PUBLIC HEALTH ASSESSMENT

STIBNITE/YELLOW PINE MINING AREA
STIBNITE, VALLEY COUNTY, IDAHO
EPA FACILITY ID: IDD980665459

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Prepared by:

Bureau of Environmental Health and Safety
Division of Health
Idaho Department of Health and Welfare
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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SUMMARY

The Stibnite Mine Area (Stibnite) engaged in active mining operations from the early 1900's until the late 1990's. Stibnite is located along the East Fork of the South Fork of the Salmon River, 14 miles southeast of the town of Yellow Pine, Valley County, Idaho. The mine was a major producer of antimony and gold. Past mining activities have deposited metals, spent and neutralized ore, waste rock, and mine tailings over approximately fifty percent of the 3,000 acre site. The Bureau of Environmental Health and Safety (BEHS), Division of Health, Idaho Department of Health and Welfare reviewed available environmental data, health information, and community health concerns for the development of this public health assessment. Stibnite/Yellow Pine Mining Area (Stibnite) site was proposed to U.S. Environmental Protection Agency's (EPA) National Priority List (NPL) on September 13, 2001. This document fulfills ATSDR Congressional mandate for preparing a public health assessment within one year of EPA proposing a site to the NPL. The BEHS prepared this public health assessment under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

Conclusions

- The completed exposure pathways identified include: surface soil, surface water, airborne particulates and sediments. The most important exposure pathway is the ingestion of surface soil and inhalation of airborne particulates. As there are no air contaminant concentrations available, and to be protective of public health, BEHS assumes that the exposure dose from inhalation is the same as from ingestion of surface soil. Consumption of fish is a potential exposure pathway, while subsurface water and ground water are eliminated exposure pathways.
- There is no information available about former mine workers, thus BEHS is unable to evaluate their past exposures and the public health implications of these exposures.
- It is unlikely that the contaminants at the Stibnite site will result in any adverse public health effects for the reclamation workers and recreational users, since the estimated exposure doses are either below the corresponding health guideline values, or below the corresponding lowest NOAELs (or LOAELs) in all the related studies. The predicted increased risk of cancer from arsenic is so low as to be negligible to the reclamation workers and recreational users.
- According to ATSDR's Interim Public Health Hazard Categories, the exposure pathways related to surface soil and sediment, airborne particulates, surface waters, and fish are categorized as no apparent public health hazard (Appendix B). However, the public health hazard posed by the consumption of biota (other than fish) cannot be evaluated at this time due to a lack of data and information, which is categorized as an indeterminate public health hazard.

Recommendations

- As a precaution, site access should be restricted by placing obvious "no trespassing" signs to prevent the public from entering the site, especially in the hotspot areas.
- BEHS should provide health education materials to the populations that use the site about potential health impacts of the Stibnite site.
- The reclamation workers should be cautious about ingestion of surface soil and surface water.
- Hot spot remediation is prudent even though BEHS does not believe that exposures will result in any adverse public health effects to the recreational users and reclamation workers
- Biota (other than fish) samples should be collected and analyzed for potential uptake of metals from site soils and surface water.

Public Health Action Plan

- BEHS will conduct health education activities to inform Yellow Pine residents of the status of the site. Recommendations against using the site for recreation will also be made.
- BEHS will assist the United States Forest Service and EPA with their community involvement plan as necessary.
- BEHS forwarded this document to HECLA and brought attention to the third recommendation, referring to their site workers.
- BEHS will request that the regulatory agencies involved with this site implement the fifth recommendation. If the agencies are unable to fulfill this request, BEHS and ATSDR will explore the feasibility of conducting an exposure investigation with regard to site biota.
- BEHS will review additional environmental sampling data as it becomes available.

- IDEQ is negotiating institutional controls with the current site owners to prevent future development of the site.
- IDEQ is negotiating with the site owners about how to prevent public exposure to the onsite contamination. Possible actions include site access restriction, posting warning signs, and site reclamation. Reclamation activities will focus on securing tailings piles and other contamination in such a way that the public and eco-receptors (biota) can utilize the area without the threat of exposure.
- IDEQ will require that the mill building containing mineral extraction equipment and chemicals be removed and properly disposed of along with process chemicals.
- IDEQ will arrange to have damaged buildings on site removed if they interfere with site reclamation or pose a significant threat to site safety.

1. PURPOSE AND HEALTH ISSUES

The Bureau of Environmental Health and Safety (BEHS), Division of Health, Idaho Department of Health and Welfare has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct public health assessments and consultations for hazardous waste sites in Idaho. BEHS completed this public health assessment under this cooperative agreement.

A public health assessment is a tool used to determine if and what kind of activities are needed to protect the health of a community residing/working near a hazardous waste site, and to determine the need for follow-up health activities (e.g., health study). To achieve this goal, this assessment contains three types of evaluations: (1) the identification of pathways of exposure to site contaminants and an evaluation of their public health implications; (2) a summary of relevant and available health outcome data (e.g., cancer registry data); and (3) evaluations of specific community health concerns about the site.

Stibnite/Yellow Pine Mining Area (Stibnite) site was proposed to the U.S. Environmental Protection Agency's (EPA) National Priority List (NPL) on September 13, 2001. This document fulfills ATSDR Congressional mandate for preparing a public health assessment within one year of EPA proposing a site to the NPL.

2. BACKGROUND

2.1 Site Description

The Stibnite/Yellow Pine Mining Area (Stibnite) site is located in Valley County, Idaho approximately 14 miles southeast of the town of Yellow Pine on Forest Road 50412 (see site location and maps in Appendix A). No permanent or year-round residents reside onsite. Seasonal workers and recreational users are the only people observed coming into contact with the site (Schuld 2002). Hunting, fishing, dirt bike or ATV riding, and camping are the main recreational activities conducted at the site.

Stibnite is located within the Payette National Forest on a mixture of National Forest Service and private lands. The site is defined as all the waste sources and areas between the sources resulting from mining activity along Meadow Creek and the East Fork of the South Fork of the Salmon River (EFSFSR) to the old Yellow Pine Pit, now referred to as the Glory Hole. Situated in a valley, Stibnite is surrounded by steep, forested mountains and various tributaries, including Meadow Creek and Sugar Creek, which drain into the EFSFSR (USFS 1993). The site encompasses over 3,000 acres, although the actual areas of contamination exposure are much

smaller, ranging from less than 1 acre to 119 acres. Approximately 50% of the site has either exposed tailings or is underlain by tailing which are susceptible to weathering and re-exposure (Schuld 2002). Annual precipitation averages approximately 31 inches. Most of the precipitation falls as snow from October through April. The predominant geology of the area is faulted granitic bedrock (specifically granodiorite) which contains oxide and sulfide ores. These ores are rich in gold, silver, mercury, antimony, and tungsten (URS 2000).

The majority of the mining and processing at the Stibnite Mine took place on patented claims on private lands within the Payette National Forest. Site mining activities generated numerous waste source areas along Meadow Creek and the EFSFSR. Changes in topography, stream channels, water quality, and habitat resulted from past site-related activities (URS 2000).

2.2 Site History

Gold, silver, copper, lead, antimony, and tungsten have been mined from Stibnite since the early 1900's. The first recorded claims were from 1914, staked by Albert Hennessy. The United Mercury Mining Company purchased the claims from Hennessy. The F. W. Bradley Mining Company obtained the claims in 1927. The Bradley Mining Company began mining and milling gold in the 1930's. Two years prior to the United State's involvement in World War II, an act of Congress listed antimony and tungsten as strategic metals essential to national defense. Bradley Mining Company turned Stibnite into a major producer of antimony and tungsten from 1941 through 1945. During this time period, the town of Stibnite was located onsite and had a population of 1,500 with a staffed hospital and a recreation center (USFS 1993).

According to the US Forest Service (USFS) *1993 Preliminary Assessment / Site Investigation,* the Bradley Mining Company originally mined underground but switched to open pit mining in 1943. In 1948, the Bradley Mining Company constructed and operated a smelter to process low grade gold and gold-antimony ore concentrates. The town of Stibnite immediately bordered the smelter area to the south and east (Schuld 2002). Tailings were stored at the south end of Meadow Creek and waste rock was placed along the banks of the EFSFSR downstream from the Glory Hole. The tailings along Meadow Creek averaged from 20 to 50 feet deep, 1,200 to 1,500 feet wide, and 2,200 feet long. As tailings were deposited along Meadow Creek, it became necessary to divert the creek. This diversion led to the formation of a pond behind the tailing impoundment as the seeps and springs continued to discharge water. A drainage culvert was constructed to drain the water and discharge it back into Meadow Creek. A dam was constructed on the East Fork of Meadow Creek (now called Blowout Creek) in order to supply hydroelectric power for milling operations. The dam failed in 1965 depositing large volumes of tailings into Meadow Creek, the EFSFSR, and the Glory Hole. The mine was closed in 1952 due to problems with the smelter and the collapse of the antimony market. By 1955, the processing plant was dismantled and most of the houses from the town of Stibnite were moved. The Meadow Creek diversions eventually failed allowing the stream to flow over and through the tailings. An estimated 10,000 cubic yards of tailing was eroded into the EFSFSR from 1952 to 1979.

In 1985, the Idaho Hazardous Materials Bureau conducted a Preliminary Assessment (PA) and submitted the results to the EPA. The site was assigned a Comprehensive Emergency Response Cleanup and Liability Act (CERCLA) identification number but did not score high enough to be included on the NPL. The Bradley tailings, spent ore piles, waste rock, old mining process chemicals (old Bradley mill), and the chlorine and cyanide processing plant were all listed in the PA as potential health threats. A site investigation was recommended, but not completed.

From 1970 to 1991, Stibnite claims were optioned or transferred numerous times. Companies that owned the claims at one time include: the Ranchers Exploration and Development Corporation, Canadian Superior Mining (U.S.) Ltd. (a.k.a. Superior Mining Company) which was purchased by Mobil Oil Corporation, Pioneer Metals, Pegasus Gold, Inc., and the Stibnite Mine Inc. (SMI). Pioneer Metals deposited neutralized ore with residual cyanide in it directly into Meadow Creek. They were issued a Notice of Violation by the Idaho Department of Environmental Quality (IDEQ) in 1990 for cyanide concentrations in Meadow Creek over the acute water quality standard. Detectable levels of cyanide were present in Meadow Creek for several years after.

Canadian Superior Mining started a full-scale cyanide-heap leach operation at Stibnite in 1982. Hecla Mining Corporation obtained the lease on the Bradley claims in 1988 and started an open pit mine and one-time heap leach. Hecla mined and processed low-grade oxide ore adjacent to the SMI operation. Hecla processed the remaining available oxide ore by the end of the 1991 mining season.

The gold mining operations from 1982 to 1998 took place in the West End Pit in the Meadow Creek Valley. During this period, neutralized ore from the leach pads was used to cover the Bradley tailings in upper Meadow Creek. Waste rock and neutralized ore was also used to cover other historic mining areas and tailings in the Meadow Creek Valley.

In 1991, the USFS discovered a release of arsenic. The release was documented through an analysis of steelhead trout taken from the EFSFSR below Sugar Creek. The trout tissue contained 6.38 parts per million (ppm) of arsenic. In 1993, the USFS conducted a preliminary assessment/site investigation (PA/SI) for the Stibnite site. Samples collected from the Bradley tailings and neutralized ore piles, waste piles in lower Meadow Creek Valley, stream sediments, Meadow Creek, and the EFSFSR indicated the presence of elevated concentrations of antimony, arsenic, cadmium, copper, lead, and mercury.

In 1993, SMI, under a consent order from the EPA, submitted a site investigation and evaluation report to IDEQ which documented the fact that the process ponds and on-off heap leach pads were leaking cyanide and chlorine into site soils and groundwater. The report also documented a release of diesel fuel into the site soils and groundwater. Total petroleum hydrocarbons were detected at levels in excess of EPA limits. Benzene, ethyl benzene, toluene, and total xylenes were also detected in the groundwater.

In 1995, SMI, under an Administrative Order of Consent (AOC) from the EPA, began further mitigation of environmental impact from the Bradley tailing pile in upper Meadow Creek Valley. The AOC was terminated by EPA in 1997 before the mitigation was complete. In 1998, Mobil entered into an AOC with the EPA to complete the cleanup left unfinished by SMI. Mobil was also required to reclamate and revegetate the Bradley tailing pile and reduce contaminant loads in Meadow Creek (URS 2000).

From 1997 through 1999, SMI, Hecla, and Mobil performed a Site Characterization Risk Evaluation at Stibnite. Surface water, ground water, seeps, springs, soil, sediment, and fish tissue were sampled and analyzed. Analytical results indicated the presence of elevated concentrations of antimony, arsenic, copper, cyanide, lead, and mercury in surface waters, ground water, tailings, neutralized ore, waste rock, smelter stack ash, process ponds, stream sediments, and fish. The Site Characterization and Risk Evaluation Reports were submitted to IDEQ in 2000. Stibnite was proposed to the NPL on September 13, 2001. Currently, the site is in the process of closure and is no longer actively mined (Schuld 2002).

2.3 Demographics

According to the 2000 US Census, the population of Yellow Pine, 14 miles away from the site, is 40 people. The site itself has no permanent residents. Hecla maintains a seasonal workforce of approximately six to eight people at Stibnite for approximately five months during late Spring through early Fall.

2.4 Site Visit

Representatives of BEHS visited the Stibnite Mine on July 10, 2002 to evaluate the site exposure pathways. IDEQ and the USFS representatives were on hand to assist BEHS with the site visit. The site visit was documented with digital photographs and field notes. BEHS directly observed evidence of recreational use (fire pit) in the Glory Hole area as well as game tracks in the former poison pond area and Bradley tailing piles. The capped and revegetated areas show little or no evidence of disturbance or erosion. The rest of the site contains vast tracts of disturbed soil and exposed tailings and neutralized ore piles. A significant amount of erosion was observed in areas that have not been capped or revegetated.

3. ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

An essential part of every public health assessment is to review environmental contaminants on the site. In this section, BEHS has listed the contaminants of concern (Appendix C). BEHS evaluates these contaminants in the subsequent sections of the public health assessment to determine whether exposure to them has any public health significance. The results from environmental testing at Stibnite are summarized for each different environmental media (e.g. groundwater, surface water, soil, air, etc.).

In evaluating the contaminant concentrations in different environmental media, health-based comparison values (CVs) (Appendix C, Table C-1) are used as screening values to determine which chemicals to examine more closely. Media specific CVs, as developed by ATSDR, incorporate assumptions of daily exposure to specific chemicals. These assumptions include a standard amount of air, water, and soil that someone may inhale or ingest each day. CVs are established at concentrations below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and non-cancer health effects. Non-cancerous levels are based on valid toxicological and epidemiological studies for a chemical. The non-cancerous levels include appropriate safety factors to account for human variability, extrapolating human studies from animal studies, etc. They also include the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one in a million excess cancer risk for an adult eating contaminated soil or drinking contaminated water every day for 70 years. If more than one CV exists for a chemical (cancerous effect or non-cancerous level), the smaller value is always used for screening to be more conservative or protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

For non-cancer toxicity, BEHS typically uses Environmental Media Evaluation Guides (EMEGs) derived from ATSDR's Minimal Risk Levels (MRLs) or the Reference Dose Media Evaluation Guides (RMEG) derived from EPA's References Doses (RfDs). MRLs and RfDs are estimates of daily human exposure to a contaminant that is unlikely to cause adverse non-cancer health effects over a lifetime. Cancer Risk Evaluation Guides (CREGs) are risk comparison values based on EPA's chemical-specific cancer slope factors and an estimated excess lifetime cancer risk of one in one million.

In addition to the health-based comparison values, BEHS also references other standards and regulations when health-based comparison values are not available or when other standards are lower than the health-based comparison values (to be conservative or protective). EPA's Maximum Contaminant Level (MCL) is the highest level of a contaminant that is allowed in drinking water. MCLs are enforceable standards and they are set as close to the Maximum Contaminant Level Goal (MCLG) as feasible. MCLG is the level of contaminant in drinking water below which there is no known or expected risk to health. MCLGs are non-enforceable public health goals. The Lifetime Health Advisories for Drinking Water (LTHAs) are lifetime exposure levels for drinking water at which adverse, noncarcinogenic health effects would not be expected to occur. EPA also recommends secondary standards that are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects (e.g., smell, taste, and color) in drinking water. The secondary standards are not health-based. Sometimes secondary standards are 10 to 100 times lower than levels that would induce health effects. The lowest of all comparison values was used to identify compounds for further evaluation (Appendix C, Table C-1).

