad condition and, in some cases, pose physical hazards. In 2005, the most significant structures remaining on the Buena Vista Mine were the former retort building and the flask shed. A large portion of the kiln distillation gallery still remains in the retort building. CDPH staff observed three areas near the retort building that had liquid (elemental) mercury visible on surface soils. The total volume observed was no more than a few ounces. However, CDPH staff did not thoroughly investigate the area due to health concerns and inadequate personal protective equipment for such an effort. As a result of these initial observations, CDPH staff wrote a letter to EPA recommending that actions be taken to reduce the potential health risks posed by a number of physical hazards and liquid mercury pooled on the surface soils [11]. As described earlier, in June 2006, EPA conducted emergency response activities, including removal of buildings and soil, to mitigate the hazards identified by CDPH.

While in the area, CDPH staff visited Lake Nacimiento to assess how much access the public might have to the reservoir for fishing and to look for mercury fish advisory postings. In 2001, signs warning of mercury contamination in fish were observed along the North Fork of Las Tablas Creek, and along Las Tablas Creek proper [4]. However, during the CDPH staff visit to the Lake Nacimiento Resort on the eastern boundary of the reservoir, there was no posting of mercury fish advisories, nor any literature about the health risk from mercury in fish. Since this area is the most readily accessible for the public, it would seem to be an obvious place for advisories to be posted.

In 2007, at the request of CDPH, San Luis Obispo County posted updated fish consumption guidelines along Lake Nacimiento. The fish consumption guidelines are based on results from the CDPH exposure investigation of fish caught from Lake Nacimiento, conducted in 2006 (discussed in the Fish section above).

Fish consumption postings should be checked occasionally and replaced or re-posted if the signs are damaged or have been removed, until fish tissue data indicate that mercury levels in fish have decreased to safe levels.

Demographics

According to the 2000 Census, there are 6,803 people residing in Census Tract 100 of San Luis Obispo County [18]. Census Tract 100 covers a large area of San Luis Obispo County (Appendix B, Figure B4). The boundaries include all of Nacimiento Reservoir and areas to the north all the way to the border with Monterey County, and to the east abutting the western edge of San Miguel and Paso Robles. Of the 6,803 people in Census Tract 100 of San Luis Obispo County, 90.4% identified themselves as white, 3.3% as American Indian and Alaska Native, 1.3 % Asian, 1.1% Black or African American, and 8.6 % were “some other race.” In addition, 13.3% of people in Census Tract 100 are Hispanic or Latino, of any race.

Approximately 89% of the people in census tract 100 speak only English, with 11% speaking other languages. Approximately 9% of people in census tract 100 are Spanish speakers. The remaining 2% speak Indo-European or Asian and Pacific Island languages. Only about 1% of the population within Census Tract 100 indicated that they do not speak English at all. Approximately 67% of the 3,922 housing units in Census Tract 100 are occupied [18].

Land Use

The Klau and Buena Vista Mines occupy approximately 250 acres in a predominantly agricultural area [2]. The area surrounding the site is mostly undeveloped open space, which appears to be used largely for grazing purposes. There are a number of small ranches and a few vineyards in the area.

There are a number of former mercury mines in the vicinity of the site; several are located within the Las Tablas Creek Watershed, including the Cypress Mountain Mines, the Kismet Mines, and the Little Bonanza Mines (Appendix B, Figure B3).

Camp Natoma, a seasonal campground, is located approximately 2 miles northwest of Klau and Buena Vista Mines.

Environmental Contamination/Pathway Analysis/Toxicological Evaluation

In this section, CDPH examines the pathways for exposure to contamination from the Klau and Buena Vista Mines. CDPH examines each of the media (soil, groundwater, surface water, air, and fish) to determine whether or not contamination is present and if people in the community are exposed to (or in contact with) the contamination. If people are exposed to contamination in any of the media, we evaluate whether there is enough exposure to pose a public health hazard. This analysis systematically evaluates each of the media. Table C1 in Appendix C presents a summary of the exposure pathways identified at this site.

Exposure pathways are means by which people in areas surrounding the sites could have been or could currently be exposed to contaminants from the site. For target populations to be exposed to environmental contamination there must be a mechanism by which the contamination comes into direct contact with them. This is called an exposure pathway. Exposure pathways are classified as either completed, potential, or eliminated.

In order for an exposure pathway to be considered completed, the following five elements must be present: a source of contamination, an environmental medium and transport mechanism, a point of exposure, a route of exposure, and a receptor population. For a population to be exposed to an environmental contaminant, a completed exposure pathway (all five elements) must be present. The following is an example of a completed exposure pathway: a contaminant from a hazardous waste site (source) is released to the air (medium-transport mechanism); the wind blows the contaminant through air into the community (point of exposure), where community members breathe the air (route of exposure and receptor population) (Appendix C, Table C1).

Potential exposure pathways are either 1) not currently complete but could become complete in the future, or 2) indeterminate due to a lack of information. Pathways are eliminated from further assessment if one or more elements are missing and are never likely to exist.

Description of Toxicological Evaluation

In a toxicological evaluation, CDPH evaluates the exposures that have occurred to site-related contaminants, based on the most current studies we can find in the scientific literature. There is not enough available information to completely evaluate exposure to multiple chemicals, or possible cancer and noncancer (other than cancer) adverse effects from exposure to very low levels of contaminants over long periods of time. Some introductory information follows to help clarify how we evaluate the possible health effects that may occur from exposure to the contaminants identified for follow-up.

When individuals are exposed to a hazardous substance, several factors determine whether harmful effects will occur and the type and severity of those health effects. These factors include the dose (how much), the duration (how long), the route by which they are exposed (breathing, eating, drinking, or skin contact), the other contaminants to which they may be exposed, and their individual characteristics such as age, sex, nutrition, family traits, lifestyle, and state of health. The scientific discipline that evaluates these factors and the potential for a chemical exposure to adversely impact health is called toxicology.

Environmental and Health Screening Criteria

The following section briefly discusses the method CDPH uses to identify contaminants of concern (COC) for further evaluation, and to determine whether levels of contaminants in various environmental media pose a health hazard from adverse noncancer or cancer health effects.

As a preliminary step in assessing the potential health risks associated with contaminants at the Klau and Buena Vista Mines, CDPH compared contaminant concentrations to health-based media-specific comparison values. Those concentrations that exceed the comparison values are identified as COC for further evaluation of potential health effects. ATSDR, EPA, and Cal/EPA's comparison values are media-specific concentrations that are estimates of a daily human exposure to a contaminant that is unlikely to cause cancer or noncancer (other than cancer) adverse health effects. The following comparison values were applied in the current evaluation:

- Cancer Risk Evaluation Guide (CREG). CREGs are media-specific comparison values used to identify concentrations of cancer-causing substances that are unlikely to result in a significant increase of cancer rates in a population exposed over an entire lifetime. CREGs are derived from EPA's cancer slope factors, which indicate the relative potency of cancer-causing chemicals. Not all chemicals are considered carcinogenic and not all carcinogenic compounds have a CREG.

- Environmental Media Evaluation Guide (EMEG). EMEGs are estimates of chemical concentrations in air, soil, and water that are not likely to cause an appreciable risk of harmful, noncancer health effects for fixed durations of exposure. EMEGs might reflect several different types of exposure: acute (1-14 days), intermediate (15-364 days), and chronic (365 or more days). EMEGs are based on ATSDR's Minimal Risk Levels (MRLs) (see Glossary in Appendix A for a more complete description of EMEGs) [19].

- Reference Dose Media Evaluation Guides (RMEGs). RMEGs are estimates of chemical concentrations in soil and water that are not likely to cause an appreciable risk of harmful, noncancer health effects for chronic exposure. RMEGs are based on EPA's References Doses (RfDs) (see Glossary in Appendix A for a more complete description of EMEGs) [20].

- Reference Exposure Levels (RELs) and Reference Concentrations (RfCs). Cal/EPA's Office of Environmental Health Hazard Assessment's RELs and EPA's RfCs are estimates of chemical concentrations in air that are not likely to cause an appreciable risk of harmful, noncancer health effects for fixed durations of exposure [21].

- Preliminary Remediation Goals (PRGs). EPA's Region IX PRGs are risk-based concentrations used in initial screening-level evaluations of environmental measurements [22].

If a contaminant is found at levels greater than its comparison value, CDPH designates the contaminant as a COC, and exposure doses are calculated. These values (exposure dose estimates) are then used to examine the potential human exposures in greater detail. CDPH uses the following health-based comparison values (or health guidelines) to identify those contaminants that have the possibility of causing noncancer adverse health effects (cancer health effects evaluation is discussed later).

- Minimal Risk Level (MRL). MRLs are estimates of daily human exposure to a substance that is likely to be without an appreciable risk of adverse, noncancer health effects over a specified duration of exposure. MRLs are based on the no-observed-adverse-effect level (NOAEL) or the lowest-observed-adverse-effect level (LOAEL) (see Glossary in Appendix A for a description of NOAEL and LOAEL) [19].

- Reference Dose (RfD). RfDs are estimates of daily human exposure to a substance that is likely to be without an appreciable risk of adverse, noncancer health effects over a specified duration of exposure. RFDs are based on the NOAEL or the LOAEL [20].

The toxicity studies used to determine the various health comparison values are usually conducted on adult animals or adult humans, typically worker populations. To be protective of sensitive populations such as children, an uncertainty factor is included in the derivation of health comparison values.

COCs that exceed health comparison values are evaluated on an individual basis, relative to the concentrations shown to cause health effects. In situations when multiple COCs are present and none of the contaminants individually exceed their respective health comparison values, it is possible that exposure to multiple contaminants (chemical mixtures) may still pose a noncancer health risk. Chemicals can interact in the body resulting in effects that might be additive, greater than additive, or less than additive. If additive, the dose of each chemical would have an equal weight in its ability to cause harmful effects. In that case, the combined dose for the two chemicals is an indication of the degree to which possible harmful effects could occur in people. When the chemicals act in a greater than additive manner, one chemical is enhancing the effect of the other chemical; this is known as synergism. In that case, the combined dose for the two chemicals underestimates the potential toxicity of the mixture of two chemicals. Some chemical mixtures act in a less than additive manner, which is known as an antagonistic effect. In this scenario, the combined dose overestimates the potential toxicity of the mixture of two chemicals.

Currently, the accepted methodology for evaluating noncancer exposure to chemical mixtures is by looking at additive effects. CDPH quantitatively evaluated the additive effect of exposure to site-related contaminants by estimating the hazard index for those contaminants. The hazard index is a sum of the hazard quotients for each of the chemicals. The hazard quotient is a ratio of the exposure (dose) to the health comparison value. If the hazard index is above 1, then exposure may pose a noncancer health risk and the mixture is evaluated further. The next step in the evaluation is a comparison of the estimated dose of each chemical to its NOAEL (when available). In situations when a NOAEL is not available, a tenfold uncertainty factor was applied to the LOAEL as a proxy for a NOAEL. If the estimated dose of one of the individual chemicals/contaminants is less than 10% of its respective NOAEL (0.1 x NOAEL), then additive or interactive (synergistic or antagonistic) effects are unlikely, and no further evaluation is needed [23].

Cancer health effects are evaluated in terms of a possible increased cancer risk. Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men will be diagnosed with cancer in their lifetime (about 43% combined) [24]. This is referred to as the background cancer risk. We say "excess cancer risk" to represent the risk above and beyond the background cancer risk. If we say that there is a "one-in-a-million" excess cancer risk from a given exposure to a contaminant, we mean that if one million people are chronically exposed to a carcinogen at a certain level over a lifetime, then one cancer above the background risk may appear in those million persons from that particular exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000.

Cancer risk numbers are a quantitative or numerical way to describe a biological process (development of cancer). This approach uses a mathematical formula to predict an estimated number of additional cancers that could occur due to the exposure modeled. The model is based on the assumption that there are no absolutely safe toxicity values for chemicals that can cause cancer. The model assumes that no matter how low, even for extremely low exposures, there is always the possibility that a carcinogen could cause a cancer. The models typically use information from higher exposure scenarios and then extend an estimate of risk into lower exposure scenarios using the assumption that lower levels would still be carcinogenic. The calculations take into account the level of exposure, frequency of exposure, length of exposure to a particular carcinogen, and an estimate of the carcinogen's potency.

EPA and Cal/EPA's Office of Environmental Health Hazard Assessment have developed cancer slope factors and unit risk values for many carcinogens. A slope factor/unit risk is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer. Unit risk values or cancer slope factors are created from studies of persons (workers exposed to chemicals occupationally) or experiments in animals to see how much illness developed as a result of exposure. In order to take into account the uncertainties in the science (such as making predictions of health outcomes at lower levels when we only have information about high exposures), the risk numbers used are plausible upper limits of the actual risk, based on conservative assumptions. In other words, the theoretical cancer risk estimates are designed to express the highest risk that is plausible for the particular exposure situation, rather than aiming to estimate the "most likely" risk. Given that there is uncertainty to these predictions, it is considered preferable to overestimate, rather than underestimate risk. If adequate information about the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen is available, an estimate of the theoretical increased cancer risk associated with the exposure can be calculated using the cancer slope factor or unit risk for that carcinogen. Specifically, to obtain lifetime risk estimates from inhalation exposure, the contaminant concentration is multiplied by the unit risk for that carcinogen. To obtain lifetime risk estimates for other pathways, a chronic exposure dose is estimated, which is then multiplied by the slope factor for that carcinogen.

Cancer risk estimates are a tool to help determine if further action is needed and they should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur.

Discussion of Environmental Contamination, Exposure Pathways, and Toxicological Evaluation

CDPH evaluated the potential and completed exposure pathways related to the Klau and Buena Vista Mines (Appendix C, Table C1). Data in this section are presented in tables located in Appendix C. Sample locations of the data collected can be seen in the figures in Appendix B. In the following pages, CDPH presents an evaluation of these pathways. A brief summary of the toxicological characteristics of the COCs identified by CDPH is presented in Appendix F. The toxicological evaluation of the completed pathways involves the use of exposure assumptions. CDPH uses conservative assumptions to ensure that any potential health hazards from the chemicals are recognized.

Evaluation of Exposure to On-Site Soil Since the Klau and Buena Vista Mines Have Been Closed (Past, Current, and Future)

Since the Klau and Buena Vista Mines are located in a sparsely populated area, the chances for exposure to the general population are limited. CDPH spoke with the caretaker of the mines, who resides on the property, and asked whether people trespass on the mine property. We were informed that people occasionally trespass on the mine property, usually on their way to fish at the BLM Reservoir. When people (trespassers) are seen on the mine property they are photographed and asked to leave (D. Brooks, Klau/Buena Vista Mines caretaker, personal communication, June 26, 2008). It was also noted that most trespassers do not return.

It is possible that some exposure to contaminated soils may have occurred or could occur at both the Klau Mine and Buena Vista Mine since they have been closed. The caretaker of the property and people who trespass on the mines could come into contact with contaminated soil, by getting it on their skin, by inadvertently ingesting it, or by breathing dust.

CDPH used soil data collected by EPA between 2007 and 2008 for evaluating potential exposure (Appendix B, Figures B5 and B6; Appendix C, Table C2) [25]. With the exception of one sample that was collected from an adjacent property[2], soil samples were collected from the mine sites/property. In general, these data are consistent with previous investigations. Further, these data are more reflective of current conditions at the processing areas of the mines, due to disturbances that have occurred as a result of remedial and emergency response activities conducted by EPA. The main COCs in surface soil at the mines when looking at maximum concentrations include: antimony, arsenic, chromium, iron, lead, mercury, nickel, thallium, and vanadium (Appendix C, Table C2). The maximum concentrations of COCs are found at different locations, making it unlikely for someone to be exposed chronically to the maximum concentration of COCs in soil. Thus, average concentrations were used in evaluating exposures.

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2 In April 2008, one surface soil sample was collected from the Dodd property. All metals detected are consistent with background levels, and below levels of health concern.

The average concentrations of arsenic, mercury, and thallium detected in surface soil from either mine exceed media-specific comparison values and will be evaluated further. It is important to note that these metals (as well as iron) are naturally occurring in the environment, which contributes to the overall concentration and potential exposure (Appendix C, Table C2). As a point of reference, background concentrations of arsenic in soil exceed media-specific comparison values (Appendix C, Table C2). Iron also exceeds a soil media-specific comparison value (PRG). However, iron is considered more of a concern based on its corrosive potential on pipes and its aesthetics in relation to water quality (undesirable taste, odor, and staining), rather than human health toxicity [26]. Iron is an essential mineral for human health; ingesting iron from water has not been directly associated with adverse health effects [26]. For these reasons, iron will not be evaluated further.

CDPH used the average concentrations of COCs detected in surface soil at the Klau and Buena Vista Mines to estimate exposure doses for the resident/caretaker and teenage trespassers who may have spent/spend time in these areas, to assess the potential health effects from exposure. (Appendix C, Table C3). CDPH assumed a teenager trespasses on the mine sites 30 days/year, for 4 years, spending an hour at the mines on each visit. Dose estimates for a teenage trespasser (15-18 years old) provide a conservative estimate for exposures to an adult trespasser. We did not estimate potential exposure to children for two reasons: 1) given the remote location of the mines, we would not expect children to be trespassing at the mines; and 2) the caretaker of the Klau/Buena Vista Mines has not seen any children trespassing or playing in the area in 17 years of living at the site (D. Brooks, Klau/Buena Vista Mines caretaker, personal communication, June 26, 2008). For the resident/caretaker, exposure was assumed to occur 350 days/year, 24 hours/day, for 30 years.

Resident/Caretaker

CDPH estimated an exposure dose for the resident/caretaker who routinely comes into contact with soil at the mines. Dose estimates for arsenic do not exceed health comparison values. Dose estimates for ingestion, inhalation and dermal exposure to mercury and thallium meet or exceed health comparison values, suggesting the possibility of noncancer health effects (Appendix C, Table C3). However, the estimated doses are more than a 1000 times lower than the LOAEL of 0.226 mg mercury/kg/day shown to cause autoimmune effects (increased antibody response) in rats and the NOAEL of 0.23 mg thallium/kg/day shown to cause moderate dose-related changes in blood chemistry parameters: increased SGOT (liver marker), LDH (marker for cell injury), and sodium levels. Since dose estimates are below the NOAEL and the LOAEL, it is possible, but not probable, that the resident/caretaker would have experienced or be experiencing health effects from ingestion (primary contributor to exposure), inhalation, and dermal exposure to mercury and thallium in soil.

CDPH also evaluated the additive effects of being exposed to more than just one chemical (mixtures) in the soil, by estimating the hazard index (see Environmental Health Screening Criteria section). The hazard index for the resident/caretaker from exposure to all contaminants (metals) detected in soil is estimated at 5.4, indicating the possibility for noncancer health effects and the need for further evaluation (Appendix C, Table C3).

Per ATSDR's guidance, the next step in evaluating mixtures when the hazard index exceeds "1" is a comparison of the estimated dose of each chemical to its NOAEL (when available) [23]. None of the estimated doses for COCs exceed 10% of their respective NOAELs (Appendix C, Table C3). Thus, additive or interactive (synergistic or antagonistic) effects are unlikely to have occurred or be occurring from exposure to the average concentration of COCs in soil.

Trespasser

The estimated exposure doses for a trespasser do not exceed health comparison values and the hazard index is below 1 (Appendix C, Table C3). Therefore, noncancer health effects would not be expected to occur from exposure to contaminants (metals) in soil for a teenage trespasser who periodically spends time at the mines.

In conclusion, the average concentrations of metals detected in soils on the Klau and Buena Vista Mines would not be expected to pose a health concern to the caretaker or a person who trespasses on the mine property. Potential exposures in the future depend largely on restricting access to the mines and the level of clean-up that will be conducted. For the caretaker, the use of proper personal protective equipment (e.g., gloves, particulate respirator, etc.) while engaging in activities at the mines is prudent, especially in areas where the highest level of contamination has been shown. Training in proper identification and use of personal protective equipment should also be considered. In addition, good housekeeping techniques (e.g., wet mopping, HEPA vacuum, etc.), to keep dust abated indoors as much as possible, is also advised.

Breathing Dust Particles from Roads Constructed with Mine Tailings (Past, Current, and Future)

Roads near the Klau and Buena Vista Mines were constructed or graded using waste rock or mine tailings from the mines (Jill Falcone, San Luis Obispo County Department of Public Works, personal communication, May 10, 2005). While using waste rock or excavation materials from mines for nearby road development is fairly common practice, it is unclear how much of the roadways around the mines were constructed with waste rock. Some of the roads that may have been built with mine waste rock have already been paved, reducing the impact from dust and runoff. As of March 2009, the only public road near the mine that is unpaved is Cypress Mountain Drive, south of the intersection with Klau Mine Road. This road is not a highly traveled road.