The public health implications of exposures to selected contaminants are evaluated in detail in the discussion section of this document. With this in mind, the following summary of environmental data highlights the chemicals that have been found on the site at levels above the comparison values, called the contaminants of concern. The sampling location identification numbers referenced in this public health assessment are the same as the Stibnite Area Risk Evaluation Report (URS 2000). The details about the selection of contaminants of concerns are summarized in Appendix C.

3.1 Soil

Surface soil samples were collected during the 1997 and 1999 site characterization activities. During the 1997 Site Characterization, 21 reference soil samples were collected from mineralized and non-mineralized areas outside the zone of influence of mining activities. In 1997, 52 soil samples were collected from areas known to be impacted by mining activities. In 1999, 46 additional samples were collected from the Bradley Waste Rock Dumps and the wetlands.

The following chemicals were detected in the analyzed samples: aluminum, antimony, arsenic, cadmium, chromium, copper, cyanide, lead, manganese, mercury, nickel, selenium, silver, and zinc. Of all the chemicals detected in the analyzed soil samples, only concentrations of antimony and arsenic were consistently elevated relative to the reference samples. Lead concentrations were elevated in samples collected from the upgradient wetland and mercury concentrations were elevated in samples collected from the smelter stack area. The soil sample results indicated that there are areas (Meadow Creek exposure areas) of moderately elevated concentrations of metals and other areas (Bradley waste rock dumps and hot spots) with significantly elevated concentrations of metals relative to the reference sample results.

Maximum concentrations of arsenic detected in soil samples collected from the Meadow Creek exposure areas ranged from 24.4 milligrams per kilogram (mg/kg) to 1,620 mg/kg. Maximum concentrations of arsenic detected in soil samples collected from the Bradley waste rock dump and other hot spots ranged from 983 mg/kg to 5,630 mg/kg. Maximum concentrations of antimony detected in soil samples collected from the Meadow Creek exposure areas ranged from 133 mg/kg to 1,550 mg/kg. Maximum concentrations of antimony detected in soil samples collected from the Bradley waste rock dump and other hot spots ranged from 292 mg/kg to 16,400 mg/kg.

The maximum concentration of lead detected in soils collected from the upgradient wetland was 754 mg/kg. In all other areas, the maximum concentrations or reasonable maximum exposure concentrations of lead detected in soil samples was less than health-based comparison values. The maximum concentration of mercury detected in soils collected from the smelter stack area was 471 mg/kg. Table C-2 and C-3, located in Appendix C, contain the maximum and reasonable maximum exposure concentrations for metals detected in soil samples collected from the site.

3.2 Surface Water and Sediment

Three surface water sampling events were conducted in 1997 and four additional sampling events were conducted in 1999. The following chemicals were detected in samples collected from site surface waters: aluminum, antimony, arsenic, copper, cyanide, lead, manganese, mercury, nickel, silver, and zinc. Background samples were collected from site surface waters in areas not impacted by mining operations. Only antimony, arsenic, and manganese were detected in concentrations above health-based comparison values.

Maximum concentrations of antimony detected in site surface water samples ranged from 0.0083 milligrams per liter (mg/L) to 0.281 mg/L. Maximum concentrations of arsenic detected in site surface water samples ranged from 0.012 mg/L to 0.535 mg/L. The maximum concentration of manganese detected in surface water collected from the keyway wetland was 0.785 mg/L. The Keyway wetland is the only area where detected concentrations of manganese in surface water exceeded health-based comparison values. Table C-4, located in Appendix C contains the maximum and reasonable maximum exposure concentrations for metals detected in surface water samples collected from the site.

3.3 Air and Dust

During past mining operations, crushing rock and hauling ore would likely have contributed to the creation of airborne particles on the site. Also, smelter stack emissions would have released contamination into the air. No environmental air samples have been collected at the site to date.

3.4 Biota

Two different sampling events were conducted at the site in 1997 and 1999 to collect fish for chemical analysis. Concentrations of antimony detected in whole body fish samples ranged from 0.07 micrograms per gram (µg/g) to 0.42 µg/g. Concentrations of arsenic detected in whole body fish samples ranged from 0.65 µg/g to 3.30 µg/g (Appendix C, Table C-5). Game and plant samples from the Stibnite site area have not been collected and analyzed for metals concentrations.

3.5 Groundwater

Yellow Pine residents use either private wells or the public water system, which is a surface water intake, as their drinking water source. The nearest active wells are located approximately 15 miles from the site. Groundwater quality has been impacted in the Meadow Creek Valley where the Bradley tailings piles are saturated or seasonally interface with groundwater (URS 2000). Detected concentrations of arsenic and antimony in samples collected from groundwater monitoring wells in this area ranged from 2 micrograms per liter (µg/L) to 3,070 µg/L for antimony and 3 µg/L to 13,800 µg/L for arsenic. These detections were elevated relative to reference samples collected outside the mining area.

3.6 Other Concerns

The mill building, while locked, poses a potential hazard to trespassers. Process chemicals, including cyanide, and carbon canisters are still present in the building. The outside of the mill building has been spray painted with warnings indicating the presence of poison inside. Multiple wooden buildings exist on site. These buildings are not secured against entry and are in serious disrepair. Loose boards and nails could pose a physical hazard to trespassers.

This document was made available for public comment for a period of 33 days. Public comments and concerns are listed and addressed in Appendix H.

3.6.1 Data Gaps

Game animal tracks have been observed on tailings piles and in the former poison pond area. Hunters are known to hunt on or near the site. A group of approximately 20 mushroom hunters were observed on the site in the past as well (Schuld 2002). Other than fish and macro invertebrates, no biota sample results are available for plants and animals present on the site. Game and plants in the mine area may have been exposed to site contaminants. It is not possible at this point in time to evaluate the potential health threat posed by human consumption of game and plants harvested from the site.

There are no environmental sample results for past exposures during mining activities. Residents of the town of Stibnite and mine workers may have been exposed to contaminants released from mining, ore processing, and smelting activities. These exposures could have resulted from ingestion of and dermal contact with soils and water. Additionally, it is not possible to evaluate the degree and magnitude of past exposures to airborne contaminants in the smelter stack emissions.

4. PATHWAYS OF HUMAN EXPOSURE

BEHS evaluates the environmental and human components that lead to exposure. Human contact with environmental contamination is only possible when a completed exposure pathway exists. A completed exposure pathway exists when all of the following five elements are present: (1) a source of contamination; (2) transport through an environmental medium; (3) a point of exposure; (4) a route of human exposure; and (5) an exposed population.

The source of contamination is the place where the chemical contamination originates. Sources can include storage tanks or drums, waste dumps, streams, ponds, or chemical processing facilities. Chemicals can move through environmental media such as soil, air, and water. Chemical contaminants are also transported from the source by accumulating in plants and animals. A point of exposure is the location where humans come into contact with the contamination. Points of exposure are areas where people can come into contact with contaminated environmental media. Points of exposure at Stibnite include contaminated creeks, tailings piles, or discharge pipes. A route of exposure is a way a chemical contaminant can enter a person's body. Breathing, eating, drinking, and skin contact are all routes of exposure. People who come into contact with a chemical through one or more routes of exposure are considered part of the exposed population. The exposed population for this site includes past, present, and future site workers, recreationists, and former residents of Stibnite.

It is important to note that if a completed exposure pathway exists, a public health hazard is not necessarily present. If an exposure to contaminated air, water, soil, or biota occurs, the exposure dose must be sufficient enough to cause a health effect in order to pose a health risk.

If the dose is too low to cause a potential health effect, there will likely be no health risk, even if an exposure pathway is complete.

ATSDR categorizes an exposure pathway as completed if all five elements above exist and indicate that exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. A potential pathway, however, requires that at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present. Table 1, Table 2, and Table 3, in the following sections, summarize the pathways for the Stibnite site. The discussion following these three tables concentrates on the pathways that are of public health significance and relevant to the site. Eliminated pathways are briefly described.

4.1 Completed Exposure Pathways

A completed exposure pathway requires all of the five elements to be present (a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population). Table 1 lists the completed exposure pathways for the Stibnite site.

Table 1.
Completed Exposure Pathways

Source	Media	Point of Exposure	Route of Exposure	Exposed Population	Time	Status
Stibnite Mine Area	onsite surface soil	tailings, neutralized ore, waste rock, smelter cinder piles, heap leach pile, old crusher area roads & air field	eating, skin contact	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed
					future	potential
Stibnite Mine Area	surface water	Blowout and Meadow Creeks, seeps, Glory Hole, EFSFSR, old crusher area roads & air field	drinking, skin contact	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed*
					future	potential
Stibnite Mine Area	sediment	banks of Blowout and Meadow Creeks, Glory Hole, EFSFSR, old crusher area roads & air field	eating, skin contact	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed
					future	potential
Stibnite Mine Area	air dust	depositional areas in Meadow Creek Valley, the Glory Hole, and along the EFSFSR, old crusher area roads & air field	breathing	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed
					future	potential

* This pathway is currently completed for dermal contact and is potentially complete for drinking.

4.1.1 Onsite Surface Soil

Spread out over the 3,000 acre site are various waste rock dumps, neutralized ore piles, exposed tailings piles, and capped tailings piles. Contaminants of concern in the site surface soils are arsenic, antimony, lead, and mercury (Appendix C, Table C-2 and C-3). Some of the depositional areas are less than an acre, while others (such as the Meadow Creek Mine hillside) are over 100 acres. The exposed tailings piles, former smelter stack site, heap leach pile, and some of the waste rock dumps are visibly different from the surrounding landscape. Color staining is visible in these exposed areas. Other areas, such as the capped Bradley tailings and neutralized ore piles and capped impoundments in Meadow Creek Valley, are not visibly different from the rest of the area.

A completed exposure pathway for surface soil currently exists and existed in the past. Past mining practices combined with the presence of mine workers and their families likely lead to multiple exposures, both chronic and acute. Tailings, neutralized ore, waste rock, and smelter cinders were deposited in open areas and were not capped until recently. Past levels of exposure are unknown but it is likely that past exposures were greater than the present exposure scenario.

Currently, a completed pathway exists for reclamation workers, recreational users, and trespassers contacting surface soils on the site. Hunters, sport anglers, hikers, campers, and other recreational users visit the site and are observed frequenting the Glory Hole, the Meadow Creek Valley, and the banks of the EFSFSR. Additionally, Hecla employs seasonal reclamation workers for their closure activities. A future potential exposure pathway for soil could exist depending on the extent of closure and reclamation activities and future erosion of the Meadow Creek Mine hillside and the slopes surrounding the Glory Hole. Recreational users are likely to be exposed to contaminated surface soils in the future since there is no current plan to cap and revegetate all of the contaminated areas.

4.1.2 Surface Water

A completed surface water pathway existed in the past and currently exists at the site through skin contact and drinking (ingestion). There are multiple streams and creeks in the area as well as seasonal seeps and the Glory Hole. The seeps are seasonal from spring until summer when they dry up. In general, many of the seeps are difficult to access, except those emanating from the Bradley tailings and neutralized ore pile near the keyway wetland. Mine tailings, neutralized ore, and waste rock deposited in and around the streams and seeps have been eroded by surface waters throughout the history of the site. Until all waste piles are stabilized and capped and the stream channels stabilized, this erosion will continue into the future. This erosion of waste piles increases the metal loads of the site surface water.

Measured concentrations of arsenic and antimony in the streams and some seeps exceed the CVs for drinking water (Appendix C, Table C-4). Contaminants of concern in the site surface waters are arsenic, antimony, and manganese (Appendix C, Table C-4). Surface water and seeps are not used for drinking water at the site. Yellow Pine's public water system (PWS) utilizes a surface water intake from the Boulder Creek, approximately 15 miles downstream. There have been no reported MCL violations for the PWS in the past 10 years.

Although the site surface waters are not known to be used as a source of drinking water, it is possible that recreational users (past, present, and future) utilize the surface waters as a drinking water source. Additionally, it is possible that site workers, former residents of

Stibnite, and recreational users have, do, or will come into contact with site surface waters while wading through streams or even swimming in the Glory Hole.

4.1.3 Sediment Pathway

Past mining activities led to the deposition of neutralized ore, waste rock, and tailings directly into the site streams. As a result, stream sediments are elevated in metals. A completed sediment exposure pathway exists currently, as well as in the past. Unless the sediments are removed, or capped, exposure to contaminated sediments may occur in the future. Exposed individuals include site workers, recreational users, and past residents of Stibnite. Recreational users and former residents could have contacted, or even accidentally ingested, contaminated sediment while fishing, wading in streams, or swimming in the Glory Hole.

4.1.4 Air and Dust Pathway

Wind erosion of surface materials, as well as soil disturbance from mining activities, such as rock crushing and ore hauling, while the mine was active introduced soil particles into the air. These activities would have constituted a completed exposure pathway for site workers and residents of the town of Stibnite in the past through inhalation of contaminated soil particles. Workers and residents of Stibnite were likely exposed to smelter stack emissions during the period the smelter was in operation.

Current activities at the site including reclamation activities, transporting personnel and equipment, and recreation also create dusty conditions, introducing soil particles into the air. These activities represent a completed pathway for recreational users and site workers through inhalation. Future activities at the site, including reclamation, transportation, and recreation may introduce particulate matter into the air constituting a potential future pathway for recreational users and site workers who may inhale potentially contaminated soil particles in the air.

4.2 Potential Exposure Pathways

A potential exposure pathway is defined as one where exposure could be possible except that one or more of the five elements is missing (a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population). In some cases, this means that the exposure is not possible now but may be possible in the future. In other cases, an exposure may be possible but cannot be confirmed because data are not available. The potential pathways for the Stibnite site are summarized in Table 2.

Table 2.

Potential Exposure Pathways

Source	Media	Point of Exposure	Route of Exposure	Exposed Population	Time	Status
Stibnite Mine Area	biota	fish game plants	eating	consumers of fish, game, or plants	past	potential
					present	potential
					future	potential

4.2.1 Biota - fish, game, and plants

A potential exposure pathway exists for individuals who consume biota such as fish, game, and plants taken from the site. Those individuals could include sports fishermen, hunters, gatherers and their families and friends who share the caught, hunted, or collected food. It is not known how much fish, game, or plants is caught, hunted, or collected on the site for human consumption.

Game tracks were observed and photographed at the Bradley tailings piles and at the former poison pond areas. In the past, site reclamation workers and government agency employees observed a group of approximately 20 mushroom hunters camping in the Meadow Creek Valley Game hunters are also occasionally observed crossing the site boundaries. Reportedly, whitefish is the only species of fish found in site surface waters that is not designated as a catch and release fish. Therefore, whitefish is the only fish species at the site that the Idaho Department of Fish and Game allows anglers to keep and consume.

Since there are no comparison values for contaminants in fish, BEHS considers all the measured contaminants in fish as contaminants of concern (Appendix C, Table C-5).

Although biota exists at the site and recreationists have been observed fishing, hunting, and collecting at the site, the degree of bioaccumulation in site biota is unknown, as is the rate of human consumption of animals and plants taken from the site. While the potential exists for past, present, and future exposure to site contaminants through the consumption of site biota, the extent and magnitude of the potential exposure is currently unknown. It is possible that the rate of fishing, hunting, and collecting will increase as closure activities are completed and the site is left vacant.

4.3 Eliminated Pathways

Eliminated exposure pathways are defined when exposure is unlikely and one or more of the five elements is missing (a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population). This means that the exposure is not possible now and it is not likely to be possible in the future. The eliminated pathways for the Stibnite site are summarized in Table 3.

Table 3.

Eliminated Exposure Pathways

Source	Media	Point of Exposure	Route of Exposure	Exposed Population	Time	Status
Stibnite Mine Area	onsite subsurface soil	Stibnite Mine Area	eating skin contact	former mine workers and current workers conducting closure activities	past	potential*
					present	eliminated
					future	eliminated
Stibnite Mine Area	ground water	onsite well and past onsite wells	drinking skin contact	site workers and past site residents	past	potential*
					present	eliminated
					future	eliminated

* This exposure pathway was potentially completed for former residence of Stibnite and completed for former mine workers.

4.3.1 Subsurface Soil

Human exposure to contaminated subsurface soils (soils beneath the site) is not expected for the present or the future. Current site activities are concentrated on site closure. Mining activities are not expected to resume in the future. Site subsurface soils contain elevated concentrations of metals such as arsenic, antimony, cadmium, lead, and mercury. It is likely that former mine workers were exposed to subsurface soils during mining operations, completing the pathway for subsurface soil. Residents of Stibnite were potentially exposed to subsurface soils during past mining activities, however, it is not possible to determine the extent and magnitude of past exposures for former workers and residents at this time. Consequently, the subsurface soil pathway was eliminated from further consideration.