Cypress Mountain Drive, north of the intersection with Klau Mine Road to the intersection with Chimney Rock Road, was paved by the County of San Luis Obispo in 2008. Prior to that, there was exposure to the dust generated from the unpaved road, composed in part with mine tailings. CDPH evaluated the past exposure to the dust.

In 1992, limited soil samples were collected from seven locations along Cypress Mountain Drive, near the Klau and Buena Vista Mines (Appendix B, Figure B7; Appendix C, Table C4) [27]. These data were presented in an unpublished master's thesis [27]. Arsenic, iron, mercury, and thallium levels in these soil samples exceed media-specific comparison values.

Between 1995 and 1997, additional samples were collected from the roadway near the mines; these data are generally consistent with the data collected in 1992 [6]. Data are not available for other dirt roads near the mines that could have been built with mine tailings.

In 2007, San Luis Obispo County secured funding from the State Water Resource Control Board to pave a 3.3 mile section of Cypress Mountain Drive, between Klau Mine Road and Chimney Rock Road. Paving of the roadway was completed in 2008. Prior to the road being paved, San Luis Obispo County collected soil samples from 26 locations along Cypress Mountain Drive (Appendix B, Figure B8). Contaminants identified (arsenic, iron, mercury, and thallium) during this sampling effort are consistent with the COCs at the mines [28]. San Luis Obispo County's sampling effort provides the most complete set of data collected on Cypress Mountain Road. It is also worth noting, with the exception of arsenic, that the data collected by San Luis Obispo County reveal higher concentrations (discussed below) of COCs in roadway soils than earlier sampling events.

In 2008, San Luis Obispo County contracted CH2MHill to conduct a risk assessment of potential exposure to contaminants in the soils of the roadways that are now paved [28]. The paving on roadways acts as cap, reducing potential exposure from dust generated while driving. It is not possible to determine how much exposure people actually received in the past from breathing roadway dust, because there were no air measurements taken while dust was being generated (i.e., primarily by motor vehicles). The risk assessment conducted by CH2MHill provides conservative estimates for three exposure scenarios, using the 95% upper confidence limit on the mean for arsenic (14.9 mg/kg), iron (58,396 mg/kg), mercury (387 mg/kg), and thallium (152 mg/kg). For the residential scenario, location-specific values were used (i.e., nearest sampling point to resident). The following provides a summary of the risks presented by CH2MHill and our interpretation of the results.

CH2MHill estimated potential exposure to three populations: 1) a seasonal worker, 2) a recreational user (a 10-year-old child), and 3) a resident. The most conservative or worst-case scenario, showing the highest risk of noncancer health effects was estimated for the "recreational user," a 10-year-old child who rides a bike on Cypress Mountain Road, 78 days per year for 10 years. In all three hypothetical scenarios, exposure was assumed to occur via inhalation, ingestion, and dermal contact of roadway soils.

CDPH did not recalculate the exposure doses. CDPH's interpretation of the worst-case scenario (recreational user/10-year old child) presented in the risk assessment is as follows: the estimated doses for mercury (0.00046 mg/kg/day) and thallium (0.00018 mg/kg/day) exceed their health comparison values, indicating the possibility of adverse health effects. However, the estimated exposure doses are roughly 70 and 1,300 times lower than the LOAEL (ADJ)[3], the level at which no adverse effects were seen in the studies used to develop the health comparison value. Thus, adverse health effects would not be expected to have occurred or be occurring.

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3 The LOAEL-a: adjusted for mercury 0.023 mg/kg/day, is based autoimmune effects in animals. When a NOAEL is not available the LOAEL is adjusted by a factor of 10 as a proxy for a NOAEL. The NOAEL for thallium (0.23 mg/kg/day) is based on an animal study where moderate dose-related changes were seen in blood chemistry parameters: increased SGOT, LDH, and sodium levels.

Given the remote location, it is improbable that a 10-year-old child would have been playing on Cypress Mountain Road for the amount of time (if at all) used to estimate exposure. The main driver of risk is from incidental ingestion of mercury and thallium in soil, not inhalation. For this calculation, the amount of soil ingested or ingestion rate (200 mg/day) is derived for daily exposure (amount of soil ingested over an entire day). The actual amount of soil ingested and resulting risk for a child playing on Cypress Mountain Road would be considerably less. The potential exposure to residents or visitors driving on Cypress Mountain Road (prior to paving), from inhalation of dust, would have been even less.

CH2MHill also estimated the theoretical increased lifetime cancer risk to contaminants considered carcinogenic. The increased lifetime cancer risks from exposure to arsenic ranged from 4 in 10,000 (for the resident) to 1 in 100,000 (for the seasonal worker). These are considered low to very low increased risks. It is important to recognize that arsenic is naturally occurring, and the levels measured in roadway soils are generally consistent with background for the area.

In conclusion, the risk assessment shows the potential for noncancer and cancer health concerns, when very conservative exposure assumptions are assumed. It is not likely that someone would be exposed under these circumstances. Thus, exposure to mine-related contaminants in roadway soils on Cypress Mountain Drive (north of Klau Mine Road) does not pose a health concern in the past, currently, or in the future. However, it is possible that the unpaved portion of Cypress Mountain Drive near the mines was built with waste rock or has been impacted by runoff from the mines or soil being tracked from the mines onto the roadway. Therefore, additional sampling should be conducted on Cypress Mountain Drive, south of the intersection with Klau Mine Road, to determine whether there is a potential health concern from exposure to roadway dust in this area.

Exposure from Breathing Elemental Mercury Vapors (Past, Current, and Future)

Past Exposure (when the mines were operational)

It is likely that workers at the mines and, to a lesser extent, visitors and/or trespassers were exposed to elemental mercury vapor while the mines were operational. Workers who processed mercury and mercury ore in the past were likely exposed to mercury vapors during normal operations. Workers operating the rotary kiln and other portions of the retort process were at greatest risk for exposure. During the operation of the Buena Vista Mine, the mine reportedly produced 30 tons of rock/ore a day, at 5-30 pounds of mercury per ton. By 1970, the total amount of mercury removed was estimated at 84,300 flasks, or 6.4 million pounds of elemental mercury (quicksilver) [3]. While specifics about site operation are not readily available, there were as many as 55 workers at the BVM in 1971, the year the mine closed, and there may have been more even workers in the past when mercury mining was more economically viable.

Elemental mercury can emit mercury vapors that are potentially very toxic, if inhaled. The condenser gallery located in the now decrepit mill building at the Buena Vista Mine was designed to capture mercury vapors and allow them to condense into liquid quicksilver. While much of the elemental mercury should have been trapped in the condenser gallery at the Buena

Vista Mine mill building, some mercury releases to ambient air likely occurred, through spills or other handling practices. During a site visit in 2005, CDPH staff observed visible liquid mercury pooled on the surface soil in two locations at the Buena Vista Mine condenser building. Further, data collected in this area in October 2007 (discussed below) support the assertion that mercury releases occurred through spills or other handling practices, as elevated levels of mercury have been measured in ambient air and soil.

While inhalation of mercury vapors by site workers appears to have occurred in the past, it is not possible to estimate how often workers were exposed and at what levels. Because there was no ambient air data collected during the mill work extraction operations, CDPH can only make a qualitative assessment of the health effects former workers may have experienced from this exposure. The major target organs of elemental mercury-induced toxicity are the kidneys and the central nervous system. At high exposure levels, respiratory, cardiovascular, and gastrointestinal effects can also occur [29]. Renal effects of inhalation of elemental mercury can range from mild alterations in kidney function (e.g., changes in urinary acid excretion) to complete renal failure in severe exposure incidents [29]. The most prominent neurological symptoms from breathing elemental mercury vapors include tremors, irritability or nervousness, insomnia, memory loss, headaches, and performance deficits in tests of cognitive function [29].

On the basis of available data and basic knowledge of operations at the Klau and Buena Vista Mines, CDPH considers this pathway to have been completed in the past and believes that some health effects likely occurred, though to what extent remains unknown.

Current Exposure

In October 2007, limited sampling of ambient air occurred after the closure of the mines and mill. Ambient air was measured on two days at various locations at the mines [25]. Samples were collected in the actual equipment (i.e., rotary furnace, mill condenser, hopper, etc.) or structure, at ground level or within a person's breathing zone (approximately 5 feet above the ground) [25].

Mercury levels in air were highest in the western retort at the Klau Mine, with measurements as high as 50 micrograms per cubic meter (μg/m^3) at ground level. The highest level of mercury (35 μg/m^3) measured in air at the Buena Vista Mine was at ground level, above an "8-inch cut on top of the concrete pad" below the rotary furnace. Mercury concentrations in soil from these areas are very high, measuring up to 10,500 mg/kg in surface soil at the Klau Mine western retort, and 14,300 mg/kg at 1 foot below ground surface from the rotary furnace area at the Buena Vista Mine [25].

Samples collected within the "breathing zone" are of most concern from an exposure perspective. The east and west sides of the rotary furnace at the Buena Vista Mine are the only areas where breathing zone samples exceed health comparison values, suggesting the possibility of noncancer health effects (Appendix C, Table C5). Mercury concentrations (4 μg/m^3) in the breathing zone near the rotary furnace at the Buena Vista Mine are only slightly lower than the LOAEL (9 μg/m^3); the lowest level shown to cause health effects (hand tremors) in workers. Workers from the studies used to derive the LOAEL were exposed on average for 15 years. The findings from these occupational studies are consistent with neurophysiological impairments that might result from accumulation of mercury in the brain [27]. Thus, while we would not expect noncancer health effects to occur or be occurring to the trespasser or caretaker from short-term exposure, mercury-induced health effects cannot be ruled out.

On the basis of limited data, exposure to mercury vapor in ambient air near the equipment areas of the Klau and Buena Vista Mines could be harmful to the health of the caretaker and/or trespasser. Removal of contaminated mine equipment and soils will prevent future exposures to elevated levels of mercury vapor in ambient air. Until remediation is completed in the equipment areas, it is advisable for the resident/caretaker to either avoid these areas or use personal protective equipment. These areas should be fenced and/or posted, warning potential trespassers of the exposure hazard.

Swimming or Wading in Creeks and Streams Near the Mines (Past, Current, and Future)

There are a number of creeks, streams and tributaries that comprise the Las Tablas watershed. While many streams and creeks are intermittent and have limited water flow in summer months, there is a possibility that people could wade in deeper portions of Las Tablas Creek or, during wet periods, in some of the smaller streams in this watershed.

Camp Natoma is a seasonal campground located approximately 2 miles northwest of the Klau and Buena Vista Mines. The camp is run by the Campfire U.S.A. and operates four 1-week sessions throughout the summer. Each year, approximately 300 to 500 children attend the camp. Camp Natoma offers activities such as swimming, hiking, archery, arts and crafts, outdoor living skills, overnight backpacking, and a ropes course. Concerns were expressed that children visiting Camp Natoma could be exposed to mercury contamination near the mine by inadvertently entering contaminated creeks and getting exposed to mercury and other metals via the surface water. Franklin Creek, the closest creek to Camp Natoma, is not connected to Las Tablas Creek, which serves as the main transport for contaminated surface water sediment from the mines.

CDPH spoke with staff from Camp Natoma to ascertain whether the children play or swim in nearby streams or creeks. We were informed that swimming activities at the camp are limited to the swimming pool; the kids have very little contact with creeks and steams (J. Hughes, Director, Camp Natoma, personal communication, November 8, 2005). Therefore, we would not expect that children at Camp Natoma are being exposed to COCs in surface water from the Klau and Buena Vista Mines.

There are several ponds located on the mine sites, the Klau Pond, West Klau Pond, and the Buena Vista upper and lower containment ponds. While it is possible that someone could have swum in these ponds in the past, there are no data showing historic contaminant levels in these ponds. Various remedial activities performed on the mine sites would have altered contaminants levels, making recent data a poor indicator of past contaminant levels in the ponds. For instance, prior to removal actions conducted in 1999, BVMI performed a number of actions to control erosion and runoff from the site, including the Buena Vista upper containment pond, and removal of sediment from the Buena Vista lower containment pond. Remedial work performed by EPA contractors since 1999 has also changed runoff and transport of AMD. Therefore, the focus of our evaluation will be on potential exposure to surface water (creeks, streams) near the mines, for adults and children who may recreate in the area. Data collected from streams and creeks off the mine property are limited. Therefore, surface water data collected from creeks on the Klau and Buena Vista Mines property were used as a conservative estimate for potential exposure to surface water near the mines.

Past Exposure (1994-2007)

The earliest surface water data available were collected in 1994, from discharge points on the mines where elevated levels of site-related contaminants were likely to be found [30] (Appendix C, Table C6). Based on rough drawings and/or limited descriptions, it appears that surface water samples at the Klau and Buena Vista Mines were collected in the vicinity of KBC-180 (Figure B5) and LTC-140 (Figure B6), respectively (Appendix B). It is not known what surface water concentrations were before 1994; they could have been higher or lower at different times. CDPH used the maximum concentration of contaminants measured in 1994 to estimate potential exposure to surface water. Using these data will likely overestimate exposures that might have occurred further down stream, where concentrations would be lower as result of dilution. Aluminum, chromium, copper, manganese, mercury, nickel, thallium, and vanadium exceed media-specific comparison values in surface water and are evaluated further.

CDPH estimated exposure doses to COCs in surface water, assuming that an adult and a child would swim or wade in nearby creeks or streams 30 days per year, for 14 and 9 years, respectively. The estimated exposure doses to individual COCs do not exceed health comparison values for adults or children (Appendix C, Table C6).

The hazard index for children from exposure to all metals detected in surface water exceeds 1, indicating the possibility for noncancer health effects and the need for further evaluation (Appendix C, Table C7). Thallium is the primary contributor to the hazard index (0.9). As a point of reference, the estimated dose (0.00006) for children from exposure to thallium is more than 3,500 times lower than the NOAEL of 0.23 mg/kg/day, the level at which no adverse effects were seen in the study used to develop the health comparison value (RfD).

As discussed previously, if the estimated dose of one or more of the individual contaminants is less than 10% of its NOAEL (0.1 x NOAEL), then additive or interactive (synergistic or antagonistic) effects are unlikely, and no further evaluation is needed [23]. None of the estimated doses for COCs exceed 10% of their respective NOAELs (Appendix C, Table C7).

There were no carcinogenic contaminants measured in surface water during the 1994 sampling event.

In summary, the data used in this evaluation (maximum detected concentrations), combined with the health-protective assumptions, and the remoteness of the sites, indicate that noncancer health effects should not have occurred or be occurring in adults or children who periodically swam or waded in creeks or streams near the Klau and Buena Vista Mines, from past exposure to site-related contaminants. CDPH recognizes the possibility that concentrations of COCs in surface water could have been higher or lower in the past, depending on site activities and proximity to a contamination source.

Current Exposure

Surface water was collected from ponds, creeks, and streams on the mine property in November 2007 (dry season) and April 2008 (wet season) (Appendix C, Tables C8 and C8-A). The two sampling events were conducted to evaluate seasonal variability of metal concentrations in surface water. Metal concentrations measured in surface water were highest during the dry season sampling, which is not unexpected since there is less rainfall and dilution occurring. (Appendix C, Tables C8 and C8-A). Surface water samples were collected at the same locations (collocated) as sediment samples (Appendix B, Figures B5 and B6).

According to the caretaker of the mines, people do not swim or wade in on-site ponds (D. Brooks, Klau and Buena Vista Mines caretaker, personal communication, June 26, 2008). Therefore, CDPH used the maximum concentration of contaminants measured in a creek or stream to evaluate potential exposure. For the most part, the highest concentrations of COCs were measured in surface water from Klau Branch Creek, in proximity to the waste rock pile (Appendix B, Figure B5; Appendix C, Table C8). COC concentrations generally decrease further away from known contaminant sources. Arsenic, manganese, nickel, and thallium exceed media-specific comparison values in surface water and are evaluated further.

CDPH estimated exposure to COCs in surface water, assuming an adult or child swims or wades in nearby creeks or streams 30 days per year, for 15 and 9 years, respectively. The estimated exposure doses to arsenic, manganese, nickel, and thallium do not exceed health comparison values and the hazard index from exposure to all contaminants measured is below 1 (Appendix C, Table C9). Thus, noncancer adverse health effects are not expected to occur or be occurring in adults or children who periodically swim or wade in creeks or streams near the Klau and Buena Vista Mines, from exposure to site-related contaminants.

CDPH also estimated the theoretical increased lifetime cancer risk to contaminants considered carcinogenic. The increased lifetime cancer risks from exposure to arsenic is 2 in 10,000,000 for an adult and 1 in 10,000,000 for a child. These are considered no apparent increased risk.

In conclusion, on the basis of available data, no adverse noncancer or cancer health effects would be expected from past and current exposure to surface water in creeks or streams near the Klau and Buena Vista Mines. While it does not appear that people currently swim in ponds on the mine sites, it would be prudent to post signs around the ponds warning people of the contamination in the ponds.

Exposure to Contaminated Drinking Groundwater (Past, Current, and Future)

Mercury and other site-related metals usually stay on the surface of soil and sediments and do not move readily through soil to groundwater [29]. Thus, significant migration of contamination through the groundwater is not likely. However, these metals can be transported via surface water as they attach to the suspended sediment or particles in the water. There are a number of ways surface water could migrate to the groundwater, including through collapsed areas of the mines, through partially collapsed adits and sinkholes, or through fractured bedrock in the area.

In 1999, five groundwater samples were collected from the mines and analyzed for iron, manganese, mercury, pH, and sulfate (Appendix C, Table C10) [5]. Only one of these samples had a concentration of mercury above the MCL (2 ppb or 0.002 ppm). Mercury was measured at 3.3 ppb in the Mill Well (MW-5). All five wells had high levels of manganese and sulfate.

In 2008, groundwater samples were collected from six locations on the mine sites and analyzed for metals and pH (Appendix C, Table C11). The pH ranged from 2.7 (acidic) to 8.2 (mildly alkaline). Aluminum, antimony, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, thallium, and vanadium exceed media-specific comparison values. The groundwater from these wells and sumps is not used for drinking water and therefore no further evaluation is necessary.

While the groundwater from the aforementioned wells is not used for drinking water, these contaminants could pose some concern for private well users in the area. It is our understanding that EPA will be conducting additional investigations to better characterize the hydrogeology underlying the mines to provide a better understanding of the potential for off-site migration of contaminated groundwater.

Private Wells

Surface waters in the vicinity of the Klau and Buena Vista Mines do not appear to be used for potable water. However, it is possible that private wells near the mines could be impacted by mine contaminants via infiltration of surface water through fractures in the bedrock [2].

The Buena Vista Water Supply Well or “spring box” is located 0.25 miles away and at a higher elevation than the abandoned mine workings and waste piles associated with the mines [2]. In 2007, EPA collected a water sample from this well and analyzed it for metals. None of the site-related metals, including mercury, were detected at or above the reporting limit. However, the reporting limit for thallium (10 µg/L) is higher than the drinking water standard (MCL) of 2 µg/L, used for municipal drinking water systems.

CDPH does not have data for any other private wells in the area. Private wells are not regulated in the State of California, therefore it is generally up to the owners to test and monitor the water quality in their wells. In this situation, CDPH recommends that EPA test the closest private wells, down-gradient of the mine sites. For the remainder of residents and ranchers in the area who receive water from private wells, it is prudent that they have their well water tested, especially since elevated levels of naturally occurring metals have been documented in the area.

Public Water Systems/Private Water Purveyors Around Lake Nacimiento

CDPH staff learned from residents that there are concerns about mercury contamination in drinking water. In California, public waters systems serving at least 15 connections are required to meet municipal drinking water standards, consisting of testing, monitoring, and treatment as required. The county is the oversight agency for public water systems with fewer than 200 connections [31].

CDPH identified a number of public water systems (private water purveyors) in the area that utilize water from Lake Nacimiento or groundwater wells influenced by the lake. Lake Nacimiento water has been monitored for mercury since 1993; monitoring results indicate that lake water meets state and federal drinking water standards for mercury [15]. Additionally, CDPH contacted San Luis Obispo County and inquired about sampling results for mercury in the various water systems. Mercury has not been detected in any of the water systems sampled. Table 1 below lists the water system and whether mercury was detected during the sampling event.

Table 1. Public Water Systems and Summary of Mercury Detections

Water System	Mercury Detected: Yes/No (Year)
Heritage Ranch Community Services District	No (2006)
Babe Ruth’s Oak View	No (2004 and 2005)
Cal-Shasta Boat and Ski Club	No (2003)
Tri-Counties Club	No (1999 and 2002)
South Shores	No (1998)
North Shore Boat Club	No (2002)
Water World Resorts	No (2005)
Laguna Vista Boat Club	No (1997)

On the basis of available data, CDPH concludes that drinking water served by local water purveyors listed above will not harm people’s health; mercury contamination from the mines has not impacted these water system.