4.3.2 Groundwater

There are no active groundwater wells within 15 miles of the site. Results of the 1997 and 1999 sampling data indicate that the groundwater at Stibnite contains concentrations of antimony and arsenic in excess of the MCLs for drinking water. However, since groundwater at the site is not currently utilized as a drinking water source and is unlikely to serve as a drinking water source in the future, this pathway was eliminated from consideration.

In 1992, the site drinking water well, located approximately one mile from the former processing plant, exceeded the MCLs for arsenic. The extracted groundwater from this well was passed through a commercial deionizer filtration unit before it was distributed for drinking. After passing through the deionizer, the concentration of arsenic was below the MCL. During the 1992 season, between 50 and 120 employees used the groundwater from the site well as a drinking water source from May to November.

Former mine workers and residents of Stibnite used this groundwater as a drinking water source. However, the location of the single drinking water well prevented it from being exposed to mining related contaminants present in surface and ground water (Schuld 2002). This well is secured against use but has not been abandoned. It will be properly abandoned when closure activities are completed. It is possible that former mine workers and residents of Stibnite were exposed to unknown levels of naturally occurring arsenic in their drinking water.

5. DISCUSSION - ADULT AND CHILDREN'S HEALTH ISSUEs

After reviewing the site-specific data and information, there are four completed and one potential exposure pathways which people could be or could have been exposed to chemicals from the site. Health effects can only result from site contaminants when people come in contact with them in sufficient doses. The public health implication of the exposures is discussed in the following sections. In Section 5.1, the actual exposures to these contaminants of concern (selected from Section 3) (Appendix C) are evaluated using estimates of exposure and the toxicological properties and epidemiological information about these chemicals. As a part of the ATSDR Child Health Initiative, and in response to community concerns, the susceptibility of young children or developing fetuses to the chemical exposures will be part of the toxicological and epidemiological review.

5.1 Public Health Implications

5.1.1 Introduction

In order to understand the health effects that may be caused by a specific chemical, three factors affecting how the human body responds to exposure needs to be considered. These factors include exposure concentration, the duration of exposure, and the route of exposure. Lifestyle factors can affect the likelihood of exposure and the exposure duration. Individual characteristics of each human such as age, sex, nutritional status, and overall health can affect how a contaminant is absorbed, distributed, metabolized or eliminated from the body. Together, these factors determine the individuals' response to chemical contaminants and what health effects may occur for that person.

To evaluate health effects, ATSDR developed Minimal Risk Levels (MRLs) for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily human exposure to a contaminant below which non-cancerous, adverse health effects are unlikely to occur. MRLs are developed for each route of exposure, such as inhalation and ingestion, and for the length of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (greater than 365 days). Acute MRLs are typically higher than chronic MRLs because of the shorter duration of exposure. BEHS also uses EPA's chemical-specific Reference Doses (RfDs) to determine if non-cancer health effects are possible. RfDs, similar to ATSDR's MRLs (Appendix C, Table C-6), are estimates of daily human exposure to a contaminant that is unlikely to result in adverse non-cancer health effects over a lifetime. For chemicals that are considered to be known, probable, or possible human carcinogens, BEHS uses EPA's chemical-specific cancer slope factors to calculate a theoretical excess lifetime cancer risk. These risks are associated with the exposures that are based on conservative, or protective, exposure assumptions. The cumulative cancer risk of the same contaminant from exposure to multiple environmental media is added together for a total risk estimation.

For determining possible exposures to contaminants in soil, maximum concentration or reasonable maximum exposure concentration in surface soil were used. The exposure scenarios for children were based on the older children (7 years or older) playing or camping at the Stibnite site. BEHS assumed that only older children would be among hunters, sport anglers, hikers, campers, and other recreational users who visit the site. It was also assumed that all recreational users would spend 8 days per year at the site, while a shorter exposure frequency of 1 day per year is used for small hot spot areas, such as the smelter stack and Location UW1 in the Upgradient Wetland, assuming that a future recreational user would visit the area only once. The reclamation workers are assumed to work for 4 months (mid-June through mid-October), 5 days per week, for a total of 90 days. Reclamation and monitoring programs are likely to be conducted during a 5-day work week (or less frequently). This exposure frequency is an alteration from former active mining operations which included a mine worker active 7 days per week. A shorter exposure frequency of 14 days is used for the hot spots small areas such as the smelter stack and location UW-1 in the Upgradient Wetland, assuming that, at most, 14 days would be required for any reclamation activity in these areas. Mining operations ceased in 1998 and are not expected resume in the future.

Exposure duration, body weight, and age are used to estimate the amount of contaminants that might have entered a person's body. The assumptions used to calculate exposure for an older child (7 -18 years of age) is a body weight of 45 kg (approximately 100 pounds) and a soil ingestion rate of 200 mg per day. The assumptions for an adult are a body weight of 75 kg (approximately 165 pounds) and a soil ingestion rate of 100 mg per day. Those estimates were chosen in reference to the Exposure Handbook (EPA 1997) and ATSDR's guideline with some Idaho-specific adjustments. Instead of the standard EPA body weight assumption (70kg), BEHS uses the median Idahoan body weight of 75kg to better represent people in Idaho (BVRHS 2001). In addition, the maximum concentration or reasonable maximum exposure

concentration found in surface soil was used for calculating risks and doses, so a worst-case scenario was evaluated.

There are no air sampling concentrations to use for determining possible exposure to contaminants in the air and windblown dust. Consequently, BEHS doubled the soil ingestion rates to calculate the inhalation exposure dose, assuming that exposure dose from air particulates is the same as that from ingestion of surface soil. This is a very conservative assumption since the exposure dose from inhalation of airborne particulates is normally much lower than the exposure dose from ingestion of surface soil.

To determine possible exposure to contaminants in drinking water, maximum contaminant concentrations or reasonable maximum exposure concentrations found in surface water samples were used to calculate risks and doses to be protective of public health. Water consumption rates are assumed to be 2 liters per day (L/day) for all the future recreational users (children aged 7 through adults). For the reclamation workers, BEHS assumes that they will not use the local surface water as their drinking water.

For determining possible exposure to contaminants in fish, maximum contaminant concentrations or reasonable maximum exposure concentrations of fish fillets were used. Fish fillets are the part of fish most likely to be consumed by humans. A fish intake rate of 25 g per day was used for the general recreational consumption of whitefish (all other species are classified as catch and release). This value is in the 95th percentile nationwide for recreational anglers (freshwater fish). For subsistence recreational users, a fish intake rate of 58.7 g per day was used (CRITFC 1994). Fish tissue was analyzed for total arsenic. However, most arsenic in fish was present in non-toxic organic forms. It was reported that 10 percent of total arsenic in freshwater fish is in the inorganic form (URS 2002). However, we still use the total arsenic as inorganic arsenic, so a worst-case scenario was evaluated.

ATSDR generally considers dermal exposure to be a minor contributor to the overall exposure dose relative to the contributions of ingestion and inhalation exposures, BEHS did not calculate the dermal exposure dose. BEHS considered the bioavailability of arsenic to be 80% in Smelter Stack and 60% in all other places (EPA 2000), and 100% for other contaminants. All assumptions are summarized in the following Table 4.

Table 4.

Exposure Assumptions Summary

Exposure Assumptions		**Populations**		
		Recreational Users		**Reclamation Workers**
		7≤Children≤18	**Adults>18**	
Body Weight (kg)		45	75	75
Exposure Frequency (days/year)	Hot Spots	1	1	14
	Other Areas	8	8	90
Exposure Duration (years)	Hot Spots	1	1	1
	Other Areas	12	30	1

Averaging Times (days) for Noncarcinogenic	Hot Spots	365	365x30	365
	Other Areas	365x12		
Averaging Times (days) for Carcinogenic[a]	Hot Spots	365x70	365x70	365x70
	Other Areas			
Surface Soil	Ingestion Rate (mg/day)	200	100	100
Air Particulate	Double the soil ingestion rate to include the air particulate inhalation			
Surface Water	Consumption Rate (L/day)	2	2	0
Fish	Fish Intake Rate (g/day)	25[b]	25[b]	25

a: assumes average lifetime is 70 years.
b: for general recreational users, the fish intake rate is 25 g per day, while the fish intake rate is 58.7 g per day for tribe recreational users.

5.1.2 Evaluation of Toxicology and Epidemiology by Pathway

Health-based CVs are established at concentrations below which no known or anticipated adverse human health effects are expected to occur. BEHS first compared the measured media contaminant concentrations with the corresponding CVs (Appendix C). The contaminants with media concentrations higher than their CVs became the contaminants of concern. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed. Once the contaminants of concern are selected, exposure doses are calculated for each exposure pathway. Exposure dose calculations can be found in Appendix C for non-cancerous doses and Appendix D and E for carcinogenic doses.

5.1.2.1 Surface soil and airborne particulate exposure pathway

As discussed before, since there are no air contaminants concentrations, BEHS doubled the soil ingestion rates to calculate the total exposure dose from both surface soil ingestion and airborne particulate inhalation. For most areas, antimony and arsenic are above the comparison values, while lead in Location UW1 in the Upgradient Wetland and mercury in the smelter stack area are also above the comparison values (Appendix C, Table C-2 and C-3).

Surface Soil and Airborne Particulate Exposure Pathway : Non-Cancer Risk Evaluation

Antimony

In most areas, the possible antimony exposure dose is lower than 0.0004 milligrams per kilogram per day (mg/kg/day) (the chronic oral RfD) (Appendix C, Table C-7 and C-8), except for: child recreational users at location BD6 (Northwest Dump hotspot) (0.0004 mg/kg/day), reclamation workers at BD6 (Northwest Dump hotspot) (0.0017 mg/kg/day), Meadow Creek Forested Wetland (0.001 mg/kg/day), and Lower Meadow Creek Valley (0.00087 mg/kg/day). The exposure to antimony at BD6 (Northwest Dump hotspot) is an acute exposure for both child recreational users and reclamation workers, while the exposures at Meadow Creek Forested Wetland and Lower Meadow Creek Valley are intermediate exposure for reclamation workers. The RfDs for both acute and intermediate oral exposures are normally higher than the

chronic oral RfDs. Health effects have been observed in humans and animals following oral exposure to a variety of antimony compounds. However, the no-observed-adverse-effect levels (NOAELs) or lowest-observed-adverse-effect levels (LOAELs) in all the related studies are equal to or higher than 0.0748 mg/kg/day (ATSDR 1992). Pre and postnatal exposure or only postnatal exposure alone to 0.0748 mg/kg/day of antimony as antimony trichloride appears to affect the development of certain cardiovascular reflexes in rats that are important for regulating systemic arterial blood pressure. The highest possible exposure dose from ingestion of surface soil and inhalation of air borne particulate is 44 times lower than 0.0748 mg/kg/day (the lowest NOAELs and LOAELs). On the other hand, BEHS supposes that the exposure dose from inhalation of air borne particulates is the same as the dose from ingestion of surface soil, which is a very conservative assumption since the exposure dose from inhalation of air borne particulates is normally much lower than the exposure dose from ingestion of surface soil. BEHS uses the maximum concentration or reasonable maximum exposure concentration to estimate the exposure dose, which is very conservative for chronic and intermediate exposure. The actual exposure dose will be much lower than the estimated highest daily exposure dose. Consequently, BEHS does not expect elevated non-cancer health risks from exposure to antimony in the surface soil at the site for the present land users.

Arsenic

While the arsenic concentrations are all above the comparison values, the estimated exposure doses (non-carcinogenic) are very different for different land users (Appendix C, Table C-7 and C-8). For the adult recreational users, the estimated arsenic exposure doses are all below the chronic oral MRL (0.0003 mg/kg) (Appendix C, Table C-6), which means arsenic in the surface soil would not likely result in any non-carcinogenic public health effects for the adult recreational users. For child recreational users, the estimated exposure doses from arsenic in all areas are lower than the chronic oral MRL except at the Southeast Dump & Midnight Creek, the Northeast Dump & Sugar Creek, Glory Hole & Northwest Dump & EFSFSR. For child recreational users, the estimated exposure doses from arsenic at the Southeast Dump & Midnight Creek, the Northeast Dump & Sugar Creek, as well as Glory Hole & Northwest Dump & EFSFSR are 6 to 16 times lower than the acute oral MRL (0.005 mg/kg/day), respectively (Appendix C, Table C-6). The recreational users are assumed to visit these sites 8 days per year, which is categorized as an acute exposure. BEHS uses the maximum concentration or reasonable maximum exposure concentration to estimate the exposure dose. BEHS assumes that the exposure dose from inhalation of air borne particulates is the same as the dose from ingestion of surface soil. All these assumptions are over protective, or conservative. It is unlikely that the arsenic in the surface soil will result in any adverse non-carcinogenic public health effects on the children recreational users.

For the reclamation workers, in two-thirds of the exposure locations on site, the non-carcinogenic exposure doses of arsenic from ingestion of surface soil and inhalation of air borne particulates are higher than chronic oral MRL while 2 to 13 times lower than acute oral MRL. The exposure time for reclamation workers is 14 or 90 days per year, which is categorized as an acute or intermediate exposure. As a note, the contaminated dumping area was covered with relatively uncontaminated soil, preventing exposure to contaminated surface soil. Ingestion of surface soil or inhalation of airborne particulates mainly comes from the relatively uncontaminated covering materials instead of the contaminated surface soil. However, to be protective, BEHS uses the maximum concentration or reasonable maximum exposure concentration to estimate the exposure dose and assumes that the exposure dose from inhalation of airborne particulates is the same as the dose from ingestion of surface soil. Because BEHS uses a conservative approach, actual exposure doses of arsenic will be much

lower than the estimated doses. It is unlikely the arsenic in the surface soil will result in any adverse non-cancer public health effect for the reclamation workers.

Mercury

Only the maximum mercury concentration (471 mg/kg) in the Smelter Stack surface soil is higher than the comparison value. However, the highest estimated exposure dose (Appendix C, Table C-8) is 59 times lower than ATSDR's intermediate oral MRL (Appendix C, Table C-6), which means no adverse public health effects from the mercury in surface soil are expected.

Lead

Among all the lead concentrations in the surface soil at Stibnite, only the maximum lead concentration (754 mg/kg) at Location UW-1 (Upgradient Wetland hotspot) is higher than EPA's Residential Soil Preliminary Remediation Goals (400mg/kg). There are no MRLs or RfDs for lead. However, for the oral and inhalation pathways, the lowest NOAEL among all the related studies is 0.0015 mg/kg/day (ATSDR 1999). The estimated exposure doses (Appendix C, C-6) for child recreational users, adult recreational users and reclamation workers are 83, 270 and 27 times lower than the lowest NOAEL respectively. BEHS uses the maximum concentration at Location UW-1 (Upgradient Wetland Hotspot) to estimate the exposure dose and assumes that the exposure dose from inhalation of airborne particulates is the same as the dose from ingestion of surface soil. Because these exposure doses are overly protective, actual exposure doses of lead will be lower than the estimated doses. Furthermore, a 1 to 8 day exposure at Location UW-1 (Upgradient Wetland hotspot) is assumed for all the present land users. Thus, it is unlikely that lead in the surface soil will result in any adverse public health effects to the present land users.

Surface Soil and Airborne Particulate Exposure Pathway: Cancer Risk Evaluation

Some chemicals have the ability to cause cancer. Cancer risk is estimated by calculating a carcinogenic exposure dose (Appendix E) and multiplying it by the cancer slope factor (Appendix F). Cancer risk estimates are not definitive answers to whether or not a person will get cancer; rather, they are measures of chance (probability). Cancer is a common illness, and there are many different forms of cancer that result from a variety of causes; not all are fatal. Approximately one quarter to one third of people living in the United States will develop cancer at some point in their lives. EPA considers arsenic to be a known human carcinogen based on evidence that human exposure through drinking water can cause skin, bladder and lung cancer (ATSDR 2000). BEHS calculated the estimated carcinogenic exposure doses of arsenic and the corresponding cancer risk (Appendix D, Table D-1). The estimated highest cancer risk is about 17 cancer estimated for 100,000 persons exposed. BEHS uses the maximum concentration or reasonable maximum exposure concentration to estimate the exposure dose and assumes that the exposure dose from inhalation of air borne particulates is the same as the dose from ingestion of surface soil. All of these are very protective assumptions. Actual risks are likely to be lower. Furthermore, this is only theoretical risk, considering the relatively small group of people living (there are only 40 people in the nearest town Yellow Pine), visiting and working (a seasonal workforce of approximately six to eight people at Stibnite) at the Stibnite area, the predicted increased risk of cancer from arsenic in the surface soil is so low as to be negligible.