Eating Fish from Lake Nacimiento, Harcourt Reservoir, and BLM Reservoir (Past, Current, and Future)

Mercury is a metal commonly found in the environment from both natural and man-made sources. Mercury can be found in three forms: elemental (quicksilver), organic mercury (methyl-mercury), and inorganic mercury (mercury salts). Because methylmercury is taken up by aquatic organisms and can bioaccumulate in aquatic organisms, concentrations of methylmercury tend to be higher in large predatory fish. Consumption of contaminated fish is the major route of human exposure to methylmercury [29]. Children and pregnant women are of greatest concern for mercury exposure.

Mercury from various sources has gotten into Las Tablas Creek and Lake Nacimiento. Several reports have implicated the Buena Vista and Klau Mines as the primary contributing source of mercury contamination in the Las Tablas Creek and Lake Nacimiento [2,5,7]. In 1994, researchers from the CRI at Cal Poly collected 120 fish samples representing 10 species and analyzed their tissue for methylmercury [7]. The 1994 “Clean Lakes” study concluded that elevated mercury levels exist in fish in the Las Tablas Creek drainage, which includes Las Tablas Creek, the Harcourt Reservoir, and the BLM Reservoir [7]. San Luis Obispo County’s Division of Environmental Health posted health advisories in the Nacimiento Reservoir and Las Tablas Creek area in July 1994, based on mercury levels in fish presented in the Cal Poly CRI Clean Lakes Report [7].

Lake Nacimiento

Lake Nacimiento is a large recreational fishing spot, hosting a number of fishing competitions throughout the year. In the summer, the lake is also a popular destination for recreational users. Roughly 25,000 people visit the lake each year [17]. As of 2000, the population in the area around Lake Nacimiento was approximately 3,200 [17].

In 2006, CDPH conducted an exposure investigation of Lake Nacimiento fish, targeting six species (spotted bass, white bass, bluegill, carp, catfish, and black crappie) and collecting over 150 fish samples for methylmercury analysis [17]. Fish were collected from three different areas of the lake. All six species of fish sampled contained elevated levels of methylmercury, posing a health a hazard. Levels of methylmercury ranged from 200 ppb/wet weight to 1,750 ppb/wet weight. Concentrations of methylmercury were highest in spotted and white bass (predators) compared to carp and catfish (bottom feeders). The information from the exposure investigation was combined with data from previous studies to provide the basis for a fish consumption recommendation for Lake Nacimiento. Using these guidelines, San Luis Obispo County posted updated fish consumption guidelines along Lake Nacimiento in 2007. The entire report is available online at www.ehib.org/project.jsp?project_key=KLAU01.

In 2007, as part of the California Surface Water Ambient Monitoring Program (SWAMP) fish samples were collected from Lake Nacimiento and analyzed for methylmercury. The following species were collected: 23 legal-sized smallmouth bass and 5 carp. In addition, a composite sample of 15 carp was analyzed for selenium and organics, none of which were detected at a level of concern [32].

In 2009, Cal/EPA’s Office of Environmental Health Hazard Assessment, the state agency responsible for issuing state fish advisories, used the SWAMP fish data combined with the data presented in the CDPH Exposure Investigation, to issue a state fish advisory for Lake Nacimiento and updated fish consumption guidelines (Appendix E) [32].

The table below shows the average methylmercury concentration for fish included in the updated fish consumption guidelines for Lake Nacimiento, which can be found in Appendix E.

Table 11. Average Methylmercury Concentration in Fish from Lake Nacimiento

Common Name	Number of Fish	Mean Methylmercury Concentration (ppb/wet weight)
Bluegill	46	360
Carp	58	500
Channel catfish	25	540
Crappie	22	450
Sucker	9	350
Black Bass	108	1,010
White Bass	59	1,150

Note: OEHHA grouped related bass species under black bass (i.e., largemouth, smallmouth, and spotted bass)

BLM Reservoir

CDPH has been informed that people fish at the BLM Reservoir, which is located immediately adjacent to the Buena Vista Mine. The dam for the reservoir was built with mine tailings. The number of people who fish at the reservoir is limited by a number of factors: the reservoir is not a publicized fishing spot; it is not visible from the main road; accessing the reservoir requires traveling through other private properties; and the reservoir is gated.

As indicated above, fish were sampled from the BLM Reservoir in 1994. The only fish species caught in the BLM Reservoir during that sampling event were largemouth bass. However, other fish species have been caught from the BLM Reservoir, including bluegill and catfish [2]. Five largemouth bass samples were analyzed for total mercury, with levels ranging from 1,300-4,360 ppb/wet weight [7].

In 2007, the U.S. Geologic Survey collected 42 fish samples from the BLM reservoir, consisting of 26 largemouth bass and 16 bluegill, and had them analyzed for total mercury. Nine of those samples were analyzed for methylmercury. The data indicated elevated levels of methylmercury, ranging from 420-2570 ppb/wet weight, with the highest concentrations measured in largemouth bass [33].

CDPH compared the fish tissue concentrations to OEHHA's Advisory Tissue Levels [34]. Fish containing concentrations of methylmercury in tissue exceeding 440 ppb/wet weight should not be consumed by children (1-17 years old) or women of childbearing age (18-45 years old). Fish containing concentrations of methylmercury exceeding 1,310 ppb/wet weight should not be eaten by women over 45 years old (non childbearing age), or men. Concentrations of methylmercury measured in fish caught from the BLM Reservoir exceed the Advisory Tissue Levels, and should not be eaten.

CDPH concludes that fish caught from the BLM Reservoir pose a health hazard if eaten, due to elevated levels of methylmercury. BLM should reduce or eliminate consumption of fish caught from the reservoir. This could include posting signs warning people about fish contamination in the reservoir.

In December 2008, CDPH provided signage options to BLM regarding the fish contamination in the reservoir. In March 2009, BLM posted signs at the reservoir advising people of the fish contamination.

Harcourt Reservoir

The land around the Harcourt Reservoir is privately owned. CDPH does not have any information on the number of people who may fish at the Harcourt Reservoir. Fish caught in the Harcourt Reservoir include brown bullhead catfish, channel catfish, white catfish, largemouth bass, bluegill sunfish, and green sunfish.

In 1994, six largemouth bass samples were collected from the Harcourt Reservoir and analyzed for total mercury [7]. Levels of total mercury ranged from 550-1,000 ppb/wet weight. Since methylmercury was not analyzed, we cannot make a direct comparison to Advisory Tissue Levels. It is reasonable to assume that methylmercury is a large percentage of the total mercury measured. As such, children (1-17 years old) or women of childbearing age (18-45 years old) should not consume largemouth bass from the Harcourt Reservoir. This conclusion is based on limited data, for one species. Additional sampling and analysis would be needed to determine appropriate fish consumption recommendations.

On the basis of limited data, CDPH concludes that fish caught in the Harcourt Reservoir could be harmful to the health of children (1-17 years old) and women of childbearing age (18-45 years old) if eaten. Owners of the Harcourt Reservoir should reduce or eliminate consumption of fish caught from the reservoir. This could include posting signs warning people about fish contamination in the reservoir.

Exposure to Mercury-Contaminated Dust from Sediment when Lake Nacimiento Water Levels Are Low

CDPH were informed by EPA staff that concerns were raised about the potential for inhalation exposure of mercury-contaminated sediments that could be kicked up into the air by all terrain vehicles (ATV) when the water levels are low. These concerns were expressed at the July 23, 2008, Nacitone Watershed Management Steering and Technical Advisory Committee meeting.

In order to determine whether people are being exposed to airborne mercury in dust from resuspension of sediments, an understanding of the contamination present in sediment is needed. The EPA is using a phased approach for investigating and remediating contamination from the mines, which started with the mine property and, more recently the Las Tablas Creek Watershed. Investigations of the Las Tablas Creek Watershed (Operable Unit 2) will extend roughly 5.5 miles downstream from the mines to and, including the Harcourt Reservoir, which is assumed to have captured significant amounts of mercury from the mines. CDPH will request that EPA collect sediment samples in areas where ATV riding occurs if ongoing investigations of sediment upstream, closer to the mines where concentrations would be higher, indicate contamination at levels of health concern.

Community Health Concerns/Health Concerns Evaluation

Introduction and Purpose

The collection, documentation, and responses to community health concerns are a vital part of the PHA process. The purpose of this section is 1) to characterize the main exposure and health concerns compiled to date by CDPH expressed by the community living near the Klau and Buena Vista Mines; 2) to provide educational information about the exposure and health concerns; and 3) to use the PHA to inform the community about what is happening at the site and the surrounding area.

Background Information

Community concerns about the environmental impact of the mines are documented as early as 1966 [35]. In 1982, early reports about mercury levels in fish at Lake Nacimiento elicited community concerns about the source of the mercury and the impact on human health of eating fish from the lake [36]. However, at that time, mercury content in Lake Nacimiento fish could not be attributed to the Klau and Buena Vista Mines; an analysis of the mines' impact on the watershed had not been conducted. At some time in the 1950s or 1960s, mine tailings were used on county roads [6].

Process for Gathering Community Health Concerns

CDPH first began work on the Klau and Buena Vista Mines site when EPA nominated the site to the NPL in September 2004. Early in the process, CDPH had several discussions with EPA, RWQCB, and San Luis Obispo County about exposure and health concerns relating to the Klau and Buena Vista Mines.

CDPH conducted an outreach effort to residents and community members with a mailing in September 2005. CDPH sent letters to over 200 addresses located within 5 miles of the mines, to provide some basic information about the mines and CDPH's involvement at the site. This letter also provided contact information for CDPH staff and requested feedback from concerned community members, so that CDPH could get a full picture of concerns for the community near the mines.

In addition to contacting community members residing near the mines, CDPH identified anglers who seasonally or habitually fish at Lake Nacimiento, as well as residents in areas surrounding the lake, as target groups for the collection of community health concerns and subsequent community health education efforts. Specifically, subsistence and recreational anglers consuming fish from Lake Nacimiento are at risk for exposure to mercury originating from the mines, and a fish advisory has been in effect since 1994.

CDPH assessed fish consumption habits and advisory awareness among residents living near the Buena Vista and Klau Mines, Las Tablas Creek, and Lake Nacimiento, anglers, and possible subsistence anglers in the city of Paso Robles [17].

CDPH communicated with residents living near the Buena Vista and Klau Mines, along Las Tablas Creek, and along Lake Nacimiento, through mail and/or home visits. These community members tended to be long-term residents of the area and aware of a fish advisory at the lake. Their concerns related to the Klau and Buena Vista Mines deal with exposure pathways other than fish consumption, namely exposure to mercury via dust on roads and in private water wells.

Community Health Concerns and Health Concerns Evaluation

Community concerns about mercury at the Klau and Buena Vista Mines were centered on potential exposure to mercury, either in the past or currently, via surface water and groundwater, the ingestion of fish, and mercury in dust from local roads. Some community members who were concerned about the dust in the roads reported having upper respiratory symptoms when the dust became airborne. However, overall no specific health concerns were reported to CDPH.

Concerns about Exposure to Mercury via Fish Consumption

Concerns related to exposure to mercury through the ingestion of mercury-contaminated fish from Lake Nacimiento are outlined in detail in the 2007 Exposure Investigation Report: Evaluation of Fish Consumption from Lake Nacimiento [17]. In sum, long-term residents who live near the mines and lake tend not to eat fish from Lake Nacimiento; anglers sometimes eat fish, although many reported practicing catch and release; and some community groups in Paso Robles reported eating fish from the lake and being unaware of the existing fish advisory. Some residents wanted to know how fish from Lake Nacimiento compared to fish from other water bodies in the area.

Analysis of mercury in fish revealed high mercury levels in all fish species analyzed from Lake Nacimiento; levels were some of the highest in the state, when compared with data collected through the Toxic Substances Monitoring Program. In 2007, San Luis Obispo County revised the fish advisory for Lake Nacimiento. CDPH conducted a series of outreach efforts, including posting of multilingual fish advisory signage; mailing the fish advisory to bait shops in four counties; mailing the advisory to dock owners and boat clubs; requesting the advisory be posted at Lake Nacimiento Resort; developing and distributing wallet-sized cards with the advisory information; and carrying out media efforts to publicize the fish advisory among the local community.

Concerns about Exposure to Mercury in Mine Tailings Used on Roads

Some community members expressed concerns about exposure to mercury in dust disturbed from unpaved Adelaida-area roads that had been topped off with mercury tailings several decades ago. One resident reported choking and coughing when dust from the road became airborne.

In 2007, San Luis Obispo County began a project to eliminate the mercury sediment load on Cypress Mountain Drive by paving and capping a 3.3-mile stretch of road; the road runs parallel to Las Tablas Creek and was a contributor of mercury to the watershed. As part of that project, roadway soil was collected and evaluated prior to paving. Results from that evaluation do not indicate exposure to contaminants in roadway soils at levels that would result in adverse health effects. However, it is not uncommon for people to have respiratory symptoms like those described above from breathing dust. Dust is made up of various sizes of particulate matter. Particulate matter less than 10 microns in diameter, known as PM10, is considered one of the most harmful of all air pollutants because when these particles are inhaled they can become lodged deeply in the lungs, potentially resulting in a number of respiratory and cardiovascular effects.

Concerns about Past and Current Exposure to Mercury in Surface and Groundwater

One former resident of the area was concerned about past exposure to mercury while swimming in a pond near the mine during the mid- to late-1980s; the former resident also reported eating fish from the pond and using surface water for baths.

It is not possible to estimate exposure from swimming in the pond in the 1980s because there are no data available. CDPH estimated potential exposure to the highest concentration of mercury and other metals in surface water collected in 1994. The estimated exposure would not be expected to have caused adverse health effects.

Some former residents were concerned about mercury levels in their private water wells, and had either already sampled water in their wells or were making plans to have it sampled.

Concerns about Animals and Mercury Exposure

Some community members were concerned that mercury in the Las Tablas Creek watershed could affect the health of animals. One community member was concerned about mercury uptake by cattle that drink water from Las Tablas Creek.

The form of mercury that can leach from the site is most likely an inorganic form (meaning it contains a positive charge), and thus it tends to attach to soil particles or sediment (because soil particles have a negative charge). The cattle drink unfiltered water, which contains some sediment. Inorganic mercury can be absorbed and cause some gastrointestinal problems. Similar to humans, cows kidneys and nervous systems can be affected by mercury [37]. Checking kidney function would be a good first step. Mercury can be measured in the blood, urine, and feces, but that information will not really help in understanding whether toxicity is occurring [37].

Another community member stated concerns about mercury bioaccumulation in bald eagles because these feed on fish from Lake Nacimiento. Some research has identified mercury accumulation in bald eagles feeding on fish with high mercury levels [38]. CDPH will not conduct testing of bald eagles at Lake Nacimiento as part of the PHA.

Child Health Considerations

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposures. This sensitivity is a result of several factors: 1) children may have greater exposures to environmental toxicants than adults because, pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults; 2) children play outdoors close to the ground, increasing their exposure to toxicants in dust, soil, surface water, and ambient air; 3) children have a tendency to put their hands in their mouths while playing, thereby exposing them to potentially contaminated soil particles at higher rates than adults (also, some children ingest non-food items, such as soil, a behavior known as “pica”); 4) children are shorter than adults, meaning that they can breathe dust, soil, and any vapors close to the ground; 5) children grow and develop rapidly; they can sustain permanent damage if toxic exposures occur during critical growth stages; and 6) children and teenagers may disregard “No Trespassing” signs and wander onto restricted locations. Because children depend on adults for risk identification and management decisions, CDPH and ATSDR are committed to evaluating their special interests at hazardous waste sites.

CDPH attempted to identify places (e.g., parks, schools, recreational facilities, etc.) in the vicinity of the Klau and Buena Vista Mines where children live, play, or go to school. The closest location where children could spend time is Camp Natoma, located approximately 2.5 miles downstream of the mines. Children were considered in the pathway evaluations for the site.

Limitations of the Exposure Evaluation

The identification and analysis of environmental exposures is difficult and inexact. This PHA was prepared using different sources of information. There are varying degrees of uncertainty associated with each source of information. The following describes four broad areas where uncertainties may be found, and provides examples of some of these uncertainties.

Environmental Data

In preparing this PHA, CDPH relied on information provided by EPA. CDPH assumes that adequate quality control measures were followed with regard to chain of custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions reported in this PHA depends on the completeness and reliability of the referenced information. As stated previously, there are data gaps in understanding past exposures, which cannot be filled.

Exposure Assessment

Exposure assumptions were used to estimate exposure doses. The exposure assumptions used in this PHA are meant to provide conservative (health protective) results for the exposure estimates. CDPH assumed that 100% of the chemicals present in the soil were taken up by the body when the soil was ingested.

For those pathways involving soil/sediment, CDPH evaluated incidental ingestion, dermal contact and inhalation of soil/sediment that becomes airborne. EPA has published conversion numbers (particulate emission factors - PEFs) that can be used to convert a soil concentration into an air concentration.

Contaminant Toxicity

Toxicity information for the compounds found elevated above background was generated mostly from animal studies at high doses and in some cases, epidemiological studies of adult worker populations. For most contaminants, we really do not know what effects will result from low level exposure to humans. There are also data gaps in the understanding of many compounds, particularly for impacts to the immune system, and reproduction and development.

To account for some of this uncertainty in contaminant toxicity information, CDPH used health comparison values developed by ATSDR, EPA, and OEHHA. These agencies have incorporated uncertainty (or safety) factors in developing the health comparison values.

Interaction of Chemicals

As discussed previously, the approach of evaluating the individual components of the mixture and adding the hazard is taken by public health officials because there is generally a lack of health information available in the scientific literature about the various mixtures found at hazardous waste sites.

CDPH believes that the limitations described above do not compromise the conclusions of this PHA. The recommendations presented in this document are aimed at addressing some of these limitations.

Health Outcome Data

ATSDR and CDPH aim to understand the potential health impacts on communities near sites containing hazardous chemicals. This involves understanding which health problems might be caused by certain chemicals (as presented in the Discussion of Environmental Contamination and Exposure Pathways section), understanding whether people had contact with contaminants, and understanding what health problems people in the community are experiencing. CDPH also tries to obtain information about the health status of a community from other sources. Additional review of health outcome data may be conducted if site information indicates there is a completed exposure pathway of health concern.

However, evaluating whether past releases from hazardous waste sites affect the health of people living near waste sites poses significant challenges. Ideally, to review the health of community members who may have been affected by Klau and Buena Vista Mines contaminants, it would be helpful to have thorough records about the symptoms and diseases of people who lived near the mines. Information about the diseases and symptoms they had could then be compared to persons who did not live in the area during that time. However, this type of community health “surveillance” system is not available in the United States, since some people go to private physicians, some to health maintenance organizations, some to county health services, and so forth. In California, there is a surveillance system for cancer cases. Surveillance for birth defects was initiated for a time in the past, but is now very limited. The only other significant source of health outcome data that are available for the state are birth rates, weight at birth, and mortality rates. These data are not very useful in making determinations about the potential impacts that hazardous waste sites in general, and the Klau and Buena Vista Mines more specifically, would pose to people who live near them. This is largely because the population of people living near the Klau and Buena Vista Mines is too small to measure an increase in disease rates. Thus, a health outcome analysis was not performed.

Conclusions

Using environmental data collected at the Klau and Buena Vista Mines, CDPH evaluated the pathways of exposure (past, current, and future) to contaminants from the mines. The conclusions of this evaluation are presented below.

CDPH concludes that the following exposure pathways and activities would not be expected to harm people's health:

- Past, current, and future exposure to the caretaker or teenage trespassers from ingestion, skin contact, and inhalation of on-site soils containing elevated levels of metals.
- Past, current, and future exposure to adults and children from ingestion and skin contact with site-related contaminants in surface water, streams or creeks near the mines.
- Past, current, and future exposure to adults and children from ingestion and skin contact with site-related contaminants in drinking water served by local water purveyors, including those that draw water from Lake Nacimiento.
- Past, current, and future exposure to adults and children from ingestion and inhalation of site-related contaminants in roadway dust on Cypress Mountain Road, north of Klau Mine Road.

Due to a lack of available data, we not able to determine whether the following exposure pathways could have harmed people's health:

- Past exposure to workers from inhalation of mercury vapor in ambient air while the mines were operational.
- Past, current, and future exposure from ingestion and skin contact with water from private wells that may contain site-related contaminants

CDPH concludes that the following exposure pathways/activities could have harmed people's health:

- Past, current and future ingestion of fish caught from Lake Nacimiento, Bureau of Land Management Reservoir, and the Harcourt Reservoir.
- Current exposure from inhalation of mercury vapor in ambient air near former process and/or equipment areas on the mines.

CDPH conducted a number of outreach activities to collect and understand the health concerns that community members believe are related to contamination at the Klau and Buena Vista Mines. The majority of concerns expressed were related to mercury exposure in surface water, groundwater, or from eating fish. Some community members were concerned about exposure to site-related contaminants in dust generated while driving on roads that were built using mine tailings. CDPH provides a response to these concerns, based on a review of the environmental data.

In conclusion, while the majority of the pathways evaluated do not pose a health hazard, there are highly contaminated areas remaining on the site. As such, interventions to prevent exposures to mine contaminants and remedial actions should continue to be undertaken to reduce or eliminate the potential for exposure.

Recommendations for Further Actions

1. CDPH and ATSDR recommend that EPA continue to take steps to eliminate or reduce exposure to contamination at the mines.
2. CDPH and ATSDR recommend that public access to the Klau and Buena Vista Mines be restricted where feasible, and that signs be posted warning people of the hazards present at the mine sites.
3. CDPH and ATSDR recommend the use of personal protective equipment by the resident or caretaker of the Klau and Buena Vista Mines, when engaging in activities on the mines.
4. CDPH and ATSDR recommend that enhanced house cleaning techniques (wet mopping, HEPA vacuum, etc.) be utilized by the resident or caretaker to minimize indoor dust exposures.
5. CDPH and ATSDR recommend that the EPA conduct sampling of roadway soils on the unpaved portion of Cypress Mountain Drive, south of the intersection with Klau Mine Road.
6. CDPH and ATSDR recommend that the EPA conduct a well survey and sampling in the vicinity of the mines to ensure that private wells are not impacted by contamination from the mines.
7. CDPH and ATSDR recommend that EPA collect samples of exposed sediment from Lake Nacimiento in areas where ATV riding occurs if upstream sediment data collected as part of the Remedial Investigation for the Las Tablas Creek Watershed (Operable Unit 2) indicate contamination at levels of health concern.
8. CDPH and ATSDR recommend that the owners of the Harcourt Reservoir reduce or eliminate consumption of fish caught from the reservoir and post signs advising people about fish contamination in the reservoir.

Public Health Action Plan

The Public Health Action Plan for this site contains a description of actions under consideration by ATSDR and CDPH at and near the site. Its purpose is to ensure that this PHA 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. CDPH and ATSDR will follow up on this plan to ensure that actions are carried out. EPA is collecting additional data to develop an appropriate remedial option at the site.

Actions Completed

1. CDPH wrote a letter to the resident/caretaker of the Klau and Buena Vista Mines discussing exposure reduction recommendations (June 2009).

2. CDPH wrote a letter to the owners of the Harcourt Reservoir recommending that signs regarding fish contamination be posted at the reservoir (June 2009).

3. CDPH provided BLM with language and signage options that could be posted around the BLM Reservoir advising people about fish contamination in the reservoir (December 2008). In March 2009, BLM posted signage at the reservoir warning people of the fish contamination.

4. CDPH released a health consultation evaluating fish consumption at Lake Nacimiento (February 2007). The document can be viewed online at http://www.ehib.org/project.jsp?project_key=KLAU01&mode=Internet.

5. CDPH produced a Public Service Announcement about the fish consumption guidelines for Lake Nacimiento. The announcement is aired on local radio stations in English and Spanish (February 2007). The fish consumption guidelines can be viewed online at http://www.ehib.org/topic.jsp?topic_key=173.

6. CDPH conducted an exposure investigation at Lake Nacimiento, collecting and analyzing over 150 fish samples (March 2006).

7. CDPH released a health consultation concerning mercury exposure and physical hazards at the mines (September 2005). The document can be viewed online at http://www.ehib.org/project.jsp?project_key=KLAU01&mode=Internet.

Actions Planned

1. CDPH will meet with any interested community members to discuss the content of the PHA and its implications for public health.

2. To the extent resources permit, CDPH will review appropriate environmental data when they become available to assess the potential health risks to residents living adjacent to the Klau and Buena Vista Mines.

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References

1. U.S. Environmental Protection Agency. Fact sheet: EPA completes emergency removal. Klau/Buena Vista Mine Superfund Site. 2007 May. Available online at http://yosemite.epa.gov/R9/SFUND/R9SFDOCW.NSF/3dc283e6c5d6056f88257426007417a2/82e4bc39967e4292882572d8002bfa1f/$FILE/Klau5_07%20107kb.pdf.
2. Ecology and Environment Inc. Buena Vista/Klau Mercury Mines preliminary assessment/site inspection report; 2001 Oct. Available to the public at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
3. Ecology and Environment Inc. Final report for Buena Vista/Klau Mercury Mines, Paso Robles; 2001 Jan. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
4. TetraTech, Inc. Site briefing summary for Buena Vista/Klau Mercury Mines; 2001 Jan. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
5. Secor. Expanded site assessment for Buena Vista Mine; 1999 Jul. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
6. Niccum R. Baseline information for characterizations and for water quality management, planning and decisions affecting BVMI property in the Las Tablas Creek watershed, San Luis Obispo County. July 7, 2000. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
7. California Polytechnic State University. Clean lake assistance program for Lake Nacimiento; 1994 Apr. Available for public viewing at San Luis Obispo (CA): California Regional Water Quality Control Board.
8. California Regional Water Quality Control Board. Memorandum from David Schwartzbart concerning the Buena Vista Mine illegal discharge. San Luis Obispo, California. March 27, 1995. Available for public viewing at San Luis Obispo (CA): California Regional Water Quality Control Board.
9. California Regional Water Quality Control Board. Inactive metal mines in four San Luis Obispo watersheds surface water quality impacts and remedial options. June 1999. Available for public viewing at San Luis Obispo (CA): California Regional Water Quality Control Board, Central Coast Region.
10. U.S. Environmental Protection Agency, Region IX. Memorandum from Daniel Suter concerning a request for a time-critical removal action at the Buena Vista/Klau Mercury Mine site. San Francisco, California. June 14, 2005. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
11. California Department of Health Services. Health consultation concerning evaluation of mercury exposures and physical hazards, Buena Vista Mine, San Luis Obispo County. Atlanta: U.S. Department of Health and Human Services; 2005 Aug 4.
12. CH2MHill. Sampling and analysis plan for remedial investigation/feasibility study, Klau and Buena Vista Mines Superfund Site, San Luis Obispo County. 2007 Sept. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
13. CH2MHill. Phase 2 addendum to sampling and analysis plan for remedial investigation/feasibility study, Klau and Buena Vista Mines Superfund Site, San Luis

Obispo County. 2008 Mar. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.

14. San Luis Obispo County Public Works Department. Prop 40 integrated watershed management program implementation grant for Cypress Mountain Drive. 2007. Available online at http://www.slocounty.ca.gov/PW/Stormwater/Lake_Nacimiento_Watershed_Mercury_Sediment_Reduction_Project.htm.
15. San Luis Obispo County Health Agency. Safe fish guidelines released for Lake Nacimiento - Mercury is in the fish, not found at hazardous levels in water. 2007 Feb. Available for public viewing at San Luis Obispo (CA): San Luis Obispo County Public Health Department.
16. San Luis Obispo County Flood Control and Water Conservation District. Nacimiento Water Project. Available online at http://www.slocounty.ca.gov/PW/NacWP.htm
17. California Department of Health Services. Health consultation concerning evaluation of fish consumption from Lake Nacimiento, Klau/Buena Vista Mines, San Luis Obispo County. 2007 Feb 6. Available online at http://www.ehib.org/project.jsp?project_key=KLAU01.
18. Bureau of the Census. American Fact Finder. Washington: U.S. Department of Commerce. Available online at http://factfinder.census.gov/servlet/AdvGeoSearchByListServlet?_command=getResults&_programYear=50&_geoAreaType=140&_treeId=420&_disp_order=1007&_currentGeoAreaType=140&_geoIdsHierarchy=60279822|60741766|50|Y&_placename=14000US06079010000&_geoBucketId=50&_lang=en. Last accessed 2005 Oct 20.
19. Agency for Toxic Substances and Disease Registry. Minimal risk levels for hazardous substances. 2007 Nov. Available online at http://www.atsdr.cdc.gov/mrls/.
20. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. Integrated Risk Information system. Available online at http://www.epa.gov/iris/subst/0073.html.
21. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. Reference exposure levels. Available online at: http://www.oehha.ca.gov/air/chronic_rels/index.html.
22. U.S. Environmental Protection Agency. Region 9 preliminary remediation goals. 2004 Oct. Available online at http://www.epa.gov/region09/waste/sfund/prg/.
23. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Available online at http://www.atsdr.cdc.gov/HAC/PHAmanual/toc.html.
24. California Cancer Registry. Cancer in California, 2000: A decade of cancer surveillance. Sacramento (CA); 2000 Jun. Available for public viewing at Sacramento (CA): California Cancer Registry.
25. CH2MHill. Data submittal, phase 1 and phase 2 remedial investigations Klau and Buena Vista Mines Superfund Site, San Luis Obispo County. 2008 Sept 26. Available for public viewing at San Francisco (CA): U.S. Environmental Protection Agency, Region IX.
26. U.S. Environmental Protection Agency. Corrosion, Scaling, and Metal Mobility Research: Iron. Available online at http://www.epa.gov/nrmrl/wswrd/cr/corr_res_iron.html.
27. Bigley FG. (1994). Unpublished Master's Thesis: Mercury concentrations in the Las Tablas watershed, San Luis Obispo County.

28. CH2MHill. Human health risk assessment portion of Cypress Mountain Drive, San Luis Obispo County. 2008 Jun. Available for public viewing (CA) San Luis Obispo: San Luis Obispo County Department of Public Works.
29. Agency for Toxic Substances and Disease Registry. Toxicological profile for mercury. Atlanta: U.S. Department of Health and Human Services; 1999 Mar. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp46.html.
30. California Regional Water Quality Control Board. Memorandum from Roger Briggs concerning the TetraTech letter of August 14, 1997, Buena Vista Mine and Klau Mine. San Luis Obispo, California. September 18, 1997. Available for public viewing at San Luis Obispo (CA): California Regional Water Quality Control Board, Central Coast Region.
31. Official California Legislative Information. California Health and Safety Code, division 104, part 12, chapter 4. Available online at http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=hsc.
32. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. 2009 update of California sport fish advisories. March 2009. Available online at http://oehha.ca.gov/fish/pdf/DiscAdvyUpdates032309.pdf. Last accessed 2009 May.
33. U.S. Geologic Survey, Burea of Land Mangement. Mercury in biota from BLM Resevoir, Buena Vista Mine, San Luis Obispo County. 2007 Jul. Available for public viewing at Richmond (CA): California Department of Public Health.
34. Office of Environmental health Hazard Assessment. Development of fish contaminant goals and advisory tissue levels for contaminants in sport fish: chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene. 2008 Jun. Available online at http://oehha.ca.gov/fish/gtlsv/pdf/FCGsATLs27June2008.pdf.
35. Larsen LB. Letter to California Department of Health Services staff concerning the Buena Vista and Klau Mines. Atascadero, California. January 2, 2006. Available for public viewing at Richmond (CA): California Department of Public Health.
36. San Luis Obispo Telegram-Tribune. Planners recommend Klau Mine operation. 1966 Feb 10; Sect. A:2 (col. 1).
37. California Department of Public Health. Letter to Raymond and Nancy Dodd concerning cattle grazing near the Klau and Buena Vista Mines, San Luis Obispo, California. September 12, 2006. Available for public viewing at Richmond (CA): California Department of Public Health.
38. Jagoe CH, Brant HA, Murphy TM. Mercury in bald eagle nestlings from South Carolina. Journal of Wildlife Diseases;38(4):706-12.
39. Oakridge National Laboratory. Risk assessment information system. 2007 May. Available online at http://rais.ornl.gov/tox/tox_values.shtml.
40. U.S. Environmental Protection Agency. Exposure factors handbook. 1997. Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12464.
41. U.S. Environmental Protection Agency. Risk assessment guidance for Superfund, Volume I, human health evaluation manual (part E, supplemental guidance for dermal risk assessment). 2004 Jul. Available online at http://www.epa.gov/oswer/riskassessment/ragse/index.htm.

42. Agency for Toxic Substances and Disease Registry. Toxicological profile for aluminum. Atlanta: U.S. Department of Health and Human Services; 2006 Sep. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp22.html.
43. Agency for Toxic Substances and Disease Registry. Toxicological profile for arsenic. Atlanta: U.S. Department of Health and Human Services; 2007 Aug. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp2.html.
44. Agency for Toxic Substances and Disease Registry. Toxicological profile for chromium. Atlanta: U.S. Department of Health and Human Services; 2000 Dec. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp7.html.
45. Agency for Toxic Substances and Disease Registry. Toxicological profile for copper. Atlanta: U.S. Department of Health and Human Services; 2004 Sep. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp132.html.
46. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead. Atlanta: U.S. Department of Health and Human Services; 2007 Aug. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp13.html.
47. Agency for Toxic Substances and Disease Registry. Toxicological profile for manganese. Atlanta: U.S. Department of Health and Human Services; 2000 Sept. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp33.html.
48. Agency for Toxic Substances and Disease Registry. Toxicological profile for nickel. Atlanta: U.S. Department of Health and Human Services; 2005 Aug. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp15.html.
49. Agency for Toxic Substances and Disease Registry. Toxicological profile for thallium. Atlanta: U.S. Department of Health and Human Services; 1992 Jul. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp54.html.
50. Agency for Toxic Substances and Disease Registry. Toxicological profile for vanadium. Atlanta: U.S. Department of Health and Human Services; 1992 Jul. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp58.html.

Certification

This public health assessment, Klau and Buena Vista Mines, San Luis Obispo County, California, was prepared by the California Department of Public Health 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. Editorial review was conducted by the cooperative agreement partner.

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The Division of Public Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with the findings.

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Appendix A. Glossary of Terms

Absorption
How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure
Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Adits
An adit is a type of entrance to an underground mine.

Adverse Health Effect
A change in body function or the structures of cells that can lead to disease or health problems.

ATSDR
The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and ten regional offices in the U.S. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

ATSDR Hazard Categories
Depending on the specific properties of the contaminant(s), the exposure situations, and the health status of individuals, a public health hazard may occur. Sites are classified using one of the following public health hazard categories:

<u>Urgent Public Health Hazard</u>
This category applies to sites that have certain physical hazards or evidence of short-term (less than 1 year), site-related exposure to hazardous substances that could result in adverse health effects. These sites require quick intervention to stop people from being exposed. ATSDR will expedite the release of a health advisory that includes strong recommendations to immediately stop or reduce exposure to correct or lessen the health risks posed by the site.

<u>Public Health Hazard</u>
This category applies to sites that have certain physical hazards or evidence of chronic (long-term, more than 1 year), site-related exposure to hazardous substances that could result in adverse health effects. ATSDR will make recommendations to stop or reduce exposure in a timely manner to correct or lessen the health risks posed by the site.

Background Level
An average or expected amount of a chemical in a specific environment or, amounts of chemicals that occur naturally in a specific environment.

Cancer Risk
The potential for exposure to a contaminant to cause cancer in an individual or population is evaluated by estimating the probability of an individual developing cancer over a lifetime as the result of the exposure. This approach is based on the assumption that there are no absolutely "safe" toxicity values for carcinogens. U.S. EPA and the California EPA have developed cancer slope factors and inhalation unity risk factors for many carcinogens. A slope factor is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer.

If adequate information about the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen is available, an estimate of excess cancer risk associated with the exposure can be calculated using the slope factor for that carcinogen. Specifically, to obtain risk estimates, the estimated, chronic exposure dose (which is averaged over a lifetime or 70 years) is multiplied by the slope factor for that carcinogen.

Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men (about 43% combined) will be diagnosed with cancer in their lifetime [24]. This is referred to as the "background cancer risk." The term "excess cancer risk" represents the risk above and beyond the "background cancer risk." A "one-in-a-million" excess cancer risk from a given exposure to a contaminant means that if one million people are chronically exposed to a carcinogen at a certain level, over a lifetime, then one cancer above the background risk may appear in those million persons from that particular exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000. Cancer risk numbers are a quantitative or numerical way to describe a biological process (development of cancer). In order to take into account the uncertainties in the science, the risk numbers used are plausible upper limits of the actual risk, based on conservative assumptions.

Chronic Exposure
A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than 1 year to be chronic.

Completed Exposure Pathway
See Exposure Pathway.

Concern
A belief or worry that chemicals in the environment might cause harm to people.

Concentration
How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant
See Environmental Contaminant.

CREG (ATSDR Cancer Risk Evaluation Guide for 1 in 1,000,000 increased cancer risk)
Like EMEGs, water CREGs are derived for potable water used in homes, including water used for drinking, cooking, and food preparation. Soil CREGs apply only to soil that is ingested.
A theoretical increased cancer risk is calculated by multiplying the dose and the CSF. When developing CREG, the target risk level (10^{-6}), which represents a theoretical risk of one excess cancer case in a population of one million, and the CSF are known. The calculation seeks to find the substance concentration and dose associated with this target risk level.
To derive water and soil CREGs, ATSDR uses CSFs developed by EPA and reported in the Integrated Risk Information System (IRIS). The IRIS summaries, available at http://www.epa.gov/iris/, provide detailed information about the derivation and basis of the CSFs for individual substances. ATSDR derives CREGs for lifetime exposures, and therefore uses exposure parameters that represent exposures as an adult. An adult is assumed to ingest 2 L/day of water and weigh 70 kg. For soil ingestion, ATSDR assumes a soil ingestion rate of 100 mg/day, for a lifetime (70 years) of exposure.

Dermal Contact
A chemical getting onto your skin. (See Route of Exposure.)

Dose
The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day.”

Dose/Response
The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration
The amount of time (days, months, and years) that a person is exposed to a chemical.

EMEG (ATSDR Environmental Media Evaluation Guide)
ATSDR uses the chronic oral MRLs from its Toxicological Profiles available at http://www.atsdr.cdc.gov/toxpro2.html, to develop EMEGs. Ideally, the MRL is based on an experiment in which the chemical was administered in water. However, in the absence of such data, an MRL based on an experiment in which the chemical was administered by gavage or in food may have been used. The Toxicological Profiles for individual substances provide detailed information about the MRL and the experiment on which it was based.

Water EMEGs are derived for potable water used in homes. Potable water includes water used for drinking, cooking, and food preparation. Exposures to substances that volatilize from potable water and are inhaled, such as volatile organic compounds released during showering, are *not* considered when deriving EMEGs.

Children are usually assumed to constitute the most sensitive segment of the population for water ingestion because their ingestion rate per unit of body weight is greater than the adults' rate. An

EMEG for a child is calculated assuming a daily water ingestion rate of 1 liter per day (L/day) for a 10-kilogram (kg) child. For adults, a water EMEG is calculated assuming a daily water ingestion rate of 2 liters per day and a body weight of 70 kg.

Soil EMEGS: Many chemicals bind tightly to organic matter or silicates in the soil. Therefore, the bioavailability of a chemical is dependent on the media in which it is administered. Ideally, an MRL for deriving a soil EMEG should be based on an experiment in which the chemical was administered in soil. However, data from this type of study are seldom available. Therefore, often ATSDR derives soil EMEGs from MRLs based on studies in which the chemical was administered in drinking water, food, or by gavage using oil or water as the vehicle. The Toxicological Profiles for individual substances provide detailed information about the MRL and the experiment on which it was based.

Children are usually assumed to be the most highly exposed segment of the population because their soil ingestion rate is greater than adults' rate. Experimental studies have reported soil ingestion rates for children ranging from approximately 40 to 270 milligrams per day (mg/day), with 100 mg/day representing the best estimate of the average intake rate (EPA 1997). ATSDR calculates an EMEG for a child using a daily soil ingestion rate of 200 mg/day for a 10-kg child.

Environmental Contaminant
A substance (chemical) that gets into a system (person, animal, or environment) in amounts higher than that found in Background Level, or what would be expected.

Environmental Media
Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an Exposure Pathway.

Exposure
Coming into contact with a chemical substance (for the three ways people can come in contact with substances, see Route of Exposure).

Exposure Assessment
The process of finding the ways people come in contact with chemicals, how often, and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway
A description of the way that a chemical moves from its source (where it began), to where, and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having five parts: 1) a source of contamination, 2) an environmental media and transport mechanism, 3) a point of exposure, 4) a route of exposure, and 5) a receptor population. When all five parts of an exposure pathway are present, it is called a Completed Exposure Pathway.

Frequency
How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.

Hazard Index
The sum of the Hazard Quotients (see below) for all chemicals of concern (COCs) identified, which an individual is exposed. If the Hazard Index (HI) is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Index is greater than 1, then adverse health effects are possible. However, an HI greater than 1.0, does not necessarily suggest a likelihood of adverse effects. The HI cannot be translated to a probability that adverse effects will occur, and is not likely to be proportional to risk

Hazard Quotient
The ratio of estimated site-specific exposure to a single chemical from a site over a specified period to the estimated daily exposure level, at which no adverse health effects are likely to occur. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Quotient is greater than 1, then adverse health effects are possible. The Hazard Quotient cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk. It is especially important to note that a Hazard Quotient exceeding 1 does not necessarily mean that adverse effects will occur.