5.1.2.2 Surface water exposure pathway

It is possible for the future recreational users to consume the surface water as their drinking water, while it is unlikely that reclamation workers will use surface water as a source of

drinking water. Manganese concentrations are above the comparison value only in Keyway Wetland surface water, while the concentrations of antimony and arsenic are higher than their comparison values in most areas except the Upgradient Wetland (Appendix C, Table C-4).

Surface Water Exposure Pathway: Non-Cancer Risk Evaluation

The estimated daily exposure doses for manganese, arsenic, and antimony (Appendix C, Table C-9) are all below ATSDR's chronic oral MRL or EPA's chronic oral RfDs (Appendix C, Table C-6) with the exception of Bailey Tunnel Outlet for Child recreational users. The actual exposure at Bailey Tunnel Outlet for child recreational users is categorized as an acute exposure. The estimated exposure dose (0.00031 mg/kg/day) is 16 times lower than the acute oral MRL. BEHS uses the maximum concentration or reasonable maximum exposure concentration to estimate the exposure dose, a very protective assumption. The water ingestion assumption of 2 L per day for all the exposure days is also very protective of human health. The contaminants in the surface water will unlikely result in any adverse non-cancer public health effects for the recreational users and are not expected to be a public health concern.

Surface Water Exposure Pathway: Cancer Risk Evaluation

The carcinogenic exposure doses are listed in Appendix D, Table D-1. Cancer risk is estimated by calculating a carcinogenic exposure dose (Appendix E) and multiplying it by the cancer slope factor (Appendix F). Cancer risk estimates are not definitive answers to whether or not a person will get cancer; rather, they are measures of chance (probability). The estimated highest cancer risk for surface water exposure is about 12 cancer estimated for 100,000 persons exposed. BEHS uses the maximum concentration or reasonable maximum exposure concentration to estimate the exposure dose and assumes that recreational users consume 2 L surface water per day for all the exposure time. Actual risks are likely to be lower. This is only theoretical risk, considering the relatively small group of people living near and visiting the Stibnite site. The predicted increased risk of cancer from arsenic in the surface water is so low as to be negligible.

5.1.2.3 Potential fish exposure pathway

Potential Fish Exposure Pathway: Non-Cancer Risk Evaluation

Since there are no comparison values for contaminants in fish, BEHS calculated estimated daily exposure doses (Appendix C, Table C-5) for all the contaminants. For general recreational users, the estimated exposure doses are 556, 19000, 111, 581, and 3160 times lower than the corresponding ATSDR's chronic oral MRLs or EPA's chronic oral RfDs (Appendix C, Table C-6), for arsenic, manganese, methyl-mercury, selenium and zinc, respectively. For reclamation workers, the estimated exposure doses are 83, 2857, 17, 86, and 517 times lower than the corresponding chronic oral MRLs or RfDs. There is no MRL or RfD for lead. Nevertheless, the estimated highest exposure doses for lead from fish are 2935 (for general recreational users) and 429 (for reclamation workers) times lower than the lowest NOAEL among all the related studies (0.0015 mg/kg/day) (ATSDR 1999). The consumption of fish for the recreational users and reclamation workers is not expected to be a public health concern.

As to the local tribe recreational users, their average daily fish consumption rate is 58.7 grams per day (CRITFC 1994), which is about 2.5 times that of general recreational users. Their estimated exposure doses are 237, 8092, 47, 247, 1346, and 1250 times lower than the corresponding ATSDR's chronic oral MRLs, EPA's chronic oral RfDs, or the lowest NOAEL among all the related studies, for arsenic, manganese, methyl-mercury, selenium, zinc, and

lead respectively. Thus, even for the local Native American recreational users, the consumption of fish is unlikely to result in any adverse non-cancer risk.

Potential Fish Exposure Pathway: Cancer Risk Evaluation

The estimated highest cancer risk for consumption of fish is about 2 (for general chid recreational users) and 5 (for tribe child recreational users) cancer cases estimated for 10,000,000 persons exposed; a slight increase in cancer risk. Considering the relative small group of people living near and visiting the Stibnite site, the predicted increased risk of cancer from arsenic from consumption of fish is so low as to be negligible.

5.1.2.4 Summary of health risks from the multiple pathways

A person can be exposed to contamination through more than one pathway and to more than one chemical. Exposure to multiple pathways occurs if a contaminant is present in more than one medium (i.e., air, soil, surface water, groundwater, and sediment). For example, the exposure dose received from drinking water may be combined with the exposure dose received from contact with that same contaminant in soil.

The exposure doses and cancer risks for the same contaminant from different pathways are listed in Table C-10 (Appendix C) and Table D-1 (Appendix D). From the Tables, we can see the total exposure doses and cancer risks for the same contaminants are similar for ingestion of surface soil and inhalation of air borne particulates. This means that most exposure doses and cancer risk result from the ingestion of surface soil and inhalation of airborne particulates. More particularly, the highest total exposure doses and cancer risks for the same contaminants are exactly the same as that from ingestion of surface soil and inhalation of air borne particulates. As stated in Section 5.1.2.1, the contaminants are not expected to result in any adverse public health effects, and the predicted increased risk of cancer from arsenic is so low as to be negligible.

According to the reclamation workers, even though it is estimated that reclamation will be completed in one season (90 days), some workers have been doing reclamation out there for up to 7 years. For non-cancer risk, since this will not change the highest estimated exposure doses, it is unlikely to result in any adverse non-cancer risk as stated in Section 5.1.2.1. For cancer risk, we further add together all the estimated cancer risk from all locations (Appendix D, Table D-1) assuming the same workers will finish all the reclamation by finishing one site per working season. The estimated highest cancer risk for the reclamation workers would be 2 cancer cases estimated for 10,000 workers exposed. This is only theoretical risk. Considering there is only a seasonal work force of 6 to 8, the predicted increased risk of cancer from arsenic is so low as to be negligible.

5.1.3 ATSDR Child Health Considerations

Children differ from adults in their physiology (e.g., respiratory rates relative to body weight), pharmacokinetics (i.e., distribution, absorption, metabolism, and excretion of chemicals), and pharmacodynamics (i.e., susceptibility of an organ to the exposure). Therefore, it is always important to address chemical exposures of these sensitive populations. Fetuses, infants, and children are more vulnerable to the toxic effects of chemicals because of the following reasons. 1) children are more likely to play outdoors and bring food into contaminated areas; 2) children are closer to the ground (shorter), resulting in a greater likelihood to breathe dust, soil, and heavy vapors laying on the ground; 3) children weigh less resulting in higher doses of

chemical exposure per body weight; and 4) the developing body system can sustain permanent damage if toxic exposures occur during critical growth stages.

It is unlikely that younger children (<7 years old) will visit the Stibnite site as recreational users. It is a concern for older children who come to swim or camp with their parents in some areas of the site. As a prudent public health practice, BEHS has made recommendations to mitigate or eliminate exposure to site-related contamination even though exposure is not expected to cause adverse health effects. BEHS's recommendations are summarized in Section 7.

5.2 Health Outcome Data (HOD) Evaluation

The main requirements for evaluating HOD are the presence of a completed human exposure pathway, high enough contaminant levels to result in measurable health effects, a sufficient number of persons in the completed pathway for health effects to be measured, and a health outcome database in which disease rates for population of concern can be identified.

Although completed human exposure pathways exist at this site, the exposed population is not large enough to permit meaningful measurements of possible site-related health effects as identified in existing HOD. According to the 2000 US Census, the population of Yellow Pine, 14 miles away from the site, is 40 people. Only a fraction of those residents are expected to regularly visit the site as recreational users. The site itself has no permanent residents. Hecla maintains a seasonal workforce of approximately four people at the Stibnite site for approximately five months of the year during late Spring through early Fall.

5.2.1 Community Health Concerns

On June 26, 2003, BEHS held a public availability session in Yellow Pine to share the preliminary results of the draft public health assessment and to gather community health concerns. Members of the general public were invited to review and comment on the draft public health assessment from June 25 until July 28, 2003. Representatives of IDEQ, EPA, and USFS indicated that the community was mainly concerned with retaining access to the site and avoiding the stigma of living next to a Superfund site. BEHS confirmed these concerns when meeting with community members and when reviewing the public comments on the draft public health assessment. The only health concern expressed by a single community member was the possibility of bioaccumulation of contaminants in plants and game animals at the site. Other concerns were strictly ecological or regulatory in nature. Community concerns are documented and addressed in Appendix H.

6. CONCLUSIONS

1. The completed exposure pathways identified include: surface soil, surface water, airborne particulates and sediments. The most important exposure pathway is the ingestion of surface soil and inhalation of airborne particulates. As there are no air contaminant concentrations available, and to be protective of public health, BEHS assumes that the exposure dose from inhalation is the same as from ingestion of surface soil. Consumption of fish is a potential exposure pathway, while subsurface water and ground water are eliminated exposure pathways.

2. There is no information available about former mine workers, thus BEHS is unable to evaluate their past exposures and the public health implications of these exposures.

3. It is unlikely that the contaminants at the Stibnite site will result in any adverse public health effects for the reclamation workers and recreational users, since the estimated exposure doses are either below the corresponding health guideline values, or below the corresponding lowest NOAELs (or LOAELs) in all the related studies. The predicted increased risk of cancer from arsenic is so low as to be negligible to the reclamation workers and recreational users.

4. According to ATSDR's Interim Public Health Hazard Categories, the exposure pathways related to surface soil and sediment, airborne particulates, surface waters, and fish are categorized as no apparent public health hazard (Appendix B). However, the public health hazard posed by the consumption of biota (other than fish) cannot be evaluated at this time due to a lack of data and information, which is categorized as an indeterminate public health hazard.

5. This report conclusion only applies to the current reclamation workers and recreational users. If land use changes, this conclusion might not be applicable.

7. RECOMMENDATIONS

1. As a precaution, signs should be posted at the access points to the site informing visitors of the presence and potential health threat of site contaminants.

2. BEHS should provide health education materials to the populations that use the site about potential health impacts of the Stibnite site.

3. The reclamation workers should be cautious about ingestion of surface soil and surface water.

4. Hot spot remediation is prudent even though BEHS does not believe that exposures will result in any adverse public health effects to the recreational users and reclamation workers

5. Biota (other than fish) samples should be collected and analyzed for potential uptake of metals from site soils and surface water.

8. PUBLIC HEALTH ACTION PLAN

The purpose of the public health action plan is to ensure this public health assessment not only identifies any current and potential exposure pathways and related health hazards, but also to provide a plan of action to mitigate and prevent adverse human health effects resulting from exposures to hazardous substances in the environment. The following lists the ongoing or planned actions by BEHS, IDEQ and other agencies.

1. BEHS will conduct health education activities to inform Yellow Pine residents of the status of the site. Recommendations against using the site for recreation will also be made.

2. BEHS will assist the USFS and EPA with their community involvement plan as necessary.

3. BEHS forwarded this document to HECLA and brought attention to the third recommendation, referring to their site workers.

4. BEHS will review additional environmental sampling data as it becomes available.

5. BEHS will request that the regulatory agencies involved with this site implement the fifth recommendation. If the agencies are unable to fulfill this request, BEHS and ATSDR will explore the feasibility of conducting an exposure investigation with regard to site biota.

6. IDEQ is negotiating institutional controls with the current site owners to prevent future development of the site.

7. IDEQ is negotiating with the site owners about how to prevent public exposure to the onsite contamination. Possible actions include site access restriction, posting warning signs, and site reclamation. Reclamation activities will focus on securing tailings piles and other contamination in such a way that the public and eco-receptors (biota) can utilize the area without the threat of exposure.

8. IDEQ will require that the mill building containing mineral extraction equipment and chemicals be removed and properly disposed of along with process chemicals.

9. IDEQ will arrange to have damaged buildings on site removed if they interfere with site reclamation or pose a significant threat to site safety.

9. REFERENCES

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11. CERTIFICATION

The Idaho Bureau of Environmental Health and Safety prepared this Public Health Assessment 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 initiated.

Gregory V. Ulirsch
Technical Project Officer, SSAB, DHAC

The Superfund Site Assessment Branch (SSAB), Division of Health Assessment and Consultation (DHAC), ATSDR has reviewed this health consultation and concurs with its findings.

Roberta Erlwein
Chief, SSAB, DHAC, ATSDR

APPENDIX A: STIBNITE LOCATION AND SAMPLING MAPS

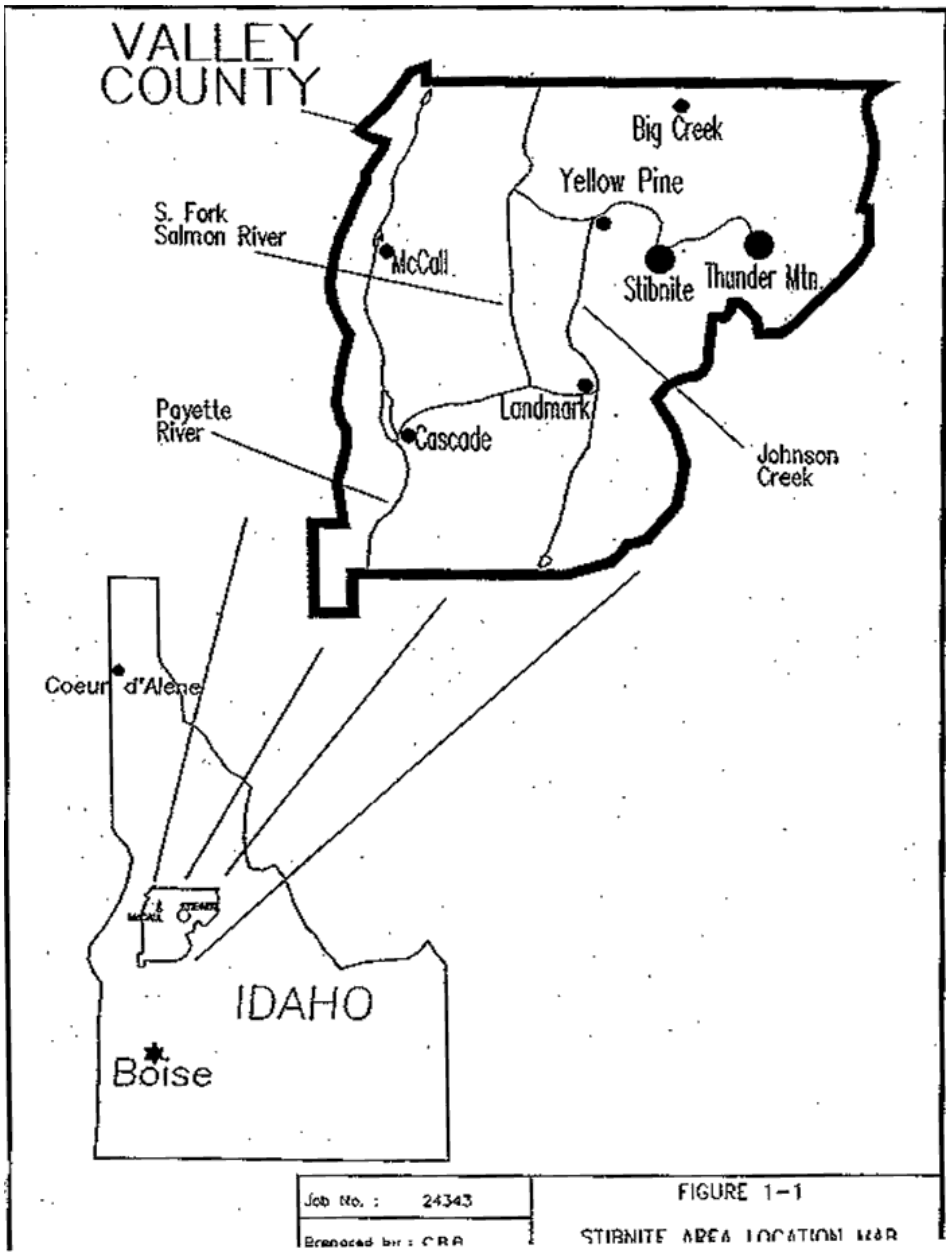
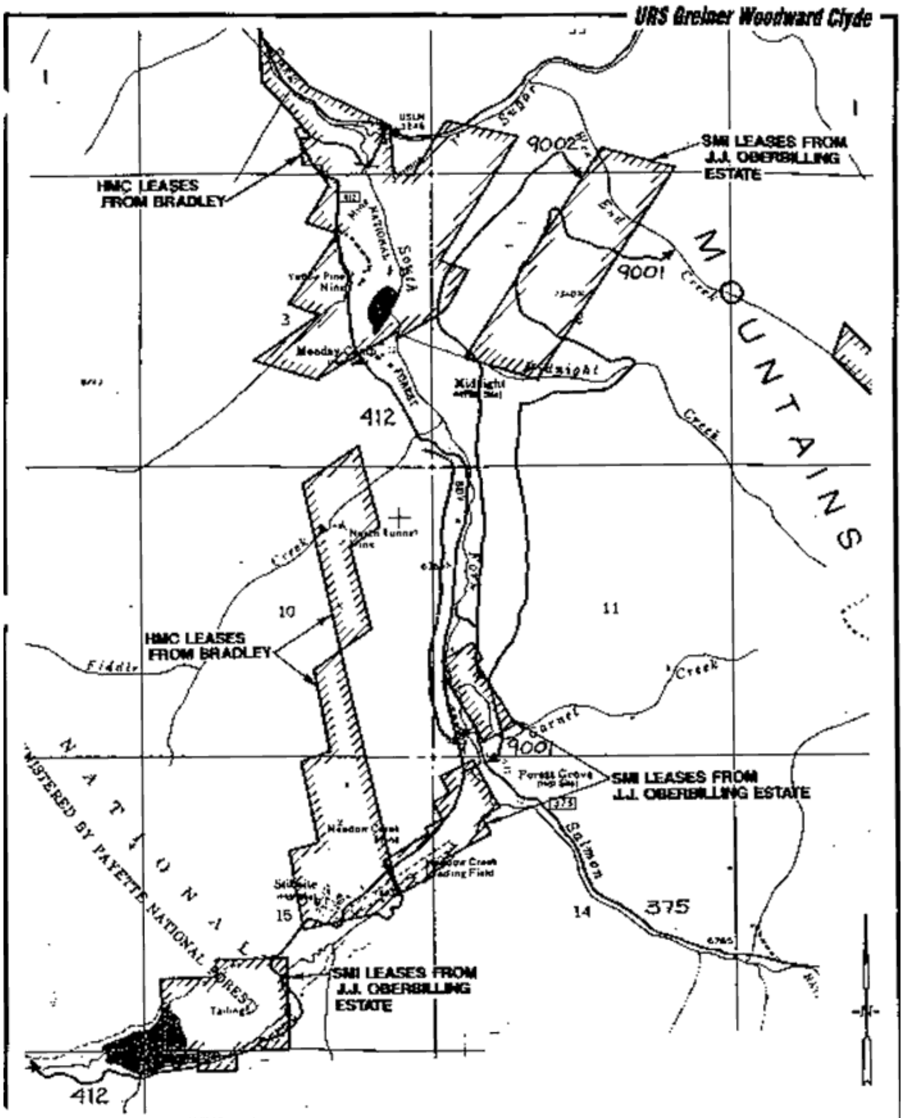