Hazardous Waste
Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Comparison Value
Media specific concentrations that are used to screen contaminants for further evaluation.

Health Effect
ATSDR deals only with Adverse Health Effects (see definition in this glossary).

Ingestion
Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (see Route of Exposure).

Inhalation
Breathing. It is a way a chemical can enter your body (see Route of Exposure).

LOAEL
Lowest-Observed-Adverse-Effect-Level (LOAEL). LOAEL is the lowest dose of a chemical in a study (animals or people), or group of studies, that produces statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

Maximum Contaminant Level (MCL)
Maximum allowable level of a contaminant in municipal drinking water.

Noncancer Evaluation, ATSDR's Minimal Risk Level (MRL), U.S. EPA's Reference Dose (RfD) and Reference Concentration (RfC), and California EPA's Reference Exposure Level (REL)
MRL, RfD, RfC, and REL are estimates of daily exposure to the human population (including sensitive subgroups), below which noncancer adverse health effects are unlikely to occur. MRL, RfD, RfC, and REL only consider noncancer effects. Because they are based only on information currently available, some uncertainty is always associated with MRL, RfD, RfC, and REL. "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 MRL, RfD, RfC or REL.

When there is adequate information from animal or human studies, MRLs and RfDs are developed for the ingestion exposure pathway, whereas RELs and RfCs are developed for the inhalation exposure pathway. MRLs are also developed for the inhalation pathway.

Separate noncancer toxicity values are also developed for different durations of exposure. ATSDR develops MRLs for acute exposures (less than 14 days), intermediate exposures (from 15 to 364 days), and for chronic exposures (greater than 1 year). The California EPA develops RELs for acute (less than 14 days) and chronic exposure (greater than 1 year). EPA develops RfDs and RfCs for acute exposures (less than 14 days), and chronic exposures (greater than 7 years). Both MRL and RfD for ingestion are expressed in units of milligrams of contaminant per kilograms body weight per day (mg/kg/day). REL, RfC, and MRL for inhalation are expressed in units of milligrams per cubic meter (mg/m^3).

NOAEL
No-Observed-Adverse-Effect-Level. NOAEL is the highest dose of a chemical at which there were no statistically or biologically significant increases in the frequency or severity of adverse effects seen between the exposed population (animals or people) and its appropriate control. Some effects may be produced at this dose, but they are not considered adverse, nor precursors to adverse effects

PHA
Public Health Assessment. A report or document that looks at chemicals at a hazardous waste site and determines if people could be harmed from coming into contact with those chemicals. The PHA also recommends possible further public health actions if needed.

Point of Exposure
The place where someone can come into contact with a contaminated environmental medium (air, water, food, or soil). For example, the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population
A group of people living in a certain area or the number of people in a certain area.

PRG
EPA Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.

Qualitative Description of Estimated Increased Cancer Risks
The qualitative interpretation for estimated increased cancer risks are as follows:

Quantitative Risk Estimate	Qualitative Interpretation
Less than 1 in 100,000	No apparent increased risk
1 in 100,000 to 9 in 100,000	Very low increased risk
1 in 10,000 to 9 in 10,000	Low increased risk
1 in 1,000 to 9 in 1,000	Moderate increased risk
Greater than 9 in 1,000	High increased risk

Receptor Population
People who live or work in the path of one or more chemicals, and who could come into contact with them (see Exposure Pathway).

RMEG (Reference Dose Media Evaluation Guides)
RMEGs represent concentrations of substances (in water, soil, and air) to which humans may be exposed without experiencing adverse health effects. If no MRL is available to derive an EMEG, ATSDR develops RMEGs using EPA's reference doses (RfDs), available at http://www.epa.gov/iris/, and default exposure assumptions, which account for variations in intake rates between adults and children. EPA's reference concentrations (RfCs), available at http://www.epa.gov/iris/, serve as RMEGs for air exposures. RfDs and RfCs consider lifetime exposures, therefore RMEGs apply to chronic exposures.

Route of Exposure
The way a chemical can get into a person's body. There are three exposure routes: 1) breathing (also called inhalation), 2) eating or drinking (also called ingestion), and 3) getting something on the skin (also called dermal contact).

Source (of Contamination)
The place where a chemical comes from, such as a smokestack, landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first point of an exposure pathway.

Sensitive Populations
People who may be more sensitive to chemical exposures because of certain factors such as age, sex, occupation, a disease they already have, or certain behaviors (cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Toxic
Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose determines the potential harm of a chemical and whether it would cause someone to get sick.

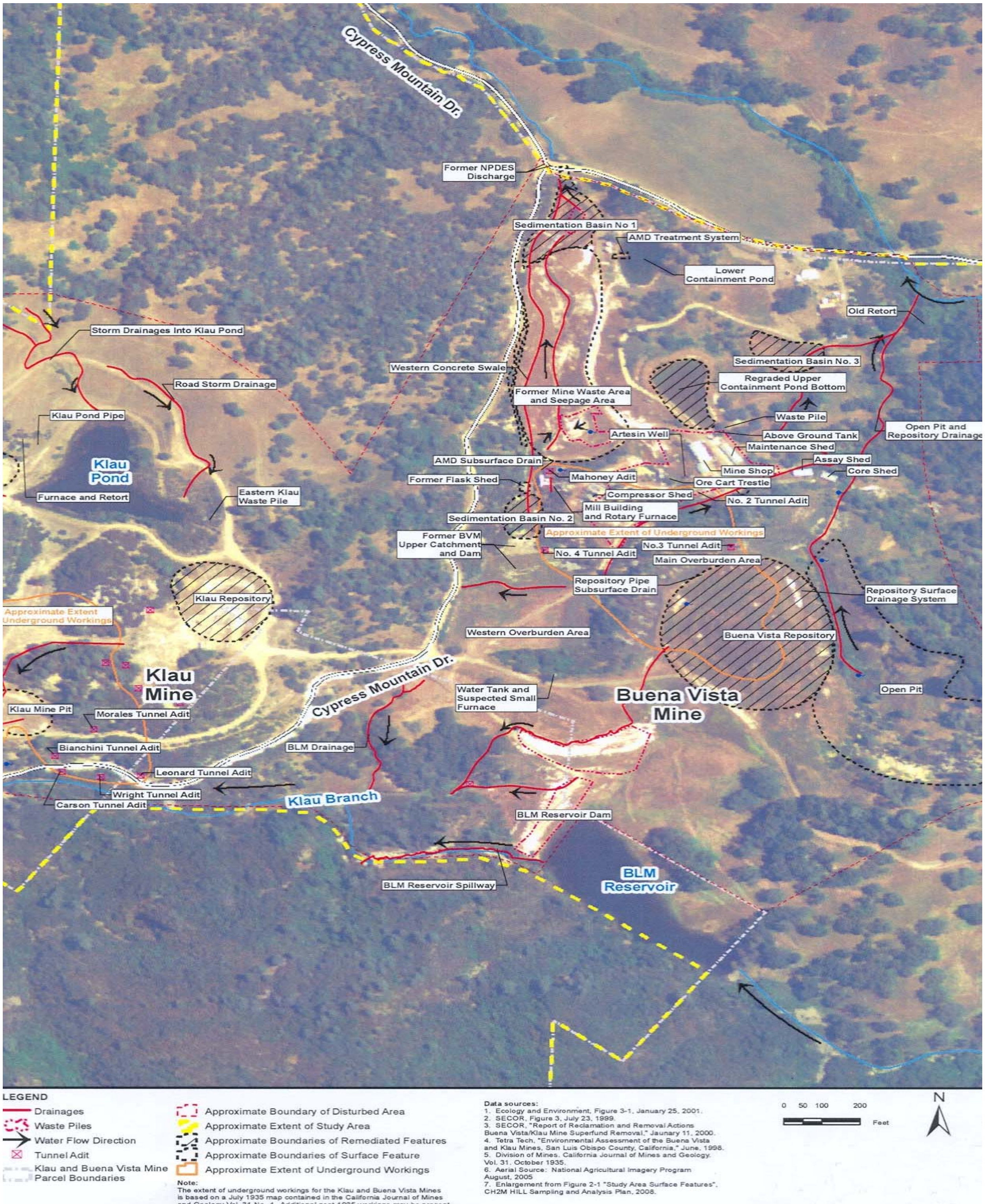
Toxicology
The study of harmful effects of chemicals on humans or animals.

Appendix B. Figures

Figure B1. Site Location, Klau and Buena Vista Mines, San Luis Obispo County, California

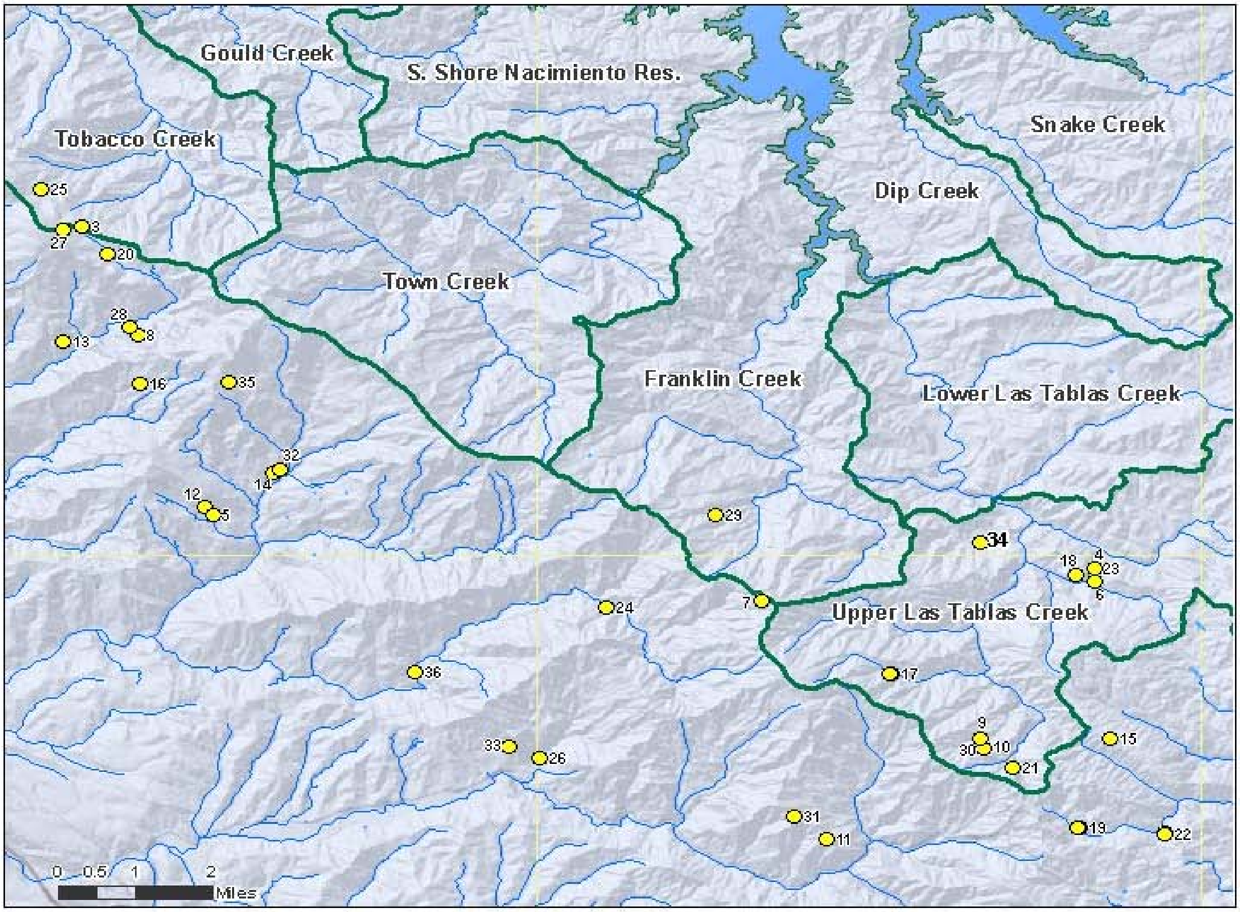
Data source [25]

Figure B2. Site Layout and Surface Features, Klau and Buena Vista Mines, San Luis Obispo County, California



Data source [25]

Figure B3. Mercury Mines Located Within 10 Miles of Lake Nacimiento, Klau and Buena Vista Mines, San Luis Obispo County, California



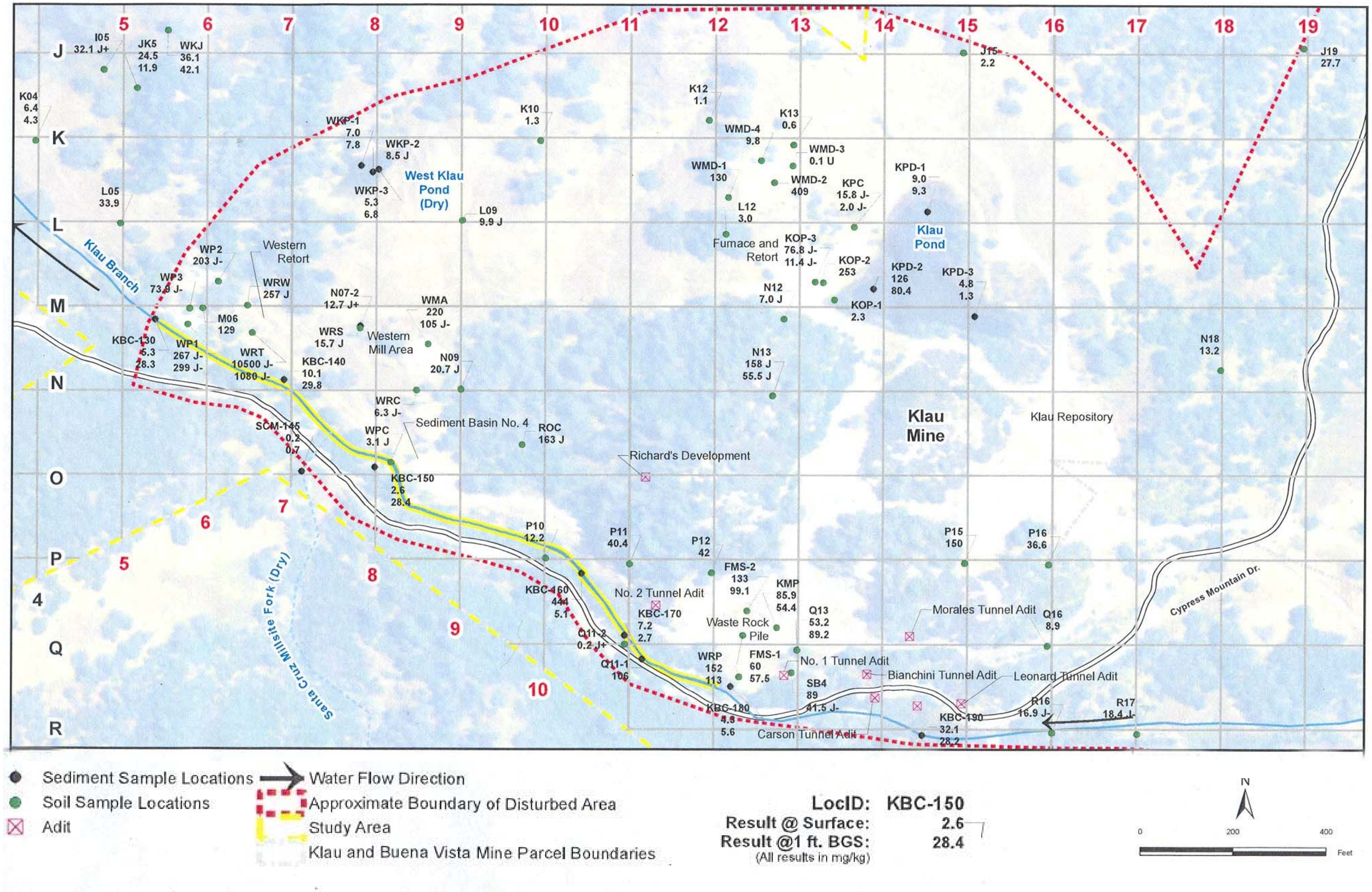
Major streams and rivers
Watershed boundaries
Mercury mines
Current and previous names
- 3, Buckeye Mine, Buckeye
- 4, Buena Vista, Mahoney Mine, Gould
- 5, Cambria Mine, Red Hill Workings, La Trinidad Mine, Bank Mine, Cambria, Bank
- 6, Capitola Mine, Canitela Mine
- 7, Cypress Mountain Group
- 8, Doty Mine, Doty
- 9, Elizabeth And Winona Group
- 10, Fine Enterprises, Tamley Claim, Tamney Group
- 11, Fitzhugh Ranch, Benton Ranch, Lehman, Leman, Fitzhugh Ranch Mine, Benton Ranch, Lehman Ranch
- 12, Gambrie Mine
- 13, Gemstone Nos. 1, 2, & 3
- 14, Hamilton Mine, Hamilton
- 15, Josephine Group, George Mine, Tartaglia
- 16, Keystone, Keystone Mine
- 17, Kismet Group, Kismet
- 18, Klau Mine, Sunderland, Sierra Morena, Santa Cruz, Klau, Karl, Carson, Capital, Klau, Capitola, Carson, Sunderland, Sierra Morena, Santa Cruz, Karl
- 19, La Libertad, Belt, Jacks 7x, La Libertad Mine, Thompson Mine
- 20, Little Almaden, Little Almaden Mine, Almaden Mine
- 21, Little Bonanza Mine, Little Bonanza, Alice, Tartaglia, Modoc, Josephine, George, Little Bonanza Mine, Modoc Claim, Josephine, Alice Claim
- 22, Madrone Mine, Madrone
- 23, Mahoney, Buena Vista, Gould
- 24, Marquart
- 25, Ocean View, Ocean View Mine, Mt. Bishop
- 26, Oceanic Mine, Oceanic
- 27, Pine Mountain Mine, Ricioli Prospect, Pine Mountain
- 28, Quien Sabe Mine, Quien Sabe, Doty Group, Quien Sabe
- 29, San Luis Obispo
- 30, Tamney
- 31, Vulture, Vulture Mine
- 32, Warren, Warren Prospect
- 33, Warren Ranch Deposit
- 34, William Tell, Williams, William Tell Mine, Williams Mine
- 35, Williams, Williams Prospect
- 36, Wittenberg Ranch, Wittenberg Mine, Wittenberg Property

Figure created by Svetlana Smorodinsky, California Department of Public Health, Environmental Health Investigations Branch

Figure B4. Location of Census Tract 100 of San Luis Obispo County, Klau and Buena Vista Mines, California

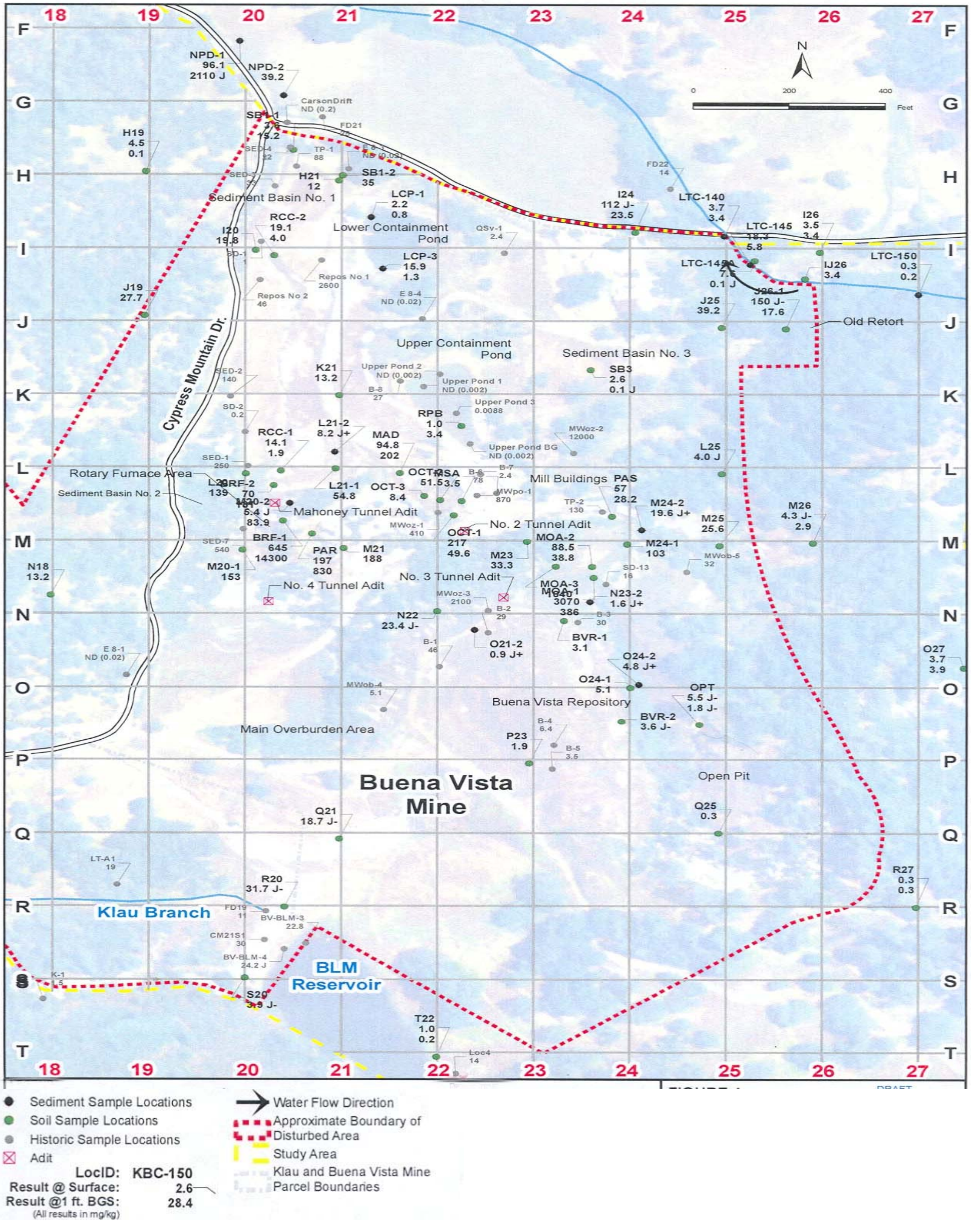
Data source [25]

Figure B5. Location of Soil Samples and Mercury Results on and near the Klau Mine, San Luis Obispo County, California



Data Source [25]

Figure B6. Location of Soil Samples and Mercury Results on and near the Buena Vista Mine, San Luis Obispo County, California

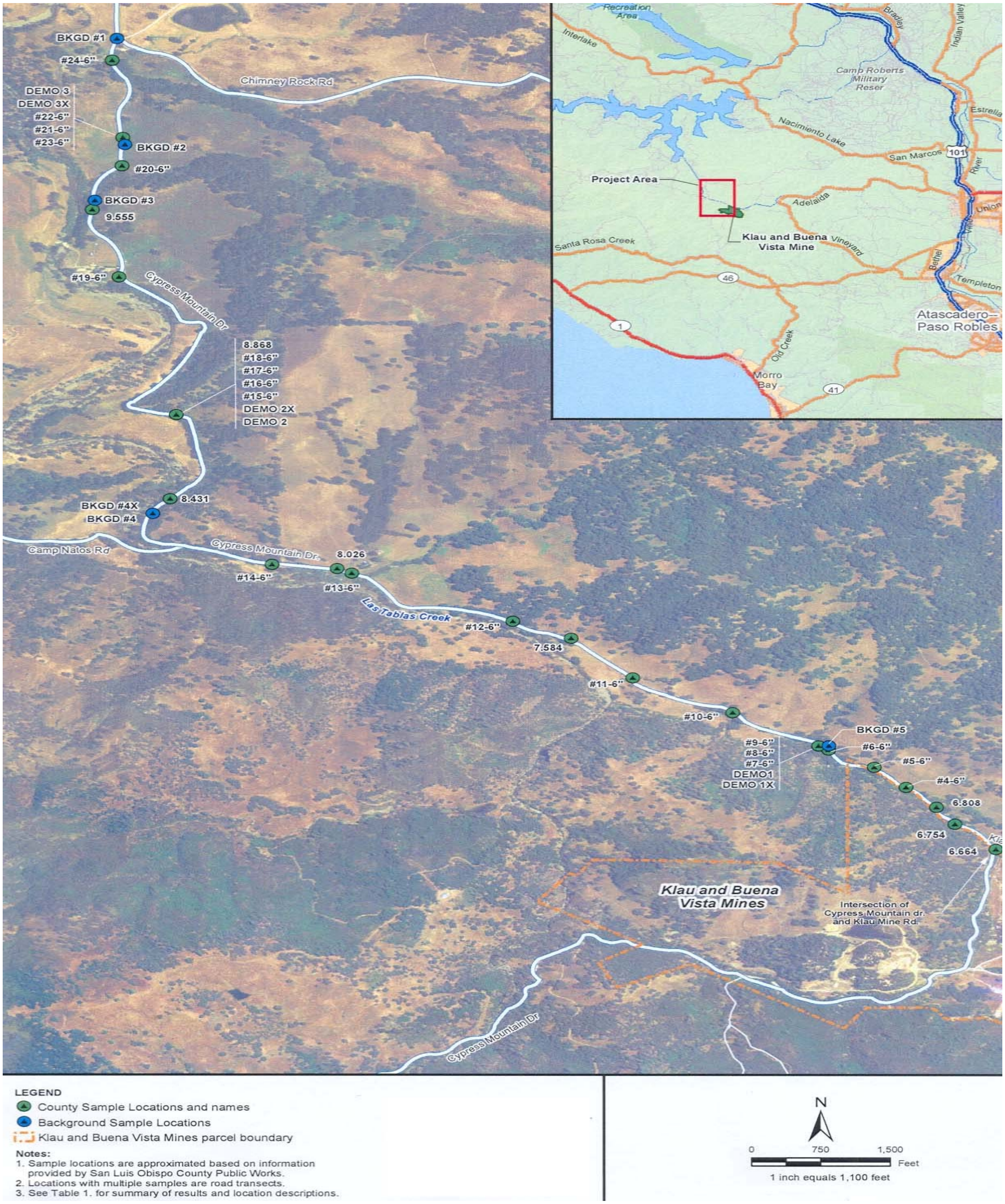


Data source [25]

Figure B7. Approximate Location of Roadway Samples Collected in 1992, Klau and Buena Vista Mines, San Luis Obispo County, California

Data source [6]

Figure B8. Location of Roadway Samples Collected on Cypress Mountain Drive in 2008, Klau and Buena Vista Mines, San Luis Obispo County, California



Data source [28]

Appendix C. Tables

Table C1. Exposure Pathways, Klau and Buena Vista Mines, San Luis Obispo **County**, California

Pathway	Media	Exposure Point	Exposure Route	Receptor	Time	Health Hazard
Completed Exposure Pathways						
Incidental ingestion of mine tailings	Soils	Buena Vista and Klau Mines	Incidental ingestion	Resident (caretaker) and trespasser	Past and current	No apparent public health hazard
Breathing dust particles from Cypress Mountain Drive	Air	3.3 mile portion of Cypress Mountain Drive (between Klau Mine Road and Chimney Rock Road)	Breathing	Residents and people traveling through the area	Past, current, and future	No apparent public health hazard
Breathing dust particles from unpaved roads, other than Cypress Mountain Drive, constructed with mine tailings	Air	Unpaved roads near the Klau and Buena Vista Mines	Breathing	Residents and people traveling through the area	Past, current, and future	Indeterminate public health hazard
Breathing vapors from elemental mercury	Air	Buena Vista mill buildings	Breathing	Resident (caretaker) and trespasser	Past	Indeterminate public health hazard
Breathing vapors from elemental mercury	Air	Buena Vista mill buildings	Breathing	Resident (caretaker) and trespasser	Current and future	Public health hazard
Wading in waters on or near the mines	Water	Surface waters	Absorbed via skin or incidental Ingestion	Residents and people who recreate in the area	Past, current, and future	No apparent public health hazard
Eating fish with methylmercury contamination	Food chain	Lake Nacimiento Reservoir, BLM Reservoir, Harcourt Reservoir	Eating	People who eat fish caught from BLM Reservoir, Harcourt Reservoir, and Lake Nacimiento Reservoir	Past, current, and future	Public health hazard

Table C1. Exposure Pathways, Klau and Buena Vista Mines, San Luis Obispo **County**, California

Pathway	Media	Exposure Point	Exposure Route	Receptor	Time	Health Hazard
Potential Exposure Pathways						
Drinking contaminated groundwater	Water	Private wells	Drinking	Private well owners	Past, current, and future	Indeterminate public health hazard
Breathing contaminated sediment when Lake Nacimiento water levels are low	Air	Lake Nacimiento Reservoir	Breathing	People who live or recreate at Lake Nacimiento	Past, current, and future	Indeterminate public health hazard
Eliminated Exposure Pathways						
Drinking water provided by local water purveyors	Water		Drinking	People who receive drinking water from local water purveyors around Lake Nacimiento	Past, current, future	No public health hazard

Tap

Table C2. Summary of Contaminants Detected in Surface Soil from the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Klau Mine Maximum Detected Concentration (Sample ID)** (mg/kg)	**Buena Vista Mine Maximum Detected Concentration (Sample ID)** (mg/kg)	**Klau and Buena Vista Mines Average Detected Concentration** (mg/kg)	**Media-Specific Comparison Values – Source (Background Level)** (mg/kg)
Aluminum	35,500 (N18)	27,200 (L20)	9,829	100,000 intermediate EMEG (child) 1,000,000 intermediate EMEG (adult) (Background = 13,908)
Antimony	7.3 (H19)	**31.7** (MOA-1)	8.3	20 chronic RMEG (child) 300 chronic RMEG (adult) (Background = 2.3))
Arsenic	**94.8** (WRT)	**205** (RPB)	**16.6**	20 chronic EMEG (child) 200 chronic EMEG (adult) 0.5 CREG (Background = 8.3)
Barium	220 (O03)	1,170 (M20-1)	171	10,000 chronic RMEG (child) 100,000 chronic RMEG (adult) (Background = 13,908)
Beryllium	2.6 (WKJ)	1.2 (H21)	0.58	100 chronic EMEG (child) 1,000 chronic EMEG (adult) (Background = 0.74)
Boron	51.4 (WRS	44.4 (RCC-2)	14.0	10,000 chronic RMEG (child) 100,000 chronic RMEG (adult) ((Background = 15)
Cadmium	3.6 (I05)	**12.3** (OPT)	1.22	10 chronic EMEG (child) 100 chronic RMEG (adult) (Background = 4.1)
Chromium	**1,460** (WKJ)	**240** (L20)	42.8	200 chronic RMEG (child)** 2,000 chronic RMEG (adult) (Background = 162)
Cobalt	197 (I05)	57.7 (M20-1)	35.4	500 intermediate EMEG (child) 7,000 intermediate EMEG (adult) (Background = 22.3)
Copper	71.7 (WKJ)	85.6 (BRF-1)	44.8	500 intermediate EMEG (child) 10,000 intermediate EMEG (adult) (Background = 48)
Iron	**191,000** (I05)	**218,000** (RPB)	**50,845**	23,000 residential PRG (Background = 48,509)

Table C2. Summary of Contaminants Detected in Surface Soil from the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Klau Mine Maximum Detected Concentration (Sample ID)** (mg/kg)	**Buena Vista Mine Maximum Detected Concentration (Sample ID)** (mg/kg)	**Klau and Buena Vista Mines Average Detected Concentration** (mg/kg)	**Media-Specific Comparison Values – Source (Background Level)** (mg/kg)
Lead	98.4 (WRT)	**830** (RPB)	21.4	150 California-modified PRG (Background = 8.1)
Manganese	2,170 (WKJ)	2,510 (OPT)	634	3,000 chronic RMEG (child) 40,000 chronic RMEG (adult) (Background = 913)
Mercury	**10,500** (WRT)	**3,070** (MOA-1)	**518**	2 chronic RMEG (child) 20 chronic RMEG (adult) (Background = 23)
Molybdenum	19.3 (L12)	24.1 (S31)	7.45	300 chronic RMEG (child) 4,000 chronic RMEG (adult) (Background = not determined)
Nickel	**2,410** (L05)	443 (L20)	289	1,000 chronic RMEG (child) 10,000 chronic RMEG (adult) (Background = 502)
Silver	1.3 (J19)	2.5 (U26)	0.61	300 chronic RMEG (child) 4,000 chronic RMEG (adult) (Background = 1.0)
Thallium	**13.1** (WRW)	**1,520** (MOA-3)	**378**	5.2 residential PRG (Background = 3.9)
Vanadium	117 (O03)	**249** (R27)	47.9	200 intermediate EMEG (child) 2,000 intermediate EMEG (adult) (Background = 73.6)
Zinc	1,230 (WRT)	316 (BRF-1)	90.7	20,000 chronic EMEG (child) 200,000 chronic EMEG (adult) (Background = 85.1)

Data source [25]
Bolded detections meet or exceed media-specific comparison values.
mg/kg: milligram per kilogram.
Background values derived from Phase I and Phase II data sets.
EMEG: Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide.
RMEG: Reference Dose Media Evaluation Guide based on Environmental Protection Agency's Reference Dose.
CREG: Agency for Toxic Substances and Disease Registry's Cancer Risk Evaluation Guide for 1 in 1,000,0000 increased cancer risk.
PRG: U.S. Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects).

Table C3. Noncancer Dose Estimates for Contaminants in Soil Exceeding Media-Specific Comparison Values and Hazard Index for All Metals Measured in Soil at the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Estimated Dose Resident/Caretaker** (mg/kg/day)	**Estimated Dose Teenage Trespasser** (mg/kg/day)	**Health Comparison Value (Source)** (mg/kg/day)	**Hazard Quotient** (Unitless)
Arsenic	0.00001	0.000002	0.0003 (MRL) 0.0008 (NOAEL)	0.04 (resident/caretaker) 0.002 (trespasser)
Mercury	0.00035	0.000004	0.0003 (RfD)* 0.226 (LOAEL) 0.023 (LOAEL-a)	1.1 (resident/caretaker) 0.02 (trespasser)
Thallium	0.0003	0.000003	0.00006 (RfD) 0.23 (NOAEL)	3.9 (resident/caretaker) 0.05 (trespasser)
Total Hazard Index from exposure to all metals measured in soil				5.4 (resident/caretaker) 0.09 (trespasser)

Dose estimates include ingestion, dermal, and inhalation exposure.
mg/kg: milligram per kilogram; MRL: Agency for Toxic Substances and Disease Registry's Minimal Risk Level; RfD: Environmental Protection Agency's Reference Dose; *RfD for mercuric chloride; NOAEL: No Observable Adverse Effect Level; LOAEL: Lowest Observed Adverse Effect Level; LOAEL-a: Lowest Observed Adverse Effect Level-adjusted by a factor of 10 as a proxy for a NOAEL.

Exposure assumptions used in estimating ingestion dose [23,39,40]
CS = chemical concentration in soil (mg/kg)
IR = ingestion rate (mg/day) – (adult 50 mg/day) (child/teen 100 mg/day – averaged over 16 hours/day [time spent awake])
ET = exposure time (resident/caretaker 24 hours/day) (trespasser 1 hour/day)
EF = exposure frequency (resident 350 days/year) (trespasser 30 days/year)
ED = exposure duration – years of exposure (teen trespasser: 4 years) (resident/caretaker: 30 years)
CF = conversion factor (10^{-6} kg/mg)
BW = body weight (kg) (teen 58 kg: average of 50^{th} percentile of females and males ages 15-19) (adult 71.8 kg: average of women and men)
AT = averaging time (days) (ED * 365 days/year) for non-carcinogen

Equation: (CS)(IR)(ET/10)(EF)(ED)(CF)/(BW)(AT)

Exposure assumptions used in estimating inhalation dose [23,39,40]
CA = estimated concentration in ambient air (µg/m^3)
IR = Inhalation rate (teen/trespasser: 1.5 µg/m^3 /hour) (resident/caretaker: 20 µg/m^3/day)
EF = exposure frequency (teen/trespasser: 30 events/year) (resident/caretaker: 350 events/year)
ED = exposure duration – years of exposure (teen trespasser: 4 years) (resident/caretaker: 30 years)
CF = conversion factor 0.001 (mg/µg)
BW = body weight (teen: 58 kg: average of 50^{th} percentile of females and males ages 15-19) (adult: 71.8 kg: average of women and men)
AT = averaging time (ED * 365 days/year)
IR rate averaged to account for 2 hour exposure period

Equation: (CA)(IR/4)(ET)(EF)(ED)(CF)/(BW)(AT)

Exposure assumptions used in estimating dermal dose [23,39-41]
CS = chemical concentration in soil (mg/kg)
SSA = soil to skin adherence factor (0.07 mg/cm^2)
CF = conversion factor (10^{-6} kg/mg)
AF = absorption factor (unitless) for contaminants of concern (chemical specific: arsenic 0.03, mercury 0.001, thallium 0.001)
SA = skin surface area (cm^2 /event) – Skin surface area (teen/trespasser 3720 cm^2) (resident/caretaker 5809 cm^2) from U.S. Environmental Protection Agency, Exposure Factors Handbook, averaging the 50^{th} percentile for hands, arms, forearms of males.
EF = exposure frequency (teen/trespasser: 30 events/year) (resident/caretaker: 350 events/year)
ED = exposure duration – years of exposure (teen trespasser: 4 years) (resident/caretaker: 30 years)
BW = body weight (teen: 58 kg: average of 50^{th} percentile of females and males ages 15-19) (adult: 71.8 kg: average of women and men)
AT = averaging time (ED * 365 days/year)

Equation: (CS)(SSA)(CF)(SA)(AF)(EF)(ED)/(BW)(AT)

Table C4. Summary of Soil Samples Collected on Nearby Roads in 1992, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	Sample RD1S1	Sample RD2S1	Sample RD3S1	Sample RD4S1	Sample RD5S1	Sample RD6S1	Sample RD7S1	Media-Specific Comparison Values – Source (mg/kg)
	Description of Sampling Locations							
	Cypress Mtn. Rd. ~3/4 mile west of Klau Mtn. Rd and Cypress Mtn. Rd. junction	Cypress Mtn. Rd. ~ 1/4 mile from RD1S1	Cypress Mtn. Rd. ~ 3/4 mile from RD1S1	Cypress Mtn. Rd. ~ 1 1/4 miles from RD1S1	Cypress Mtn. Rd. ~ 1 1/2 miles from RD1S1	Cypress Mtn. Rd. ~ 2 1/4 miles from RD1S1	Chimney Rock Rd. ~1500 feet east of junction with Cypress Mt. Rd.	
Aluminum	17,000	15,000	21,000	29,000	32,000	12,000	8,700	100,000 intermediate EMEG (child) 1,000,000 intermediate EMEG (adult)
Arsenic	**11**	**20**	**5.6**	**16**	**40**	**10**	**3.6**	20 chronic EMEG (child) 200 chronic EMEG (adult) 0.5 CREG
Beryllium	ND	0.6	ND	ND	0.6	ND	0.06	100 chronic EMEG (child) 1,000 chronic EMEG (adult)
Iron	**51,000**	**30,000**	**52,000**	**39,000**	**60,000**	**42,000**	15,000	23,000 residential PRG
Lead	4	10	ND	ND	4	ND	4	150 California-modified PRG
Mercury	**34**	**17**	**14**	**46**	**15**	**26**	0.05	2 chronic RMEG (child) 20 chronic RMEG (adult)
Nickel	83	270	50	120	600	56	18	1,000 chronic RMEG (child) 10,000 chronic RMEG (adult
Thallium	**40**	**34**	**17**	**53**	**8**	**24**	ND	5.2 residential PRG
Zinc	59	99	55	45	64	47	45	20,000 chronic EMEG (child) 200,000 chronic EMEG (adult)

Data source [27]
Bolded detections meet or exceed comparison values.
~: approximate; mg/kg: milligram per kilogram; ND: not detected.
EMEG: Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide; CREG: Agency for Toxic Substances and Disease Registry's Cancer Risk Evaluation Guide for 1 in 1,000,0000 increased cancer risk; PRG: U.S. Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects); RMEG: Reference Dose Media Evaluation Guide based on U.S. Environmental Protection Agency's Reference Dose.

Table C5. Equipment Areas Where Ambient Air Levels of Mercury Exceed Health Comparison Values, Klau and Buena Vista Mines, San Luis Obispo County, California

Buena Vista Mine		Klau Mine		Health Comparison Values ($\mu g/m^3$)
Equipment Description	**Mercury Level** ($\mu g/m^3$)	**Equipment Description**	**Mercury Level** ($\mu g/m^3$)	
Rotary furnace (east side at breathing zone)	**2**	Klau pond parking area (from parking to condenser)	0.15-**0.25**	0.2 chronic MRL 0.3 RfC 9 LOAEL(HEC)
Rotary furnace (west side at breathing zone)	**3-4**	Western mill area concrete condenser (inside equipment)	**0.55**	
Rotary furnace hopper (perimeter at ground level)	**8.2**	Western retort (perimeter at breathing zone)	**0.2**	
Rotary furnace hopper (under Hopper at ground level)	**27**	Western retort (perimeter at ground level)	**0.7-50**	

Data source [25]
Bolded detections meet or exceed health comparison values.
MRL: Agency for Toxic Substances and Disease Registry's Minimal Risk Level.
RfC: Environmental Protection Agency's Reference Concentration.
LOAEL: Lowest Observed Adverse Effect Level based on hand tremors seen in workers exposed for 15.3 (± 2.6) years.
HEC: Human equivalent concentration.
$\mu g/m^3$: microgram per cubic meter.