Figure 2. Privately Owned Parcels within the Stibnite Site



SMI – STIBNITE MINING INC.
HMC – HECLA MINING CO.
BRADLEY – BRADLEY MINING CO.
PROPERTY BOUNDARY
375 ROAD NUMBER

Job No. :	6800024343.00
Prepared By :	TGC
Date :	7/11/00

FIGURE 3-1
PRIVATELY OWNED PARCELS WITHIN THE STIBNITE SITE
STIBNITE MINE

Figure 3. Site Map

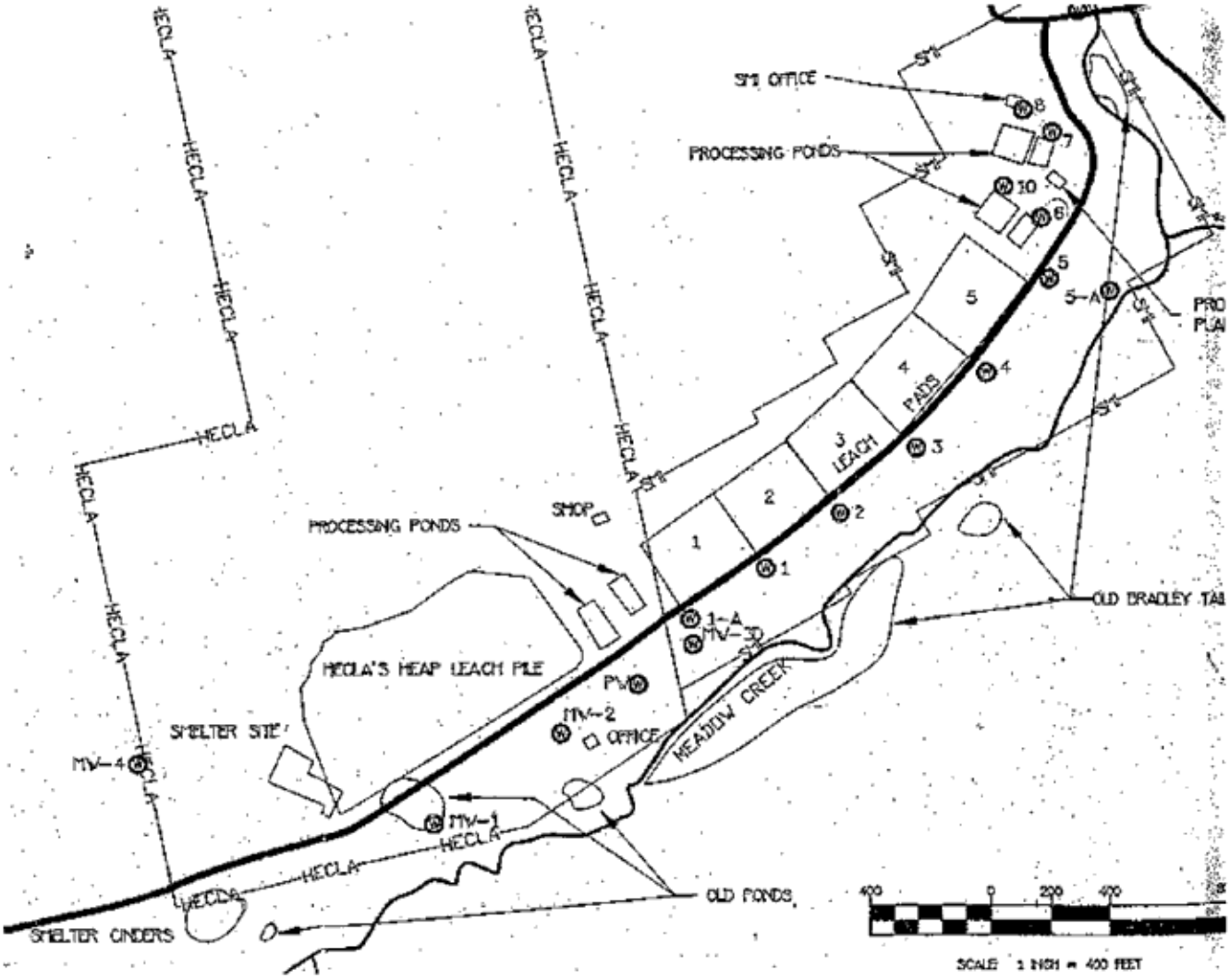
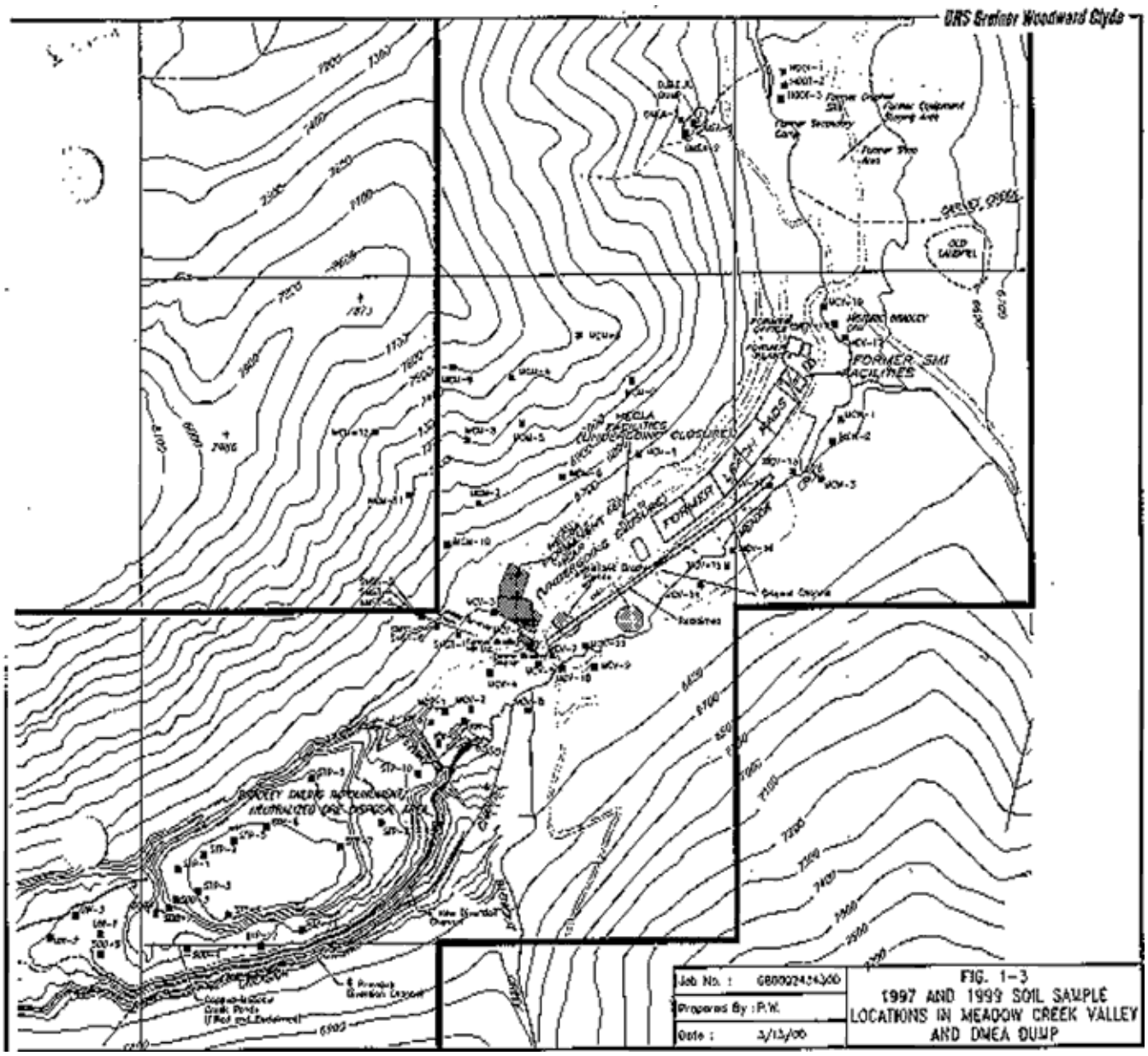


Figure 4. 1997 and 1999 Soil Sample Locations in Meadow Creek Valley and DMEA Dump



APPENDIX B: ATSDR INTERIM PUBLIC HEALTH HAZARD CATEGORIES

Table B-1.

Interim Public Health Hazard Categories

CATEGORY/DEFINITION	DATA SUFFICIENCY	CRITERIA
Urgent Public Health Hazard This category is used for sites where short-term exposures (<1yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgment based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicated that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the pre of serious physical or safety hazards.
Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposure (>1yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgment based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one of more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.
Indeterminate Public Health Hazard This category is used for sites in which "critical" data are insufficient with regard to extent of exposure and/or toxicological properties at estimated exposure levels.	This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	The health assessor much determine, using professional judgment, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.
No Apparent Public Health Hazard This category is used for sites where human exposure to contaminantd media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgment based on critical data, which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures, exposure to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
No Public Health Hazard This category is used for sites that,	Sufficient evidence indicates that no human exposures to	

because of the absence of exposure, do NOT pose a public health hazard.	contaminantd media have occurred, none are now occurring, and none are likely to occur in the future.	

*: Such as environmental and demographic data; health outcome data; community health concerns information; toxicological, medical, and epidemiological data; monitoring and management plans

APPENDIX C: CONTAMINANTS OF CONCERN SELECTION AND ESTIMATED NON-CARCINOGENIC EXPOSURE DOSES

Table C-1.

Health Comparison Values/Screening Values

Medium	Contaminant	Non-cancer			Cancer and Other	
		Child	Adult	Source	Standards	Source
Soil (mg/kg)	Aluminum	100000	1000000	I-EMEG	--	--
	Antimony	20	300	RMEG	--	--
	Arsenic	20	200	C-EMEG	0.5	CREG
	Cadmium	10	100	C-EMEG		
	*Chromium III	80000	1000000	RMEG	--	--
	Copper	2900		RS-PRG	--	--
	Cyanide	1000	10000	RMEG	--	--
	Lead	400		RS-PRG	--	--
	Manganese	3000	40000	RMEG	--	--
	Mercury	100	1000	I-EMEG	--	--
	Methyl Mercury	20	200	C-EMEG		
	Nickel	1000	10000	RMEG	--	--
	Selenium	300	4000	C-EMEG	--	--
	Silver	300	4000	RMEG	--	--
	Zinc	20000	200000	C-EMEG	--	--
Drinking Water (µg/L)	Aluminum	20000	70000	I-EMEG	--	--
	Antimony	4	10	RMEG	6	LTHA
	Arsenic	3	10	C-EMEG	0.02	CREG
	Cadmium	2	7	C-EMEG		

Chromium III	20000	50000	RMEG	--	--
Copper	1400		TW-PRG	1300	MCLG
Cyanide	200	700	RMEG	--	--
Lead	--	--	MCLG	15	AL
Manganese-w	500	2000	RMEG	--	--
Mercury	20	70	I-EMEG	--	--
Methyl Mercury	3	10	C-EMEG		
Nickel	200	700	RMEG	--	--
Selenium	50	200	C-EMEG	--	--
Silver	50	200	RMEG	--	--
Zinc	3000	10000	C-EMEG	--	--

* Chromium at the site is assumed to be trivalent chromium.
AL: Action Level
C-EMEG: Chronic Environmental Media Evaluation Guide
CREG: Cancer Risk Evaluation Guide for 10^{-6} excess cancer risk
I-EMEG: Intermidiate Environmental Media Evaluation Guide
LTHA: Lifetime Health Advisory for drinking water (EPA)
MCLG: Maximum Contaminant Level Goal for drinking water (EPA)
RMEG: Reference Dose Media Evaluation Guide
RS-PRG: Residential Soil Preliminary Remediation Goals (USEPA Region IX)
TW-PRG: Tap Water Preliminary Remediation Goals (USEPA Region IX)

Table C-2.

Contaminants of Concern in Surface Soil of Meadow Creek Exposure Areas

Contaminant	Site Specific Background (mg/kg)	Bradley Tailings and Neutralied Ore Disposal Area (RME)	Above CVs (Y/N)	Meadow Creek Mine Hillside (RME)	Above CVs (Y/N)	Lower Meadow Creak Valley (RME)	Above CVs (Y/N)	Upgradient Wetland (MAX)	Above CVs (Y/N)	Keyway Wetland (MAX)	Above CVs (Y/N)	Meadow Creek Forested Wetland (MAX)	Above CVs (Y/N)
Aluminum	9300	5680	N	13300	N	7210	N	43300	N	13000	N	34200	N
Antimony	1.81	133	Y	15.6	N	1320	Y	--	N	333	Y	1550	Y

Arsenic	5.68	1620	Y	1460	Y	955	Y	24.4	Y	634	Y	1230	Y
Cadmium	<0.1	2.7	N	--	N	--	N	--	N	--	N	0.13	N
Chromium	2.92	17.7	N	4.08	N	7.78	N	39.9	N	7.1	N	14.3	N
Copper	3.55	19.3	N	5.63	N	17.4	N	12.1	N	19.6	N	68.8	N
Cyanide	--	1.03	N	--	N	--	N	--	N	0.27	N	--	N
Lead	2.72	15.6	N	4.5	N	34.7	N	9.4	N	47.8	N	160	N
Manganese	368	400	N	1580	N	271	N	206	N	233	N	199	N
Mercury	<0.1	2.62	N	0.416	N	0.716	N	0.11	N	0.89	N	3.1	N
Nickel	2.01	35.2	N	3.83	N	9.78	N	21	N	5.9	N	8	N
Selenium	<0.3	--	N	--	N	0.48	N	0.19	N	0.52	N	5.3	N
Silver	<0.1	0.81	N	0.149	N	2.52	N	0.1	N	2.8	N	19.6	N
Zinc	25.7	18.1	N	45.3	N	58.2	N	67.7	N	40.9	N	70.9	N

RME = Reasonable Maximum Exposure Concentration (mg/kg)
MAX = Maximum Concentration (mg/kg)
Note: Highlighted concentrations indicate contaminant concentration is above the health-based comparison values

Table C-3.