Table C6. Summary of Contaminants Detected at Discharge Points from Mines to Surface Water in 1994-1995, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	Maximum Concentration (µg/L)				Media-Specific Comparison Values – Source (µg/L)
	Sample Locations and Date Sampled				
	Klau Discharge 1/10/1994	Klau Discharge 10/19/1994	Buena Vista Culvert (North End) 3/24/1995	Buena Vista Conveyance Channel 3/24/1995	
Aluminum	**27,700**	**45,000**	**43,000**	6,600	10,000 chronic EMEG (child) 40,000 chronic EMEG (adult)
Barium	40	33	82	65	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Chromium	**190**	**140**	80	10	100 MCL
Cobalt	360	1200	150	110	7,300 tap water PRG
Copper	90	**150**	70	20	100 intermediate EMEG (child) 400 intermediate EMEG (adult)
Iron	69,100	**180,000**	**2,300,000**	**920,000**	110,000 PRG
Manganese	**17,000**	**41,000**	**11,000**	**5,600**	500 chronic RMEG (child) 2,000 chronic RMEG (adult)
Mercury	**77**	**83**	**14**	1.4	3 chronic EMEG (child) 10 chronic EMEG (adult
Nickel	**4,120**	**13,000**	**1,200**	**540**	200 chronic RMEG (child) 700 chronic RMEG (adult)
Silver	ND	ND	ND	2	50 chronic RMEG (child) 200 chronic RMEG (adult)
Thallium	ND	**7**	**190**	**43**	2 MCL
Vanadium	ND	**30**	**170**	**40**	30 intermediate EMEG (child) 100 intermediate EMEG (adult)
Zinc	220	740	700	230	3,000 chronic EMEG (child) 10,000 chronic EMEG (adult)

Data source [30]
Bolded detections meet or exceed comparison values.
ND: not detected; EMEG: Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide; RMEG: Reference Dose Media Evaluation Guide based on U.S. Environmental Protection Agency's Reference Dose; MCL: Maximum Contaminant Level for drinking water (state and federal); PRG: U.S. Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects).

Table C7. Noncancer Dose Estimates for Past (1994-2007) Exposure to Contaminants in Surface Water Exceeding Media-Specific Comparison Values and Hazard Index for All Metals, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Estimated Dose Adult** (mg/kg/day)	**Estimated Dose Child** (mg/kg/day)	**Health Comparison Value (Source)** (mg/kg/day)	**Hazard Quotient** (unitless)
Aluminum	0.008	0.01	1 (MRL) 10 (LOAEL-a)	0.008 (adult) 0.01 (child)
Chromium	0.00003	0.00006	1.5 (RfD) 1468 (NOAEL)	<0.001 (adult) <0.001 (child)
Manganese	0.007	0.01	0.05 (RfD) 0.14 (NOAEL)	0.1 (adult) 0.2 (child)
Mercury	0.0001	0.0002	0.003 (RfD) 0.23 (NOAEL)	0.04 (adult) 0.06 (child)
Nickel	0.002	0.004	0.02 (RfD) 5 (NOAEL)	0.1 (adult) 0.2 (child)
Thallium	0.00003	0.00006	0.00006 (RfD) 0.23 (NOAEL)	0.5 (adult) 0.9 (child)
Vanadium	0.00003	0.00005	0.009 (MRL) 0.89 (NOAEL)	0.003 (adult) 0.006 (child)
Total Hazard Index from exposure to all metals measured in surface water				0.9 (adult) 1.5 (child)

Dose estimates include ingestion and dermal exposure.
mg/kg/day: milligram per kilogram per day.
MRL: Agency for Toxic Substances and Disease Registry's Minimal Risk Level.
NOAEL: No Observed Adverse Effect Level.
LOAEL-a: Lowest Observed Adverse Effect Level–adjusted by a factor of 10 as a proxy for a NOAEL.
RfD: Environmental Protection Agency's Reference Dose.
Hazard Quotient: intake dose/toxicity value.
Hazard Index: sum of hazard quotients.

Exposure assumptions used in estimating ingestion dose from surface water [23,39,40]
CW = chemical concentration in water (mg/L)
IR = ingestion rate (0.05 liter/hour)
ET = exposure time (1 hour/day)
EF = exposure frequency (90 days/year)
ED = exposure duration – years of exposure (child: 8 years) (adult: 14 years)
BW = body weight (kg) (for child 41.9 kg: average of 50^{th} percentile of females and males ages 8-16) (for adult 71.8 kg: average of women and men)
AT = averaging time (days) (ED * 365 days/year) for non carcinogen; averaging time for carcinogen dose is equal to 70 years * 365 days/year

Equation: (CW)(IR)(ET)(EF)(ED)/(BW)(AT)

Exposure assumptions used in estimating dermal dose from surface water [23,39-41]
CW = chemical concentration in water (mg/L)
P = permeability constant (cm/hour) for COCs (chemical specific: arsenic 0.001, manganese 0.001, thallium 0.001)
Conversion factor = liters to cm^2
SA = exposed surface body area (cm^2) adult = 5809 cm^2; child = 5323 cm^2. Skin surface area (adult) from the U.S. Environmental Protection Agency (EPA) exposure factors handbook, averaging the 50^{th} percentile for lower legs feet and hands of females and males with that of the forearms of males (data not supplied for women). Skin surface area (child) from the EPA exposure factors handbook, averaging the 50^{th} percentile for total body surface area for males and females ages 8-15 multiplied by the percentage of total surface area that the legs, hands, and feet.
ET = exposure time (1 hour/day)
EF = exposure frequency (30 days/year)
ED = exposure duration – years of exposure (child: 8 years) (Adult: 14 years)
BW = body weight (kg) (for child 45.5 kg: average of females and males ages 8-16) (for adult 71.8 kg: average of women and men)
AT = averaging time (days) (ED * 365 days/year) for non carcinogen; averaging time for carcinogen dose is equal to 70 years * 365 days/year

Equation: (CW)(P)(0.001L/cm^2)(SA)(ET)(EF)(ED)/(BW)(AT)

Table C8. Summary of Contaminants Detected in Surface Water in November 2007 from the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Maximum Detected Concentration in Buena Vista Ponds (location)** (µg/L)	**Maximum Detected Concentration in Klau Pond** (µg/L)	**Maximum Detected Concentration in Creeks/Streams (Location)** (µg/L)	**Media-Specific Comparison Values – Source** (µg/L)
Aluminum	**39,100**	52.3	1,240 (KBC-180)	10,000 chronic EMEG (child) 40,000 chronic EMEG (adult)
Antimony	0.22	0.28	0.23 (LTC-130)	4 chronic RMEG (child) 10 chronic RMEG (adult)
Arsenic	**68.6**	NA	**1.2** (LTC-140)	3 chronic EMEG (child) 10 chronic EMEG (adult) 0.02 CREG
Barium	545	NA	96 (SLT-080)	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Beryllium	0.95	NA	<5 (all creeks sampled)	20 chronic EMEG (child) 70 chronic EMEG (adult)
Boron	**2,050**	0.96	597 (KBC-170)	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Cadmium	0.2	NA	<1 (all creeks sampled)	2 chronic EMEG (child) 7 chronic RMEG (adult)
Chromium	91.4	NA	2.5 (KBC-180)	100 MCL
Cobalt	136	0.01	249 (KBC-180)	7,300 tap water PRG
Copper	**119**	NA	3.4 (KBC-180)	100 intermediate EMEG (child) 400 intermediate EMEG (adult)
Iron	**860,000**	214	**172,000** (KBC-180)	11,000 tap water PRG

Table C8. Summary of Contaminants Detected in Surface Water in November 2007 from the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Maximum Detected Concentration in Buena Vista Ponds (location)** (µg/L)	**Maximum Detected Concentration in Klau Pond** (µg/L)	**Maximum Detected Concentration in Creeks/Streams (Location)** (µg/L)	**Media-Specific Comparison Values – Source** (µg/L)
Lead	<10	NA	3.5 (KBC-140)	15 MCL
Manganese	**60,200**	NA	**16,600** (KBC-170)	500 chronic RMEG (child) 2,000 chronic RMEG (adult)
Mercury	**25.6**	0.4	1.3 (KBC-180)	3 chronic EMEG (child) 10 chronic EMEG (adult)
Nickel	**625**	NA	**2,460** (KBC-180)	200 chronic RMEG (child) 700 chronic RMEG (adult)
Selenium	271	NA	0.78 (LTC-140)	1,800 tap water PRG
Silver	**1,240**	NA	4.8 (KBC-160)	50 chronic RMEG (child) 200 chronic RMEG (adult)
Thallium	**3.1**	NA	**21.6** (KBC-180)	2 MCL
Vanadium	**92.1**	NA	6.7 (LTC-140)	30 intermediate EMEG (child) 100 intermediate EMEG (adult)
Zinc	2,070	NA	62 (KBC-180)	3,000 chronic EMEG (child) 10,000 chronic EMEG (adult)

Data source [25]
Buena Vista pond data collected from the lower containment pond.
Bolded detections meet or exceed media-specific comparison values.
µg/L: micrograms per liter; NA: not analyzed; LTC: Las Tablas Creek; KBC: Klau Branch Creek; EMEG: Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide; RMEG: Reference Dose Media Evaluation Guide based on Environmental Protection Agency's Reference Dose; CREG: Agency for Toxic Substances and Disease Registry's Cancer Risk Evaluation Guide for 1 in 1,000,0000 increased cancer risk; MCL: Maximum Contaminant Level for drinking water (state and federal); PRG: U.S. Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects).

Table C8-A. Summary of Contaminants Detected in Surface Water in April 2008 from the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	Maximum Detected Concentration in Buena Vista Containment Ponds (location) (µg/L)	Maximum Detected Concentration in Klau Ponds (location) (µg/L)	Maximum Detected Concentration in BLM Reservoir (µg/L)	Maximum Detected Concentration in Creeks/Streams (location) (µg/L)	Media-Specific Comparison Values – Source (µg/L)
Aluminum	<200 (upper pond) <200 (lower pond)	77 (Klau Pond) <200 (West Klau Pond)	700	907 (LTC-140W)	10,000 chronic EMEG (child) 40,000 chronic EMEG (adult)
Antimony	<60 (upper pond) <60 (lower pond)	**7.9** (Klau Pond) <60 (West Klau pond)	<60	<60	4 chronic RMEG (child) 10 chronic RMEG (adult)
Arsenic	<10 (upper pond) <10 (lower pond)	<10 (Klau Pond) <10 (West Klau Pond)	<10	<10	3 chronic EMEG (child) 10 chronic EMEG (adult) 0.02 CREG
Barium	14.3 (upper pond) 15.5 (lower pond)	38.2 (Klau pond) <200 (West Klau pond)	84.6	200 (LTC-135, KBC-200; SCM-145; NPD-2s)	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Beryllium	<5 (upper pond) <5 (lower pond)	<5 (Klau Pond) <5 (West Klau Pond)	<5	<5	20 chronic EMEG (child) 70 chronic EMEG (adult)
Boron	457 (upper pond) 157 (lower pond)	56.2 (Klau Pond) 68.3 (West Klau Pond)	120	1,200 (NPD-2w)	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Cadmium	<5 (upper pond) <5 (lower pond)	<5 (Klau Pond) <5 (West Klau Pond)	<5	<5	2 chronic EMEG (child) 7 chronic RMEG (adult)
Chromium	<10 (upper pond) <10 (lower pond)	1.2 (Klau Pond) 0.54 (West Klau Pond)	2.9	2.9 (LTC-140w)	50 MCL (California)
Cobalt	<50 (upper pond) <50 (lower pond)	<50 (Klau Pond) <50 (West Klau Pond)	<50	20.9 (KBC-170w)	7,300 tap water PRG
Copper	<25 (upper pond) <25 (lower pond)	1.8 (Klau Pond) 25 (West Klau Pond)	3	3.8 (LTC-140w)	100 intermediate EMEG (child) 400 intermediate EMEG (adult)
Iron	550,000 (upper pond) 198,000 (lower pond)	698 (Klau Pond) 184 (West Klau Pond)	1,480	9,630 (NPD-2s)	11,000 tap water PRG
Lead	<10 (upper pond) <10 (lower pond)	<10 (Klau Pond) <10 (West Klau Pond)	<10	<10	15 MCL

Table C8-A. Summary of Contaminants Detected in Surface Water in April 2008 from the Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Maximum Detected Concentration in Buena Vista Containment Ponds (location)** (µg/L)	**Maximum Detected Concentration in Klau Ponds (location)** (µg/L)	**Maximum Detected Concentration in BLM Reservoir** (µg/L)	**Maximum Detected Concentration in Creeks/Streams (location)** (µg/L)	**Media-Specific Comparison Values – Source** (µg/L)
Manganese	<15 (upper pond) 18.9 (lower pond)	65.7 (Klau Pond) 39.7 (West Klau Pond)	121	**1,230** (KBC-170w)	500 chronic RMEG (child) 2,000 chronic RMEG (adult)
Mercury	<0.2 (upper pond) <0.2 (lower pond)	<0.2 (Klau Pond) <0.2 (West Klau Pond)	0.26	0.6 (LTC-140w)	3 chronic EMEG (child) 10 chronic EMEG (adult)
Nickel	1.9 (upper pond) 12.7 (lower pond)	9.8 (Klau Pond) 12.9 (West Klau Pond)	106	**326** (KBC-170w)	200 chronic RMEG (child) 700 chronic RMEG (adult)
Selenium	<35 (upper pond) <35 (lower pond)	<35 (Klau Pond) <35 (West Klau Pond)	<35	<35	1,800 tap water PRG
Silver	<10 (upper pond) <10 (lower pond)	<10 (Klau Pond) <10 (West Klau Pond)	<10	<10	50 chronic RMEG (child) 200 chronic RMEG (adult)
Thallium	**19.3** (upper pond) <25 (lower pond)	<25 (Klau Pond) <25 (West Klau Pond)	<25	<25	2 MCL
Vanadium	0.44 (upper pond) 0.5 (lower pond)	0.87 (Klau Pond) <50 (West Klau Pond)	2.8	10.4 (LTC-140w)	30 intermediate EMEG (child) 100 intermediate EMEG (adult)
Zinc	<60 (upper pond) <60 (lower pond)	<60 (Klau Pond) <60 (West Klau Pond)	61.3	114 (NPD-2w)	3,000 chronic EMEG (child) 10,000 chronic EMEG (adult)

Data source [25]
Buena Vista pond data collected from the lower containment pond.
Bolded detections meet or exceed comparison values.
µg/L: micrograms per liter; NA: not analyzed.
LTC: Las Tablas Creek; KBC: Klau Branch Creek; NPDES conveyance ditch; SCM: Santa Cruz Mill drainage.
EMEG: Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide; RMEG: Reference Dose Media Evaluation Guide based on U.S. Environmental Protection Agency's Reference Dose; CREG: Agency for Toxic Substances and Disease Registry's Cancer Risk Evaluation Guide for 1 in 1,000,0000 increased cancer risk; MCL: Maximum Contaminant Level for drinking water (state and federal); PRG: U.S. Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects).

Table C9. Noncancer Dose Estimates for Current Exposure to Contaminants in Surface Water Exceeding Media-Specific Comparison Values and Hazard Index for All Metals, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	**Estimated Dose Adult** (mg/kg/day)	**Estimated Dose Child** (mg/kg/day)	**Health Comparison Value (Source)** (mg/kg/day)	**Hazard Quotient** (unitless)
Arsenic	0.00000008	0.0000001	0.0003 (MRL)	0.0003 (adult) 0.0004 (child)
Manganese	0.001	0.002	0.05 (RfD)	0.02 (adult) 0.03 (child)
Nickel	0.0001	0.0002	0.02 (RfD)	0.007 (adult) 0.01 (child)
Thallium	0.000001	0.000002	0.00006 (RfD)	0.2 (adult) 0.4 (child)
Total Hazard Index from exposure to all metals measured in surface water				0.3 (adult) 0.4 (child)

Dose estimates include ingestion and dermal exposure.
mg/kg/day: milligram per kilogram per day; MRL: Agency for Toxic Substances and Disease Registry's Minimal Risk Level; RfD: U.S. Environmental Protection Agency's Reference Dose.

Exposure assumptions used in estimating ingestion dose from surface water [23,39,40]
CW = chemical concentration in water (mg/L)
IR = ingestion rate (0.05 liter/hour)
ET = exposure time (1 hour/day)
EF = exposure frequency (90 days/year)
ED = exposure duration – years of exposure (child: 8 years) (adult: 15 years)
BW = body weight (kg) (for child 41.9 kg: average of 50^{th} percentile of females and males ages 8-16) (for adult 71.8 kg: average of women and men)
AT = averaging time (days) (ED * 365 days/year) for non carcinogen; averaging time for carcinogen dose is equal to 70 years * 365 days/year

Equation: (CW)(IR)(ET)(EF)(ED)/(BW)(AT)

Exposure assumptions used in estimating dermal dose from surface water [23,39-41]
CW = chemical concentration in water (mg/L)
P = permeability constant (cm/hour) for contaminants of concern (chemical specific: arsenic 0.001, manganese 0.001, thallium 0.001)
Conversion factor = liters to cm^2
SA = exposed surface body area (cm^2) adult = 5809 cm^2; child = 5323 cm^2. Skin surface area (adult) from the U.S. Environmental Protection Agency (EPA) exposure factors handbook, averaging the 50^{th} percentile for lower legs feet and hands of females and males with that of the forearms of males (data not supplied for women). Skin surface area (child) from the EPA exposure factors handbook, averaging the 50^{th} percentile for total body surface area for males and females ages 8-15 multiplied by the percentage of total surface area that the legs, hands, and feet.
ET = exposure time (1 hour/day)
EF = exposure frequency (30 days/year)
ED = exposure duration – years of exposure (child: 8 years) (Adult: 15 years)
BW = body weight (kg) (for child 45.5 kg: average of females and males ages 8-16) (for adult 71.8 kg: average of women and men)
AT = averaging time (days) (ED * 365 days/year) for non carcinogen; averaging time for carcinogen dose is equal to 70 years * 365 days/year

Equation: (CW)(P)(0.001L/cm^2)(SA)(ET)(EF)(ED)/(BW)(AT)

Table C10. Summary of Groundwater Data Collected in 1999, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant (µg/L)	**Sample Location/Well Identification**						**Media-Specific Comparison Value Source** (µg/L)
	B-2-GW	**B-6-GW**	**Mahoney Sump**	**Mill Well (MW-5)**	**Ore Shed Well (MW-6)**	**Horizontal Drain Sump (#1)**	
Iron	4,000	2,700	53,000	21,000	**2,600,000**	**13,000,000**	110,000 PRG
Manganese	**3,000**	**9,400**	**5,800**	**2,600**	**28,000**	**34,000**	500 chronic RMEG (child) 2,000 chronic RMEG (adult)
Mercury	1.5	1.3	0.53	**3.3**	0.18		3 chronic EMEG (child) 10 chronic EMEG (adult) 2 MCL
pH	6.7	6.5	**6.09**	7.08	**4.91**	**3.45**	6.5-8.5 (neutral)
Sulfate	**1,900,000**	**12,000,000**	**3,500,000**	**1,700,000**	**12,000,000** 0.11	**33,000,000**	250,000 Secondary MCL

Data source [5].
µg/L: micrograms per liter.
PRG: Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects).
RMEG: Reference Dose Media Evaluation Guide based on Environmental Protection Agency's Reference Dose.
MCL: Maximum Contaminant Level for drinking water (state and federal).
Bolded detections meet or exceed comparison values.
pH and Sulfate comparison values are the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Level drinking water standards, which are based on taste, odor, or color concerns, not on health.

Table C11. Summary of Groundwater Data Collected in 2008, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	Maximum Detected Concentration (location) µg/L	Media-Specific Comparison Value – Source µg/L
Aluminum	**131,000** (Klau repository underdrain)	10,000 chronic EMEG (child) 40,000 chronic EMEG (adult)
Antimony	**21.7** (Buena Vista adit sump)	4 chronic RMEG (child) 10 chronic RMEG (adult)
Arsenic	**586** (Klau repository underdrain)	3 chronic EMEG (child) 10 chronic EMEG (adult) 0.02 CREG
Barium	631 (Klau – Richard's adit area well)	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Beryllium	7.1 (Klau repository underdrain)	20 chronic EMEG (child) 70 chronic EMEG (adult)
Boron	**63,000** (Klau – Richard's adit area well)	2,000 chronic RMEG (child) 7,000 chronic RMEG (adult)
Cadmium	**36.1** (Klau repository underdrain)	2 chronic EMEG (child) 7 chronic RMEG (adult)
Chromium	**234** (Klau repository underdrain)	100 MCL
Cobalt	1,560 (Klau repository underdrain)	7,300 tap water PRG
Copper	**143** (Buena Vista mine shop sump)	100 intermediate EMEG (child) 400 intermediate EMEG (adult)
Iron	**311,000** (Buena Vista mine shop sump)	11,000 tap water PRG
Lead	**154** (Klau repository underdrain)	15 MCL
Manganese	**33,900** (Klau repository underdrain)	500 chronic RMEG (child) 2,000 chronic RMEG (adult)
Mercury	**95.9** (Buena Vista adit sump)	3 chronic EMEG (child) 10 chronic EMEG (adult) 2 MCL
Nickel	**12,600** (Klau repository underdrain)	200 chronic RMEG (child) 700 chronic RMEG (adult)

Table C11. Summary of Groundwater Data Collected in 2008, Klau and Buena Vista Mines, San Luis Obispo County, California

Contaminant	Maximum Detected Concentration (location) µg/L	Media-Specific Comparison Value – Source µg/L
Selenium	29.3 (Klau repository underdrain)	1,800 tap water PRG
Silver	10 (Klau repository underdrain)	50 chronic RMEG (child) 200 chronic RMEG (adult)
Thallium	**116** (Buena Vista mine shop sump)	2 MCL
Vanadium	**82** (Buena Vista adit sump)	30 intermediate EMEG (child) 100 intermediate EMEG (adult)
Zinc	2,750 (Klau repository underdrain)	3,000 chronic EMEG (child) 10,000 chronic EMEG (adult)

Data source [25]
Bolded detections meet or exceed comparison values.
µg/L: micrograms per liter.
PRG: U.S. Environmental Protection Agency, Region IX, Preliminary Remediation Goal (based on noncancer health effects).
RMEG: Reference Dose Media Evaluation Guide based on Environmental Protection Agency's Reference Dose.
MCL: Maximum Contaminant Level for drinking water (state and federal).

Appendix D. Health Advisory on Mine Tailings and Runoff

HEALTH WARNING

The San Luis Obispo County Health Agency is issuing the following advisory:

Avoid contact with runoff water from mine tailings and creek water within 100 feet downstream from mine runoff areas. Avoid contact with any pooled or ponded water on or immediately adjacent to mine property.

CONTACT WITH RUNOFF WATER FROM MINE TAILINGS AND CREEK WATER MAY CAUSE:

- MILD BURNS AND IRRITATION TO SKIN IMMEDIATELY AFTER CONTACT.
- SEVERE BURNS AND TISSUE DAMAGE TO EYES, NOSE, MOUTH OR OTHER MUCOUS MEMBRANES.

Runoff water from mercury mine tailings may be acidic in the immediate area of the mine property and within 100 feet downstream of mine discharge points. Acidic water may cause mild skin burns and irritation immediately after contact. Exposure to eyes, nose, mouth or other mucous membranes may cause more severe burns and tissue damage.

For further information contact San Luis Obispo County Environmental Health at (805) 781-5544.

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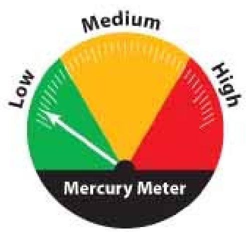
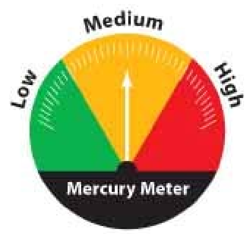
Appendix E. Health Advisory on Catching and Eating Fish

A Guide to Eating Fish Caught in Lake Nacimiento

Women 18 - 45, especially those who are pregnant or breastfeeding, and children 1 - 17

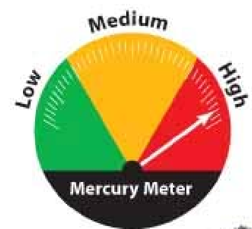


There are no fish with low levels of chemicals



Bluegill and other sunfish

Sucker



Spotted, smallmouth, or largemouth bass

White bass

Crappie

Catfish

Carp

	Safe to eat 1 serving per week	Do not eat

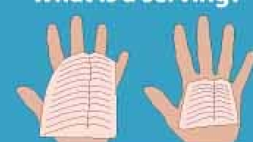
Why eat fish?

Eating fish is good for your health. Fish have Omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

What is the concern?

Some fish have high levels of mercury that can negatively affect how the brain develops in unborn babies and children.

What is a serving?



For Adults For Children

The recommended serving of fish is about the size and thickness of your hand. Give children smaller servings.

Men over 17 and women over 45 can safely eat more fish

- There are no fish with low levels of mercury
- **Safe to eat 2 servings per week** — bluegill and other sunfish, or sucker

OR

- **Safe to eat 1 serving per week** — black bass, carp, catfish, crappie, or white bass

Fish buying guidelines for women 18 – 45 and children 1 – 17

Do not eat fish caught in Lake Nacimiento in the same week that you eat fish bought in a store or restaurant. For fish that you buy:

- **Safe to eat 2 servings per week** of low mercury fish such as salmon ♥, pollock, catfish, tilapia, shrimp, anchovies ♥, sardines ♥, trout ♥, and canned chunk-light tuna

OR

- **Safe to eat 1 serving per week** of medium-mercury fish such as canned albacore (white) tuna ♥

- **Do not eat** shark, swordfish, tilefish, or king mackerel

♥ = High in Omega-3s

California Office of Environmental Health Hazard Assessment
www.oehha.ca.gov/fish.html
(916) 327-7319 or (510) 622-3170

5-09

Appendix F. Toxicological Summaries

This appendix provides background information from toxicological profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR), information developed by the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA), and the U.S. Environmental Protection Agency (EPA). It highlights the toxicological effects of contaminants of concern (exceeding health comparison or media-specific comparison values) detected in soil, surface water, or groundwater, in and around the Klau and Buena Vista Mines.

Acronyms and units of measure used in this appendix:

IARC—International Agency for Research on Cancer
DHHS—Department of Health and Human Services
ppb—parts per billion
mg/kg/day—milligram per kilogram per day
$\mu g/m^3$—microgram per cubic meter
μg/dL—microgram per deciliter
pCi—picocuries

Aluminum [42]

- Is ubiquitous; the third most common element of the earth's crust.
- Naturally released to the environment from the weathering of rocks and volcanic activity. Human activities such as mining also result in the release of aluminum to the environment.
- Found in over-the-counter medicinals, such as antacids and buffered aspirin; used as a food additive; found in a number of topically applied consumer products such as antiperspirants, and in first aid antibiotic and antiseptics, diaper rash and prickly heat, insect sting and bite, sunscreen and suntan, and dry skin products.
- Numerous studies have examined aluminum's potential to induce toxic effects in humans exposed via inhalation, oral, or dermal exposure. Most of these findings are supported by a large number of studies in laboratory animals. Occupational exposure studies and animal studies suggest that the lungs and nervous system may be the most sensitive targets of toxicity following inhalation exposure. The nervous system may be the primarily organ affected by ingestion.
- Exposure to most people is through the consumption of food items, although minor exposures may occur through ingestion of aluminum in drinking water and inhalation of ambient air.
- ATSDR intermediate and chronic oral Minimal Risk Level = 1 mg/kg/day (developmental effect in offspring, decreased limb strength and decreased thermal sensitivity).

Carcinogenicity Classification

- Aluminum production is carcinogenic to humans and pitch volatiles have fairly consistently been suggested in epidemiological studies as being possible causative agents (IARC).
- Not evaluated (DHHS).

Arsenic [43]

- Naturally occurring element commonly found in surface soil and surface water.
- Arsenic trioxide is the primary form marketed and consumed, with 90% used in the production of wood preservatives (copper chromated arsenic).
- Various organic arsenicals are still used in herbicides and as antimicrobials in animal and poultry feed.
- Long-term exposures of lower levels of arsenic through drinking water (170-800 ppb) can lead to a condition known as "blackfoot disease."
- Other effects include gastrointestinal irritation, and contact with skin can cause discoloration (hypo-or hyper-pigmentation), wart-like growths, and skin cancer.
- ATSDR acute oral Minimal Risk Level = 0.005 mg/kg/day (gastrointestinal effects in humans).
- ATSDR chronic oral Minimal Risk Level = 0.0003 mg/kg/day (dermal effects in humans).
- EPA's Oral Reference Dose = 0.0003 mg/kg/day (dermal effects in humans).
- Acute Reference Exposure Level = 0.19 µg/m^3 (reproductive, developmental effects in mice).
- Chronic Reference Exposure Level = 0.03 µg/m^3 (developmental, cardiovascular, nervous system in mice).

- EPA inhalation unit risk = 0.0043 μg/m^3.
- Oral cancer slope factor = 1.5 $(mg/kg\text{-}day)^{-1}$.
- Inhalation slope factor = 12 $(mg/kg\text{-}day)^{-1}$.

Carcinogenicity classification

- Known human carcinogen due to its ability to cause skin cancer, with oral exposures increasing the risks of liver, bladder, and lung cancer (EPA).
- Carcinogenic to humans (IARC).

Chromium [44]

- Naturally occurring element found in soil and in volcanic dust and gases.
- Different forms (valence states) of chromium; most common are trivalent chromium and hexavalent chromium.
- Trivalent chromium is an essential nutrient that plays a role in glucose, fat, and protein metabolism by potentiating the action of insulin.
- Ingestion of hexavalent chromium poses a relatively low health concern because it is rapidly transformed into trivalent chromium in the gastrointestinal tract.
- Hexavalent chromium is generally produced by industrial sources.
- Adverse health effects from breathing hexavalent chromium include asthma, bloody nose, nasal septum scarring and perforation, runny nose, mild decreased lung function, bronchitis, gastric irritation, and subtle changes in kidney function (affects primarily the proximal tubule).
- EPA chronic oral Reference Dose for trivalent chromium = 1.5 mg/kg/day (reduced liver weight in rats).
- EPA chronic oral Reference Dose for hexavalent chromium = 0.003 mg/kg/day (reduced body weight in rats).

Carcinogenicity classification for hexavalent chromium

- Human carcinogen (EPA).
- Carcinogenic to humans (IARC).
- Known human carcinogen (DHHS).
- Inhalation unit risk = 0.15 $(\mu g/m^3)^{-1}$.

Carcinogenicity Classification for trivalent and total chromium

- Not classifiable (EPA and IARC).
- Not classified (DHHS).

Copper [45]

- Naturally occurring metal found in rocks, soil sediment, and water.
- Essential element for humans, plants, and other animals.
- Long-term exposure to copper dust can irritate nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea.
- Common effects from ingestion of higher than normal levels of copper include nausea, vomiting, stomach cramps, or diarrhea.
- ATSDR acute and intermediate oral Minimal Risk Level = 0.01 mg/kg/day (gastrointestinal effects in humans).

Carcinogenicity Classification

- Not classifiable due to a lack of studies (EPA).
- Not reviewed (IARC).

Lead [46]

- Naturally occurring metal found in small amounts in the earth's crust; most of the high levels of lead found in the environment are from human activities.
- People may be exposed to lead by eating foods or drinking water that contains lead, spending time in areas where leaded paints have been used or are deteriorating, lead pipes, and drinking from leaded-crystal glassware.
- People who live near hazardous waste sites may be exposed to lead and chemicals containing lead by breathing the air, swallowing dust and dirt containing lead, or drinking lead-contaminated water.
- Lead affects the nervous system, the blood system, the kidneys, and the reproductive system.
- Low blood levels (30 µg/dL) may contribute to behavioral disorders; lead levels in young children have been consistently associated with deficits in reaction time and with reaction behavior. These effects on attention occur at blood lead levels extending below 30 µg/dL, and possibly as low as 15-20 µg/dL; the developing nervous system of a young child can be adversely affected at blood lead levels below 10 µg/dL.
- Health effects associated with lead are not based on an external dose, but on internal dose that takes into account total exposure.
- Federal agencies and advisory groups have defined childhood lead poisoning as a blood lead level of 10 µg/dL.
- Occupational Safety and Health Administration requires workers with a blood lead level above 50 µg/dL be removed from the workroom where lead exposure is occurring.

Carcinogenicity Classification

- Probable human carcinogen (renal tumors in mice) (EPA).
- Possibly carcinogenic to humans (limited evidence of kidney, brain, and lung cancer) (IARC).
- Listed on State of California Proposition 65 Reproductive/Developmental Toxicants (OEHHA).

Manganese [47]

- Naturally occurring substance found in many types of rock.
- Released into the air from iron- and steel- producing plants, power plants, coke ovens, burning of fossil fuels, and erosion of soil containing manganese.
- Is an essential nutrient.
- Workers exposed to high levels of manganese dust in the air may experience mental and emotional disturbances, slow and clumsy body movements, and impotence.
- People whose water supply contained high levels of manganese showed symptoms of lethargy, increased muscle tone, tremor, and mental disturbances. In another community with high manganese in the drinking water, the children's academic performance was affected.

- There is indirect evidence that reproductive outcomes might be affected (decreased libido, impotence, and sexual dysfunction have been observed in manganese-exposed men); however, the available studies on the effect manganese has on fertility is inconclusive.
- Developmental data in humans exposed to manganese are limited. Animal studies indicate that manganese is a developmental toxin when administered orally and intravenously, but inhalation data concerning these effects are scarce and not definitive.
- Newborns and infants absorb more manganese from the intestinal tract, are less able to excrete it in the feces once taken up, the absorbed manganese passes more easily through the neonatal blood brain barrier, and greater number of transferrin molecules that carry manganese into the brain.
- EPA chronic oral Reference Dose = 0.05 mg/kg/day in water or soil (highest intake for nutritional value without toxicity).
- ATSDR chronic inhalation Minimal Risk Level = 0.04 $\mu g/m^3$ (neurobehavioral changes in workers).
- OEHHA child-specific Reference Dose = 0.03 mg/kg/day (highest intake for nutritional value without toxicity, children have greater potential for toxicity (see above).

Carcinogenicity Classification

- Not classifiable (EPA).

Mercury [29]

- Mercury occurs naturally in the environment and exists in several forms; these forms can be organized under three headings: metallic mercury (also known as elemental mercury), inorganic mercury, and organic mercury.
- Metallic mercury is used in a variety of household products and industrial items, including thermostats, fluorescent light bulbs, barometers, glass thermometers, and some blood pressure devices.
- Spills of metallic mercury from broken thermometers or damaged electrical switches in the home may result in exposure to mercury vapors in indoor air that could be harmful to health; microorganisms (bacteria, phytoplankton in the ocean, and fungi) convert inorganic mercury to methylmercury.
- Ingestion of fish one of the most common ways people are exposed to methylmercury.
- Exposure to high levels (above 500 $\mu g/m^3$ and above 1.9 mg/kg/day) of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus.
- ATSDR chronic inhalation Minimal Risk Level = 0.2 $\mu g/m^3$ (neurological effects in humans).
- ATSDR intermediate oral Minimal Risk Level (inorganic mercury/mercuric chloride) = 0.002 mg/kg/day (renal effects in mice).
- ATSDR chronic Minimal Risk Level (methylmercury) = 0.0003 mg/kg/day (neurodevelopment effects in humans).
- EPA chronic oral Reference Dose for (inorganic mercury/mercuric chloride = 0.0003 mg/kg/day (autoimmune effects in rats).

Carcinogenicity classification

- Mercury chloride and methylmercury are possible human carcinogens (EPA).
- Not classified (IARC).

Nickel [48]

- Hard metal that occurs naturally in soils and volcanic dust.
- Released to the atmosphere by windblown dust, volcanoes, combustion of fuel oil, municipal incineration, and industries involved in nickel refining, steel production, and other nickel alloy production.
- The most commonly reported adverse health effect associated with nickel exposure is contact dermatitis. Contact dermatitis is the result of an allergic reaction to nickel that has been reported in the general population and workers exposed via dermal contact with airborne nickel, liquid nickel solution, or prolonged contact with metal items such as jewelry and prosthetic devices that contain nickel. After an individual becomes sensitized to nickel, dermal contact with a small amount of nickel or oral exposure to fairly low doses of nickel can result in dermatitis. Approximately 10%–20% of the general population is sensitized to nickel.
- Adverse noncancer respiratory effects have been reported in humans and animals exposed to nickel compounds at concentrations much higher than typically found in the environment.
- The potential for nickel compounds to induce reproductive effects (male reproductive effects and decreased fertility) has not been firmly established but some animal studies have shown such effects (changes in the male reproductive system and impaired fertility) while other studies have not.
- Nickel refinery dust caused lung and nasal tumors in sulfide nickel matte refinery workers in several epidemiologic studies in different countries, and on animal data in which carcinomas were produced in rats by inhalation and injection.
- EPA Reference Dose = 0.02 mg/kg/day (decreased body weight in offspring).
- OEHHA child-specific Reference Dose = 0.011 mg/kg/day (offspring mortality in 3 rat studies).

Carcinogenicity Classification

- Metallic nickel may reasonably be anticipated to be a human carcinogen and nickel compounds are known to be human carcinogens (DHHS).
- Metallic nickel classified in group 2B (possibly carcinogenic to humans) and nickel compounds in group 1 (carcinogenic to humans) (IARC).
- Nickel refinery dust and nickel subsulfide classified in Group A (human carcinogen); other nickel compounds not classified (EPA).
- Listed on State of California Proposition 65 Reproductive/Developmental Toxicants (OEHHA).
- EPA Inhalation Slope Factor = 0.91 $(mg/kg\text{-}day)^{-1}$ (lung and nasal cancer).

Thallium [49]

- Naturally occurring substance found in many types of rock.
- Has no recognizable smell or taste.
- Used in the manufacture of electrical equipment such as semiconductors.
- Human occupational studies indicate that thallium exposure might affect the nervous system.
- Short-term exposure to thallium can cause gastrointestinal irritation and nerve damage.
- Long-term exposure to thallium can cause changes in blood chemistry; damage to the liver, kidney, intestinal, and testicular tissues, as well as hair loss.

- EPA has set the Maximum Contaminant Level for thallium at 2.0 ppb because this is the lowest level to which water systems can reasonably be required to remove this contaminant, should it occur in drinking water. The Maximum Contaminant Level Goal is set at 0.5 ppb.
- EPA Reference Dose for thallium acetate, thallium nitrate = 0.00009 mg/kg/day (hepatic effects in rats).
- EPA Reference Dose for thallium carbonate, thallium chloride = 0.00008 mg/kg/day (hepatic effects in rats).
- EPA Reference Dose for thallium sulfate = 0.00008 mg/kg/day (no adverse effects in rats).

Carcinogenicity

- Not classified (EPA, DHHS, and IARC).

Vanadium [50]

- Naturally occurring substance found in many types of rock.
- Vanadium oxide is a man-made form of vanadium commonly used in industry.
- People are exposed daily to low levels of vanadium in food, water, and air.
- Breathing vanadium containing dust can cause irritation of the lungs, throat, and eyes.
- Limited understanding of health effects from ingesting vanadium.
- High levels in water given to rats resulted in minor birth defects.
- EPA chronic oral Reference Dose = 0.009 mg/kg/day (critical endpoint: decreased hair cystine in rats).
- ATSDR intermediate oral Minimal Risk Level = 0.003 mg/kg/day (critical endpoint: renal effects in rats).

Carcinogenicity

- Not classified (EPA and DHHS).
- Vanadium pentoxide is a possible carcinogenic (IARC).

Appendix G. Public Comment and Response from the California Department of Public Health

On July 9, 2009, this public health assessment (PHA) for the Klau and Buena Vista Mines was released in draft for public comment. On July 14, 2009, CDPH and the U.S. Environmental Protection Agency (EPA) shared results of the PHA with the community at a joint public meeting. The comment period ended on August 10, 2009.

As part of the release of this PHA, the California Department of Public Health (CDPH) placed the report in several libraries in the area for public review and comment. CPDH mailed the PHA to about 100 addresses from its mailing list for the Klau and Buena Vista Mines. This list contains on-site residents, neighbors, other community stakeholders, civic, political interested parties, and government agencies. The PHA is available on the CDPH website at www.ehib.org.

CDPH received comments from one community member. The comment is provided below; CDPH's response is provided in *italics.*

Comment submitted by a community member

Comment: Just finished reading and studying the Klau & BV mine's PHA. Thanks for summarizing a lot of confusing sample data into a fine health report. The last sentence on Page 37 and following two asterisk statements seem unnecessary. Technically, I question laboratory results of samples when cinnabar is outcropped all over the area and mercury sulfide particulate has been spread wide and far naturally and through mining operations. (This is not a comment, just scientific curiosity.) Thanks to you and Dr. Underwood for your efforts.

CDPH's response: Comments noted. If you have questions or interest regarding the effects of cinnabar on the laboratory analyses, Jim Sickles, the project manager with EPA, is very knowledgeable and could either answer your questions or put you in contact with an EPA chemist.