Contaminants of Concern in Surface Soil of Bradley Waste Rock Dumps and Hot Spots

Contaminant	**Site Specific Background (mg/kg)**	**Southeast Dump and Midnight Creek (RME)**	**Above CVs (Y/N)**	**Glory Hole, Northwest Dump and EFSFSR (RME)**	**Above CVs (Y/N)**	**Northeast Dump and Sugar Creek (RME)**	**Above CVs (Y/N)**	**Location UW-1 (Upgradient Wetland) (Max)**	**Above CVs (Y/N)**	**Smelter Stack (Max)**	**Above CVs (Y/N)**	**DMEA Dump (Max)**	**Above CVs (Y/N)**	**Location BD6 (Northwest Dump) (Max)**	Above CVs (Y/N)
Aluminum	31567	4740	N	7920	N	11000	N	20200	N	13500	N	4400	N	6850	N
Antimony	11.75	0.7	N	368	Y	19.1	N	689	Y	292	Y	7.4	N	16400	Y

Arsenic	200	4970	Y	2720	Y	5630	Y	983	Y	9420[a]	Y	9460	Y	4790	Y
Cadmium	0.08	--	N	--	N	--	N	--	N	0.09	N	--	N	0.09	N
Chromium	25	5.7	N	10.9	N	16.2	N	10.1	N	6.1	N	6.4	N	8.57	N
Copper	9.15	7.27	N	9.49	N	11.1	N	286	N	8.3	N	6.3	N	26.5	N
Cyanide	--	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Lead	8.03	11.5	N	6.51	N	8.56	N	754	Y	16.6	N	9.2	N	34.7	N
Manganese	1563	56.1	N	2.53	N	359	N	147	N	370	N	885	N	130	N
Mercury	0.16	2.51	N	1.39	N	1.52	N	2.3	N	471	Y	9.9	N	13.6	N
Nickel	19.9	3.89	N	5.97	N	17.1	N	8.2	N	2.8	N	--	N	2.89	N
Selenium	<0.3	--	N	0.316	N	0.248	N	1.1	N	66.7	N	0.35	N	7.7	N
Silver	0.09	0.54	N	2.52	N	1.95	N	2.2	N	4.1	N	3.4	N	6.79	N
Zinc	71.9	53.9	N	40.5	N	30	N	48.2	N	47.3	N	42.7	N	150	N

RME = Reasonable Maximum Exposure Concentration (mg/kg)
MAX = Maximum Concentration (mg/kg)
[a] the arsenic concentration in the surface soil of Smelter Stack (9420 mg/kg) came from USFS confirmation soil sample results (email communication, USFS, Dec. 16, 2002).

Note: Highlighted concentrations indicate contaminant concentration is above the health-based comparison values

Table C-4.

Contaminants of Concern in Surface Water of Different Exposure Locations (mg/L)

Contaminant	**Lower Meadow Creak Valley (RME)**	**Y/N**	**Upgradient Wetland, (MAX)**	**Y/N**	**Keyway Wetland (MAX)**	**Y/N**	**Southeast Dump and Midnight Creek**	**Y/N**	**Glory Hole, Northwest Dump and EFSFSR**	**Y/N**	**Northeast Dump and Sugar Creek (RME)**	**Y/N**	**Location UW-1 (Upgradient Wetland) (Max)**	**Y/N**	**Bailey Tunnel Outlet**	**Y/N**

							(RME)		**(RME)**							
Aluminum	0.0831	N	0.153	N	0.12	N	0.079	N	0.047	N	0.137	N	--	N	--	N
Antimony	0.0112	Y	--	N	0.127	Y	0.0392	Y	0.0267	Y	0.0083	Y	0.069	Y	0.281	Y
Arsenic	0.0323	Y	--	N	0.463	Y	0.0577	Y	0.059	Y	0.012	Y	0.316	Y	0.535	Y
Cadmium	--	N	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Chromium III	--	N	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Copper	0.002	N	0.0017	N	--	N	--	N	--	N	--	N	0.004	N	--	N
Cyanide	0.0023	N	0.0021	N	0.0056	N	0.0021	N	--	N	--	N	--	N	--	N
Lead	0.00143	N	0.001	N	--	N	0.0046	N	0.00032	N	--	N	0.0053	N	0.0064	N
Manganese-w	0.0314	N	0.0072	N	0.785	Y	0.0154	N	0.0282	N	0.005	N	0.0491	N	0.181	N
Mercury	0.0000054	N	--	N	0.0000118	N	0.0000131	N	0.000039	N	0.0000255	N	--	N	--	N
Nickel	--	N	--	N	--	N	--	N	0.0144	N	--	N	--	N	--	N
Selenium	--	N	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Silver	--	N	--	N	--	N	--	N	0.0000129	N	--	N	--	N	0.0000106	N
Zinc	0.00252	N	--	N	0.0044	N	0.0159	N	0.00385	N	0.008	N	--	N	0.0075	N

RME = Reasonable Maximum Exposure Concentration (mg/L)
MAX = Maximum Concentration (mg/L)

Note: Highlighted concentrations indicate contaminant concentration is above the health-based comparison values

Table C-5.

Estimated Daily Exposure Dose of Concerned Contaminants from Consumption of Fish by Recreational Users

Contaminant	Lower Meadow Creak Valley (RME)	Exposure Dose (mg/kg/d)			Southeast Dump and Midnight Creek (RME)	Exposure Dose (mg/kg/d)			Glory Hole, Northwest Dump and EFSFSR (RME)	Exposure Dose (mg/kg/d)		
		Children	Adult	Workers		Children	Adult	Workers		Children	Adult	Workers
Aluminum	--				--				--			
Antimony	--				--				--			
Arsenic	0.0728	5.3E-07	3.2E-07	3.6E-06	0.0728	5.3E-07	3.2E-07	3.6E-06	0.0739	5.4E-07	3.2E-07	3.6E-06
Cadmium	--				--				--			
Chromium III	--				--				--			
Copper	--				--				--			
Cyanide	--				--				--			
Lead	--				--				0.042	5.1142E-07	3.0685E-07	3.5E-06
Manganese	0.599	7.3E-06	4.4E-06	4.9E-05	0.599	7.3E-06	4.4E-06	4.9E-05	0.353	4.3E-06	2.6E-06	2.9E-05
Mercury	--				--				--			
Methyl Mercury	0.218	2.7E-06	1.6E-06	1.8E-05	0.218	2.7E-06	1.6E-06	1.8E-05	0.117	1.4E-06	8.5E-07	9.6E-06
Nickel	--				--				--			
Selenium	0.706	8.6E-06	5.2E-06	5.8E-05	0.706	8.6E-06	5.2E-06	5.8E-05	0.615	7.5E-06	4.5E-06	5.1E-05
Silver	--				--				--			
Zinc	7.05	8.6E-05	5.2E-05	5.8E-04	7.05	8.6E-05	5.2E-05	5.8E-04	7.83	9.5E-05	5.7E-05	6.4E-04

RME = Reasonable Maximum Exposure Concentration (mg/kg)

Note: There is no comparison value available for lead

Table C-6.

Health Guidelines Values

Contaminant	ATSDR's Chronic Oral MRL mg/kg/day	ATSDR's Intermediate Oral MRL mg/kg/day	ATSDR's Acute Oral MRL mg/kg/day	EPA's Chronic Oral RfD mg/kg/day	EPA's Oral Slope Factor $(mg/kg/day)^{-1}$
Aluminum		2			
Antimony				0.0004	
Arsenic	0.0003		0.005	0.0003	1.5
Cadmium	0.0002				
Chromium				1.5	
Copper					
Cyanide				0.02	
Lead					
Manganese (environmental)				0.05	
Manganese (food)				0.14	
Mercury		0.002	0.007	0.0003	
Methyl Mercury	0.0003			0.0001	
Nickel				0.02	
Selenium	0.005			0.005	
Silver				0.005	
Zinc	0.3	0.3		0.3	

MRL: Minimal Risk Level
RfD: Reference Dose

Table C-7.

Estimated Daily Exposure Dose (mg/kg/d) of Concerned Contaminants from Ingestion of Surface Soil and Inhalation of Airborne Particulate in Meadow Creek Exposure Areas

Population	Contaminant	Bradley Tailings and Neutralied Ore Dispos	Dose	Meadow Creek Mine Hillside	Dose	Lower Meadow Creak Valley	Dose	Upgradient Wetland (MAX)	Dose	Keyway Wetland (MAX)	Dose	Meadow Creek Forested Wetland	Dose

		al Area (RME)		(RME)		(RME)						(MAX)	
Children (7 years old) Recreational Users	Antimony	133	2.6E-05			1320	2.6E-04			333	6.5E-05	1550	3.0E-04
	Arsenic	1620	1.9E-04	1460	1.7E-04	955	1.1E-04	24.4	2.9E-06	634	7.4E-05	1230	1.4E-04
Adult Recreational Users	Antimony	133	7.8E-06			1320	7.7E-05			333	1.9E-05	1550	9.1E-05
	Arsenic	1620	5.7E-05	1460	5.1E-05	955	3.3E-05	24.4	8.6E-07	634	2.2E-05	1230	4.3E-05
Reclamation Workers	Antimony	133	8.7E-05			1320	8.7E-04			333	2.2E-04	1550	1.0E-03
	Arsenic	1620	6.4E-04	1460	5.8E-04	955	3.8E-04	24.4	9.6E-06	634	2.5E-04	1230	4.9E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-8.

Estimated Daily Exposure Dose (mg/kg/d) of Concerned Contaminants from Ingestion of Surface Soil and Inhalation of Airborne Particulate in Bradley Waste Rock Dumps and Hot Spots

Population	Contaminant	Southeast Dump and Midnight Creek (RME)	Dose	Glory Hole, Northwest Dump and EFSFSR (RME)	Dose	Northeast Dump and Sugar Creek (RME)	Dose	Location UW-1 (Upgradient Wetland) (Max)	Dose	Smelter Stack (Max)	Dose	DMEA Dump (Max)	Dose	Location BD-6 (Northwest Dump) (Max)	Dose
Children (7 years old) Recreational Users	Antimony			368	7.2E-05			689	1.7E-05	292	7.1E-06			16400	4.0E-04
	Arsenic	4970	5.8E-04	2720	3.2E-04	5630	6.6E-04	983	1.4E-05	9420	1.8E-04	9460	1.5E-04	4790	7.0E-05

	Lead							754	1.8E-05						
	Mercury									471	1.1E-05				
Adult Recreational Users	Antimony			368	2.2E-05			689	5.0E-06	292	2.1E-06			16400	1.2E-04
	Arsenic	4970	1.7E-04	2720	9.5E-05	5630	2.0E-04	983	4.3E-06	9420	5.5E-05	9460	4.1E-05	4790	2.1E-05
	Lead							754	5.5E-06						
	Mercury									471	3.4E-06				
Reclamation Workers	Antimony			368	2.4E-04			689	7.0E-05	292	3.0E-05			16400	1.7E-03
	Arsenic	4970	2.0E-03	2720	1.1E-03	5630	2.2E-03	983	6.0E-05	9420	7.7E-04	9460	5.8E-04	4790	2.9E-04
	Lead							754	7.7E-05						
	Mercury									471	4.8E-05				

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD. No MRL or RfD available for lead.

Table C-9.

Estimated Daily Exposure Dose (mg/kg/d) of Concerned Contaminants from Ingestion of Surface Water

	Contaminant	Lower Mea	Dose	Keyway Wet	Dose	Southeast	Dose	Glory Hole,	Dose	Northeast	Dose	Location UW-1	Dose	Bailey Tu	Dose

		dow Creak Valley (RME)		land (MAX)		Dump and Midnight Creek (RME)		Northwest Dump and EFSFSR (RME)		Dump and Sugar Creek (RME)		(Upgradient Wetland) (Max)		nnel Outlet	
Children (7 years old) Recreational Users	Antimony	0.0112	1.1E-05	0.127	1.2E-04	0.0392	3.8E-05	0.0267	2.6E-05	0.0083	8.1E-06	0.069	8.4E-06	0.281	2.7E-04
	Arsenic	0.0323	1.9E-05	0.463	2.7E-04	0.0577	3.4E-05	0.059	3.4E-05	0.012	7.0E-06	0.316	2.3E-05	0.535	3.1E-04
	Manganese-w			0.785	7.6E-04										
Adult Recreational Users	Antimony	0.0112	6.5E-06	0.127	7.4E-05	0.0392	2.3E-05	0.0267	1.6E-05	0.0083	4.9E-06	0.069	5.0E-06	0.281	1.6E-04
	Arsenic	0.0323	1.1E-05	0.463	1.6E-04	0.0577	2.0E-05	0.059	2.1E-05	0.012	4.2E-06	0.316	1.4E-05	0.535	1.9E-04
	Manganese-w			0.785	4.6E-04										

Note: No estimated daily contaminant exposure dose is above the health guidelines values

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Area 1 (Bradley Tailings and Naturalized Ore Disposal Area)			Area 1 (Meadow Creek Mine Hillside)			Lower Meadow Creek Valley		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		

Antimony	Surface Soil	2.6E-05	7.8E-06	8.7E-05				2.6E-04	7.7E-05	8.7E-04
	Surface Water							1.1E-05	6.5E-06	
	Fish									
	Total	2.6E-05	7.8E-06	8.7E-05				2.7E-04	8.4E-05	8.7E-04
Arsenic	Surface Soil	1.9E-04	5.7E-05	6.4E-04	1.7E-04	5.1E-05	5.8E-04	1.1E-05	3.3E-05	3.8E-04
	Surface Water							1.9E-05	1.1E-05	
	Fish							5.3E-07	3.2E-07	3.6E-06
	Total	1.9E-04	5.7E-05	6.4E-04	1.7E-04	5.1E-05	5.8E-04	3.1E-04	4.4E-05	3.8E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	**Exposure Media**	**Area 1 (Upgradient Wetland, excl. the UW-1 Hot Spot)**			**Area 1 (Keyway Wetland)**			**Area1 (Meadow Creek Forested Wetland)**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**		**Children**	**Adults**	
		Exposure Dose (mg/kg/day)			**Exposure Dose (mg/kg/day)**			**Exposure Dose (mg/kg/day)**		
Antimony	Surface Soil				6.5E-05	1.9E-05	2.2E-04	3.0E-04	9.1E-05	1.0E-03
	Surface Water				1.2E-04	7.4E-05				
	Fish									
	Total				1.9E-04	9.3E-05	2.2E-04	3.0E-04	9.1E-05	1.0E-03
Arsenic	Surface Soil	2.9E-06	8.6E-07	9.6E-06	7.4E-05	2.2E-05	2.5E-04	1.4E-04	4.3E-05	4.9E-04

	Surface Water				2.7E-04	1.6E-04				
	Fish									
	Total	2.9E-06	8.6E-07	9.6E-06	3.4E-04	1.8E-04	2.5E-04	1.4E-04	4.3E-05	4.9E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Southeast Dump and Midnight Creek)			Glory Hole, Northwest Dump and EFSFSR			Northeast Dump and Sugar Creek		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		
Antimony	Surface Soil				7.2E-05	2.2E-05	2.4E-04			
	Surface Water	3.8E-05	2.3E-05		2.6E-05	1.6E-05		8.1E-06	4.9E-06	
	Fish									
	Total	3.8E-05	2.3E-05		9.8E-05	3.8E-05	2.4E-04	8.1E-06	4.9E-06	
Arsenic	Surface Soil	5.8E-04	1.7E-04	2.0E-03	3.2E-04	9.5E-05	1.1E-03	6.6E-04	2.0E-04	2.2E-03
	Surface Water	3.4E-05	2.0E-05		3.4E-05	2.1E-05		7.0E-06	4.2E-06	
	Fish	5.3E-07	3.2E-07	3.6E-06	5.4E-07	3.2E-07	3.6E-06			
	Total	6.1E-04	1.9E-04	2.0E-03	3.5E-04	1.2E-04	1.1E-03	6.6E-04	2.0E-04	2.2E-03

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Location UW-1 (Upgradient Wetland)			Smelter Stack			DMEA Dump		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		
Antimony	Surface Soil	1.7E-05	5.0E-06	7.0E-05	7.1E-06	2.1E-06	3.0E-05			
	Surface Water	8.4E-06	5.0E-06							
	Fish									
	Total	2.5E-05	1.0E-05	7.0E-05	7.1E-06	2.1E-06	3.0E-05			
Arsenic	Surface Soil	1.4E-05	4.3E-06	6.0E-05	1.8E-04	5.5E-05	7.7E-04	1.5E-04	4.1E-05	5.8E-04
	Surface Water	2.3E-05	1.4E-05							
	Fish									
	Total	3.7E-05	1.8E-05	6.0E-05	1.8E-04	5.5E-05	7.7E-04	1.5E-04	4.1E-05	5.8E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Location BD6 (Northwest Dump)			Bailey Tunnel Outlet					
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	

		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		
Antimony	Surface Soil	4.0E-04	1.2E-04	1.7E-03						
	Surface Water				2.7E-04	1.6E-04				
	Fish									
	Total	4.0E-04	1.2E-04	1.7E-03	2.7E-04	1.6E-04				
Arsenic	Surface Soil	7.0E-05	2.1E-05	2.9E-04						
	Surface Water				3.1E-04	1.9E-04				
	Fish									
	Total	7.0E-05	2.1E-05	2.9E-04	3.1E-04	1.9E-04				

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

APPENDIX D: ESTIMATED CARCINOGENIC EXPOSURE DOSES AND CANCER RISK

Table D-1.

Summary of Carcinogenic Exposure Dose and Cancer Risk of Arsenic in Different Areas

Contaminant	Exposure Media	Area 1 (Bradley Tailings and Naturalized Ore Disposal Area)			Area 1 (Meadow Creek Mine Hillside)			Lower Meadow Creek Valley		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	3.2E-05	2.4E-05	9.1E-06	2.9E-05	2.2E-05	8.2E-06	1.9E-05	1.4E-05	5.4E-06
	Surface Water							3.2E-06	4.9E-06	
	Fish							9.1E-08	1.4E-07	5.1E-08
	Total	3.2E-05	2.4E-05	9.1E-06	2.9E-05	2.2E-05	8.2E-06	2.2E-05	1.9E-05	5.5E-06

Total Cancer Risk		4.8E-05	3.6E-05	1.4E-05	4.4E-05	3.3E-05	1.2E-05	3.3E-05	2.9E-05	8.3E-06

Contaminant	**Exposure Media**	**Area 1 (Upgradient Wetland, excl. the UW-1 Hot Spot)**			**Area 1 (Keyway Wetland)**			**Area1 (Meadow Creek Forested Wetland)**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**		**Children**	**Adults**	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	4.9E-07	3.7E-07	1.4E-07	1.3E-05	9.5E-06	3.6E-06	2.5E-05	1.8E-05	6.9E-06
	Surface Water				4.6E-05	7.0E-05				
	Fish									
	Total	4.9E-07	3.7E-07	1.4E-07	5.9E-05	8.0E-05	3.6E-06	2.5E-05	1.8E-05	6.9E-06
Total Cancer Risk		7.4E-07	5.6E-07	2.1E-07	8.9E-05	1.2E-04	5.4E-06	3.8E-05	2.7E-05	1.0E-05

Table D-1.

Summary of Carcinogenic Exposure Dose and Cancer Risk of Arsenic in Different Areas

Contaminant	**Exposure Media**	**Southeast Dump and Midnight Creek)**			**Glory Hole, Northwest Dump and EFSFSR**			**Northeast Dump and Sugar Creek**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**		**Children**	**Adults**	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	1.0E-04	7.5E-05	2.8E-05	5.5E-05	4.1E-05	1.5E-05	1.1E-04	8.5E-05	3.2E-05
	Surface Water	5.8E-06	8.7E-06		5.9E-06	8.9E-06		1.2E-06	1.8E-06	
	Fish	9.1E-08	1.4E-07	5.1E-08	9.3E-08	1.4E-07	5.2E-08			
	Total	1.1E-04	8.4E-05	2.8E-05	6.1E-05	5.0E-05	1.5E-05	1.1E-04	8.7E-05	3.2E-05

Total Cancer Risk		1.7E-04	1.3E-04	4.2E-05	9.2E-05	7.5E-05	2.3E-05	1.7E-04	1.3E-04	4.8E-05

Contaminant	**Exposure Media**	**Location UW-1 (Upgradient Wetland)**			**Smelter Stack**			**DMEA Dump**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**		**Children**	**Adults**	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	2.1E-07	6.2E-08	8.6E-07	2.6E-06	7.9E-07	1.1E-05	2.0E-06	5.9E-07	8.3E-06
	Surface Water	3.3E-07	2.0E-07							
	Fish									
	Total	5.4E-07	2.6E-07	8.6E-07	2.6E-06	7.9E-07	1.1E-05	2.0E-06	5.9E-07	8.3E-06
Total Cancer Risk		8.1E-07	3.9E-07	1.3E-06	3.9E-06	1.2E-06	1.7E-05	3.0E-06	1.4E-06	1.2E-05

Table D-1.

Summary of Carcinogenic Exposure Dose and Cancer Risk of Arsenic in Different Areas

Contaminant	**Exposure Media**	**Location BD6 (Northwest Dump)**			**Bailey Tunnel Outlet**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	1.0E-06	3.0E-07	4.2E-06			
	Surface Water				5.4E-05	8.0E-05	
	Fish						
	Total	1.0E-06	3.0E-07	4.2E-06	5.4E-05	8.0E-05	
Total Cancer Risk		1.5E-06	4.5E-07	6.3E-06	8.1E-05	1.2E-04	

APPENDIX E: EXPOSURE DOSE CALCULATION EQUATIONS

Surface Soil

Estimated daily exposure from ingestion of surface soil

$$Dose = \frac{Conc \times EF \times IR \times ED \times AF}{BW \times AT \times 365} \times 10^{-6} (kg/mg) \quad \text{---------- Equation 1}$$

Where,
Dose = mg/kg/day
Conc. = Concentration (mg/kg)
EF = Exposure frequency (days)

- Children (7-18 years of age) recreational users: 1 day for hotspots and 8 days for other areas
- Adult (19 or older) recreational users: 1 day for hotspots and 8 days for other areas
- Reclamation workers: 14 day for hotspots and 90 days for other areas

IR = soil ingestion rate (mg/day)

- Children (7-18 years of age) recreational users: 200 mg/day
- Adult (19 or older) recreational users: 100 mg/day
- Reclamation workers: 100 mg/day

ED = exposure duration (years)

- Children (7-18 years of age) recreational users: 1 year for hotspots and 12 years for other areas
- Adult (19 or older) recreational users: 1 year for hotspots and 30 years for other areas
- Reclamation workers: 1 year for all hotspots and other areas

AF = absorption fraction (arsenic: 80% in Smelter Stack and 60% in all other place; other contaminants: 100%)

BW = body weight (kg)

- Children (7-18 years of age) recreational users: 45 kg
- Adult (19 or older) recreational users: 75 kg
- Reclamation workers: 75 kg

AT = average time

For carcinogenic: 70 years (lifetime) for all the recreational users and reclamation workers
For non-carcinogenic:

- Children (7-18 years of age) recreational users: 1 year for hotspots and 12 years for other areas
- Adult (19 or older) recreational users: 1 year for hotspots and 30 years for other areas
- Reclamation workers: 1 year for all hotspots and other areas

Air Borne Particulate:

Estimated daily exposure from inhalation of airborne particulate

No data available. BEHS assumes it is the same as the daily exposure from ingestion of surface soil.

Surface Water:

Estimated daily exposure from ingestion of surface water

$$Dose = \frac{Conc \times EF \times IR \times ED \times AF}{BW \times AT \times 365} \quad \text{---------- Equation 2}$$

Where,
Dose = mg/kg/day
Conc. = Concentration (mg/L)
EF = Exposure frequency (days)

- Children (7-18 years of age) recreational users: 1 day for hotspots and 8 days for other areas
- Adult (19 or older) recreational users: 1 day for hotspots and 8 days for other areas

IR = surface water consumption rate (L/day)

- Children (7-18 years of age) recreational users: 2 L/day
- Adult (19 or older) recreational users: 2 L/day

ED = exposure duration (years)

- Children (7-18 years of age) recreational users: 1 year for hotspots and 12 years for other areas
- Adult (19 or older) recreational users: 1 year for hotspots and 30 years for other areas

AF = absorption fraction (arsenic: 80% in Smelter Stack and 60% in all other place; other contaminants: 100%)

BW = body weight (kg)

- Children (7-18 years of age) recreational users: 45 kg
- Adult (19 or older) recreational users: 75 kg

AT = average time

For carcinogenic: 70 years (lifetime) for all the recreational users
For non-carcinogenic:

- Children (7-18 years of age) recreational users: 1 year for hotspots and 12 years for other areas
- Adult (19 or older) recreational users: 1 year for hotspots and 30 years for other areas

Fish:

Estimated daily exposure from consumption of fish

$$Dose = \frac{Conc \times EF \times ED \times AF}{BW \times AT \times 365} \times 10^{-3} (kg/g) \quad \text{---------- Equation 3}$$

Where,
Dose = mg/kg/day
Conc. = Concentration (mg/kg)
EF = Exposure frequency (days)

- Children (7-18 years of age) recreational users: 1 day for hotspots and 8 days for other areas
- Adult (19 or older) recreational users: 1 day for hotspots and 8 days for other areas
- Reclamation workers: 14 day for hotspots and 90 days for other areas

IR = fish intake rate (g/day)

- Children (7-18 years of age) recreational users: 25 g/day (58.7g/day for Tribe)
- Adult (19 or older) recreational users: 25 g/day (58.7g/day for Tribe)
- Reclamation Workers: 25 g/day

ED = exposure duration (years)

- Children (7-18 years of age) recreational users: 1 year for hotspots and 12 years for other areas
- Adult (19 or older) recreational users: 1 year for hotspots and 30 years for other areas
- Reclamation workers: 1 year for all hotspots and other areas

AF = absorption fraction (arsenic: 80% in Smelter Stack and 60% in all other place; other contaminants: 100%)

BW = body weight (kg)

- Children (7-18 years of age) recreational users: 45 kg
- Adult (19 or older) recreational users: 75 kg
- Reclamation workers: 75 kg

AT = average time

For carcinogenic: 70 years (lifetime) for all the recreational users and reclamation workers
For non-carcinogenic:

- Children (7-18 years of age) recreational users: 1 year for hotspots and 12 years for other areas
- Adult (19 or older) recreational users: 1 year for hotspots and 30 years for other areas
- Reclamation workers: 1 year for all hotspots and other areas

APPENDIX F: CANCER RISK CALCULATION EQUATION

$Risk = Dose(carcinogenic) \times SF$

Where,

Risk = estimated excess cancer risk over a lifetime (unitless)
Dose (carcinogenic) = mg/kg/day (lifetime average exposure dose)
SF = cancer slope factor $(mg/kg/day)^{-1}$, chemical specific

APPENDIX G: ATSDR GLOSSARY OF ENVIRONMENTAL HEALTH TERMS

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. 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.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption:
The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute:
Occurring over a short time [compare with **chronic**].

Acute exposure:
Contactwith a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure]**.

Additive effect:
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with **antagonistic effect** and **synergistic effect]**.

Adverse health effect:
A change in body function or cell structure that might lead to disease or health problems.

Aerobic:
Requiring oxygen [compare with **anaerobic**].

Ambient:
Surrounding (for example, *ambient* air).

Anaerobic:
Requiring the absence of oxygen [compare with **aerobic**].

Analyte:
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study:

A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect:

A biologic response to exposure to multiple substances that is **less** than would be expected if the known effects of the individual substances were added together [compare with **additive effect** and **synergistic effect**].

Background level:

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation:

Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study:

A study that uses (a) **biomedical testing** or (b) the measurement of a substance [an **analyte**], its **metabolite**, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see **exposure investigation**].

Biologic monitoring :

Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake:

The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing:

Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota:

Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden :

The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP:
See **Community Assistance Panel**.

Cancer:
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk:
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen:
A substance that causes cancer.

Case study:
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study:
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number:
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system:
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA:
[see **Comprehensive Environmental Response, Compensation, and Liability Act of 1980**]

Chronic:
Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure:

Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

Cluster investigation:
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP):
A group of people, from a community and from health and environmental agencies, who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV):
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway:
[see **exposure pathway**].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA):
CERCLA, also known as **Superfund**, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration:
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant:
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect:
A disease or injury that happens as a result of exposures that might have occurred in the past.

Dermal:
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact:
Contact with (touching) the skin [see **route of exposure**].

Descriptive epidemiology:
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit:
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention:
Measures used to prevent a disease or reduce its severity.

Disease registry:
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD:
United States Department of Defense.

DOE:
United States Department of Energy.

Dose (for chemicals that are not radioactive) :
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals):

The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship :
The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

Environmental media :
Soil, water, air, **biota** (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism:
Environmental media include water, air, soil, and **biota** (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The **environmental media and transport mechanism** is the second part of an **exposure pathway**.

EPA:
United States Environmental Protection Agency.

Epidemiologic surveillance:
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Epidemiology:
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure:
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

Exposure assessment :
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction:

A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation:
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway:
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a **source of contamination** (such as an abandoned business);an **environmental media and transport mechanism** (such as movement through groundwater); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching); and a **receptor population** (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a **completed exposure pathway**.

Exposure registry:
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study:
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS) :
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds:
Training sessions for physicians and other health care providers about health topics.

Groundwater:
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with **surface water**].

Half-life ($t_{1/2}$):
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other

chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard :
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat):
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste:
Potentially harmful substances that have been released or discarded into the environment.

Health consultation:
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

Health education:
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation:
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health promotion:
The process of enabling people to increase control over, and to improve, their health.

Health statistics review :
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific

population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard:
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence :
The number of new cases of disease in a defined population over a specific time period [contrast with **prevalence**].

Ingestion:
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation:
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Intermediate duration exposure:
Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

In vitro :
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with **in vivo**].

In vivo :
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with **in vitro**].

Lowest-observed-adverse-effect level (LOAEL):
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring:
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism :
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite:
Any product of **metabolism**.

mg/kg:
Milligram per kilogram.

mg/cm^2:
Milligram per square centimeter (of a surface).

mg/m^3:
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration:
Moving from one location to another.

Minimal risk level (MRL):
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

Morbidity :
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality:
Death. Usually the cause (a specific disease, condition, or injury) is stated.

Mutagen :
A substance that causes **mutations** (genetic damage).

Mutation :
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL):

EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard:

A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL):

The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard:

A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL:

[see **National Priorities List for Uncontrolled Hazardous Waste Sites**]

Physiologically based pharmacokinetic model (PBPK model):

A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica:

A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume :

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure:

The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

Population:
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP):
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb:
Parts per billion.

ppm:
Parts per million.

Prevalence :
The number of existing disease cases in a defined population during a specific time period [contrast with **incidence**].

Prevalence survey:
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention:
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period:
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session:
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action:
A list of steps to protect public health.

Public health advisory:

A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA):
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **health consultation**].

Public health hazard:
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories:
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are **no public health hazard**, **no apparent public health hazard**, **indeterminate public health hazard**, **public health hazard**, and **urgent public health hazard**.

Public health statement:
The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting:
A public forum with community members for communication about a site.

Radioisotope:
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide:
Any radioactive isotope (form) of any element.

RCRA:
[see **Resource Conservation and Recovery Act (1976, 1984)**]

Receptor population:
People who could come into contact with hazardous substances [see **exposure pathway**].

Reference dose (RfD):
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry :
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

Remedial investigation:
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA):
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA:
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD:
See **reference dose**.

Risk:
The probability that something will cause injury or harm.

Risk reduction:
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication:
The exchange of information to increase understanding of health risks.

Route of exposure:
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].

Safety factor:
[see **uncertainty factor**]

SARA:
[see **Superfund Amendments and Reauthorization Act**]

Sample:
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see **population**]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size :
The number of units chosen from a population or environment.

Solvent:
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination:
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an **exposure pathway**.

Special populations:
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder:
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics :
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance :
A chemical.

Substance-specific applied research:
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's **toxicological profiles**. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund Amendments and Reauthorization Act (SARA):
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water:
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Surveillance:
[see **epidemiologic surveillance**]

Survey:
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see **prevalence survey**].

Synergistic effect:
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see **additive effect** and **antagonistic effect**].

Teratogen :
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent:
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile:

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology:

The study of the harmful effects of substances on humans or animals.

Tumor:

An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor:

Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Urgent public health hazard:

A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs) :

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

APPENDIX H: STIBNITE MINE PUBLIC HEALTH ASSESSMENT RELEASE REVIEW COMMENTS ADDRESSED AUGUST 2003

The following comments were provided by members of the general public. Responses to reviewer comments immediately follow the comment. All editorial comments were incorporated, as necessary, and are not included in the following narrative.

1. **I find it difficult to justify access restrictions based upon your data. It seems that, according to Conclusion 3, page 24, "It is unlikely that the**

contaminants at the Stibnite site will result in any adverse public health effects for the reclamation users and recreational users, since the estimated exposure doses are below the corresponding health guideline values, or below the corresponding lowest NOAELS (or LOAELs) in all related studies." I believe that says it all! I take umbrage that you then proceed to recommend denial of access to the site.

BEHS considered current peer reviewed toxicological and epidemiological information on the chemicals present in environmental samples. BEHS determined that at this time, under current site land uses and exposure scenarios, the site poses no apparent public health hazard. If members of the public avoid the site, they will not be exposed to site contamination. Eliminating exposure pathways to hazardous chemicals is a priority for BEHS. However, upon further consideration, it was determined that signs warning visitors of the presence and potential health threat of site contaminants would be sufficiently prudent. Consequently, BEHS revised its recommendations to reflect this change.

2. **I record snow fall during the winter in Yellow Pine. During that time frame I recorded 10 ½ feet of snow. That is not counting the rain. The mine is higher up. So your figures are not correct.**

The average annual precipitation values used in this public health assessment were cited from the following report: *URS 2000, Stibnite Area Risk Evaluation Report, URS Corporation, Stibnite Area Site Characterization Voluntary Consent Order Respondents, Denver, CO.* BEHS checked this figure with information from the Western Regional Climate Center. The precipitation values from these two separate, peer-reviewed sources were in agreement. It is important to note that ten feet of snow does not equal ten feet of precipitation (water). Variables such as compaction and water content must be taken into account when estimating the amount of water in a given snowpack.

3. **Yellow Pine has more than 40 people in Yellow Pine during the year. In the summer, people are around 200 who only come in then and own property. Plus we have water runners and campers. Harmonic is around 3,000 to 4,000 people. Plus all the holidays we have more people come in. Then during the winter, we have hunters and snowmobilers. So you see, at any time we have more than 40. These people also go up to the mine area.**

BEHS used 2000 U. S. Census Bureau data when attempting to determine the number of permanent Yellow Pine residents. BEHS concedes that many more people may visit Yellow Pine and the site itself. At this time, the number of people recreating on or near the site has not been quantified.

4. **I am concerned that no tests have been done with plants and animals. We have lots of hunters who come into hunt and also Yellow Pine residents who go up to that area to hunt. I am concerned about the safety of eating deer and elk meat and other eating the meat that has eaten plants up there and been exposed to the area.**

The commenter points out a potentially important data gap. BEHS made the following recommendation in the public health assessment: "Biota (other than fish) samples should be collected and analyzed for potential uptake of metals from site soils and surface water." If such a sampling event occurs, BEHS will analyze the results and assess any public health threat posed by consuming biota exposed to site contamination.

5. **In the <u>Summary</u>, it states that "This document fulfills ATSDR Congressional mandate for preparing a public health assessment within one year of EPA**

proposing a site to the NPL." Stibnite was proposed to the NPL on September 13, 2001. The PHA is dated May 2003, which is approximately nineteen and one-half months after the site was proposed to the NPL. The PHA does not appear to have met the twelve month time frame in which it should have been completed. Please advise.

Work on the public health assessment began within twelve months of the proposed listing and ATSDR and BEHS produced an Initial Release of the assessment on September 13, 2002. This satisfies the Congressional mandate.

6. **Please advise exactly where the hot spats are located and what remediation will be performed, when it will be accomplished and the source of funds for accomplishing the same.**

This question is regulatory in nature and is best answered by the environmental and ecological regulatory agencies with jurisdiction over the site. Commenter was referred to the appropriate personnel at IDEQ, USFS, and EPA.

7. **Please correct me, but I was under the impression that Stibnite's proposal to the NPL had been put on hold in the latter part of 2002. If it is not on hold, please advise of the current status and ongoing developments.**

During a telephone conversation, the commenter clarified that she is interested in what is happening and what will happen at the site with regard to on-going environmental remediation. Since this concern is regulatory in nature and is best answered by the environmental and ecological regulatory agencies with jurisdiction over the site, the commenter was referred to the appropriate personnel at IDEQ, USFS, and EPA.

8. **First, please identify the site owners; second, describe in detail exactly what the reclamation activities will consist of and how the tailings piles and other contamination (please identify the location) will be secured; third, who will perform the reclamation activities; and fourth, identify the source(s) for the funds to accomplish the reclamation.**

This question is regulatory in nature and is best answered by the environmental and ecological regulatory agencies with jurisdiction over the site. Commenter was referred to the appropriate personnel at IDEQ, USFS, and EPA.

9. **"IDEQ will arrange to have damaged buildings on site removed if they interfere with site reclamation or pose a significant threat to site safety." Please identify as to location, the damaged buildings referenced to be on site.**

This question is regulatory in nature and is best answered by the environmental and ecological regulatory agencies with jurisdiction over the site. Commenter was referred to the appropriate personnel at IDEQ, USFS, and EPA.

10. **I would like to review the photographs and field notes documenting the July 10, (2)002 site visit. Please provide me with copies of the same.**

Copies were mailed to commenter on August 1, 2003.

11. **Please advise of the relevance of sampling events conducted at the site in 1997 and 1999. Additionally, please advise of the dates, if any, of more current sampling (e)vents and the results thereof.**

This question is regulatory in nature and is best answered by the environmental and ecological regulatory agencies with jurisdiction over the site. Commenter was referred to the appropriate personnel at IDEQ, USFS, and EPA.

12. **Please identify the multiple wooden structures existing on site that are not secured against entry and which are in serious disrepair and whose loose boards and nails could pose a physical hazard to trespassers.**

This question is regulatory in nature and is best answered by the environmental and ecological regulatory agencies with jurisdiction over the site. Commenter was referred to the appropriate personnel at IDEQ, USFS, and EPA.

13. **Section 9. References - Commenter requested copies of various reports cited in the Section 9**

Commenter was referred to the agencies and consultants who produced the requested reports. The reports the commenter requested are voluminous. Reproducing and distributing these reports is prohibitively expensive for BEHS. Commenter was directed to request the reports directly from the agencies and contractors who produced them.

14. **Appendix A Stibnite location and Sampling Maps - Please provide legible copies of the maps on pages 31 and 33.**

These maps are the most legible maps that BEHS possesses. Commenter was referred to the USFS in order to view original copies of the maps.

LIST OF TABLES

Table 1.

Completed Exposure Pathways

Source	Media	Point of Exposure	Route of Exposure	Exposed Population	Time	Status
Stibnite Mine Area	onsite surface soil	tailings, neutralized ore, waste rock, smelter cinder piles, heap leach pile, old crusher area roads & air field	eating, skin contact	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed
					future	potential
Stibnite Mine Area	surface water	Blowout and Meadow Creeks, seeps, Glory Hole, EFSFSR, old crusher area roads & air field	drinking, skin contact	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed*
					future	potential
Stibnite Mine Area	sediment	banks of Blowout and Meadow Creeks, Glory Hole, EFSFSR, old crusher area roads & air field	eating, skin contact	site workers, recreational users, former residents of Stibnite	past	completed
					present	completed
					future	potential
Stibnite Mine Area	air dust	depositional areas in Meadow Creek Valley, the Glory Hole, and along the	breathing	site workers, recreational users,	past	completed
					present	completed

		EFSFSR, old crusher area roads & air field		former residents of Stibnite	future	potential

* This pathway is currently completed for dermal contact and is potentially complete for drinking.

Table 2. Potential Exposure Pathways

Potential Exposure Pathways

Source	Media	Point of Exposure	Route of Exposure	Exposed Population	Time	Status
Stibnite Mine Area	biota	fish game plants	eating	consumers of fish, game, or plants	past	potential
					present	potential
					future	potential

Table 3. Eliminated Exposure Pathways

Table 3.

Eliminated Exposure Pathways

Source	Media	Point of Exposure	Route of Exposure	Exposed Population	Time	Status
Stibnite Mine Area	onsite subsurface soil	Stibnite Mine Area	eating skin contact	former mine workers and current workers conducting closure activities	past	potential*
					present	eliminated
					future	eliminated
Stibnite Mine Area	ground water	onsite well and past onsite wells	drinking skin contact	site workers and past site residents	past	potential*
					present	eliminated
					future	eliminated

* This exposure pathway was potentially completed for former residence of Stibnite and completed for former mine workers.

Table 4. Exposure Assumptions Summary

Table 4.

Exposure Assumptions Summary

Exposure Assumptions	Populations		
	Recreational Users		Reclamation Workers
	7≤Children≤18	Adults>18	
Body Weight (kg)	45	75	75

Exposure Frequency (days/year)	Hot Spots	1	1	14
	Other Areas	8	8	90
Exposure Duration (years)	Hot Spots	1	1	1
	Other Areas	12	30	1
Averaging Times (days) for Noncarcinogenic	Hot Spots	365	365x30	365
	Other Areas	365x12		
Averaging Times (days) for Carcinogenic[a]	Hot Spots	365x70	365x70	365x70
	Other Areas			
Surface Soil	Ingestion Rate (mg/day)	200	100	100
Air Particulate	Double the soil ingestion rate to include the air particulate inhalation			
Surface Water	Consumption Rate (L/day)	2	2	0
Fish	Fish Intake Rate (g/day)	25[b]	25[b]	25

a: assumes average lifetime is 70 years.
b: for general recreational users, the fish intake rate is 25 g per day, while the fish intake rate is 58.7 g per day for tribe recreational users.

Table B-1. Interim Public Health Hazard Categories

Table B-1.

Interim Public Health Hazard Categories

CATEGORY/DEFINITION	DATA SUFFICIENCY	CRITERIA
Urgent Public Health Hazard This category is used for sites where short-term exposures (<1yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgment based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicated that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the pre of serious physical or safety hazards.
Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposure (>1yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgment based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health

	be required to confirm or further support the decision made.	that requires one of more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.
Indeterminate Public Health Hazard This category is used for sites in which "critical" data are insufficient with regard to extent of exposure and/or toxicological properties at estimated exposure levels.	This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	The health assessor much determine, using professional judgment, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.
No Apparent Public Health Hazard This category is used for sites where human exposure to contaminantd media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgment based on critical data, which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures, exposure to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
No Public Health Hazard This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.	Sufficient evidence indicates that no human exposures to contaminantd media have occurred, none are now occurring, and none are likely to occur in the future.	

*: Such as environmental and demographic data; health outcome data; community health concerns information; toxicological, medical, and epidemiological data; monitoring and management plans

Table C-1. Health Comparison Values

Table C-1.

Health Comparison Values/Screening Values

Medium	Contaminant	Non-cancer			Cancer and Other	
		Child	Adult	Source	Standards	Source
Soil (mg/kg)	Aluminum	100000	1000000	I-EMEG	--	--
	Antimony	20	300	RMEG	--	--
	Arsenic	20	200	C-EMEG	0.5	CREG
	Cadmium	10	100	C-EMEG		

	*Chromium III	80000	1000000	RMEG	--	--
	Copper	2900		RS-PRG	--	--
	Cyanide	1000	10000	RMEG	--	--
	Lead	400		RS-PRG	--	--
	Manganese	3000	40000	RMEG	--	--
	Mercury	100	1000	I-EMEG	--	--
	Methyl Mercury	20	200	C-EMEG		
	Nickel	1000	10000	RMEG	--	--
	Selenium	300	4000	C-EMEG	--	--
	Silver	300	4000	RMEG	--	--
	Zinc	20000	200000	C-EMEG	--	--
Drinking Water (µg/L)	Aluminum	20000	70000	I-EMEG	--	--
	Antimony	4	10	RMEG	6	LTHA
	Arsenic	3	10	C-EMEG	0.02	CREG
	Cadmium	2	7	C-EMEG		
	Chromium III	20000	50000	RMEG	--	--
	Copper	1400		TW-PRG	1300	MCLG
	Cyanide	200	700	RMEG	--	--
	Lead	--	--	MCLG	15	AL
	Manganese-w	500	2000	RMEG	--	--
	Mercury	20	70	I-EMEG	--	--
	Methyl Mercury	3	10	C-EMEG		
	Nickel	200	700	RMEG	--	--
	Selenium	50	200	C-EMEG	--	--
	Silver	50	200	RMEG	--	--
	Zinc	3000	10000	C-EMEG	--	--

* Chromium at the site is assumed to be trivalent chromium.
AL: Action Level
C-EMEG: Chronic Environmental Media Evaluation Guide
CREG: Cancer Risk Evaluation Guide for 10^{-6} excess cancer risk
I-EMEG: Intermidiate Environmental Media Evaluation Guide
LTHA: Lifetime Health Advisory for drinking water (EPA)

MCLG: Maximum Contaminant Level Goal for drinking water (EPA)
RMEG: Reference Dose Media Evaluation Guide
RS-PRG: Residential Soil Preliminary Remediation Goals (USEPA Region IX)
TW-PRG: Tap Water Preliminary Remediation Goals (USEPA Region IX)

Table C-2. Contaminants of Corcern in Surface Soil of Meadow Greek exposure Areas

Table C-2.

Contaminants of Concern in Surface Soil of Meadow Creek Exposure Areas

Contaminant	Site Specific Background (mg/kg)	Bradley Tailings and Neutralied Ore Disposal Area (RME)	Above CVs (Y/N)	Meadow Creek Mine Hillside (RME)	Above CVs (Y/N)	Lower Meadow Creak Valley (RME)	Above CVs (Y/N)	Upgradient Wetland (MAX)	Above CVs (Y/N)	Keyway Wetland (MAX)	Above CVs (Y/N)	Meadow Creek Forested Wetland (MAX)	Above CVs (Y/N)
Aluminum	9300	5680	N	13300	N	7210	N	43300	N	13000	N	34200	N
Antimony	1.81	133	Y	15.6	N	1320	Y	--	N	333	Y	1550	Y
Arsenic	5.68	1620	Y	1460	Y	955	Y	24.4	Y	634	Y	1230	Y
Cadmium	<0.1	2.7	N	--	N	--	N	--	N	--	N	0.13	N
Chromium	2.92	17.7	N	4.08	N	7.78	N	39.9	N	7.1	N	14.3	N
Copper	3.55	19.3	N	5.63	N	17.4	N	12.1	N	19.6	N	68.8	N
Cyanide	--	1.03	N	--	N	--	N	--	N	0.27	N	--	N
Lead	2.72	15.6	N	4.5	N	34.7	N	9.4	N	47.8	N	160	N
Manganese	368	400	N	1580	N	271	N	206	N	233	N	199	N
Mercury	<0.1	2.62	N	0.416	N	0.716	N	0.11	N	0.89	N	3.1	N
Nickel	2.01	35.2	N	3.83	N	9.78	N	21	N	5.9	N	8	N
Selenium	<0.3	--	N	--	N	0.48	N	0.19	N	0.52	N	5.3	N
Silver	<0.1	0.81	N	0.149	N	2.52	N	0.1	N	2.8	N	19.6	N
Zinc	25.7	18.1	N	45.3	N	58.2	N	67.7	N	40.9	N	70.9	N

RME = Reasonable Maximum Exposure Concentration (mg/kg)
MAX = Maximum Concentration (mg/kg)
Note: Highlighted concentrations indicate contaminant concentration is above the health-based comparison values

Table C-3. Contaminants of Corcern in Surface Soil of Bradley waste Rock Dumps and Hot Spots

Table C-3.

Contaminants of Concern in Surface Soil of Bradley Waste Rock Dumps and Hot Spots

Contaminant	Site Specific Background (mg/kg)	Southeast Dump and Midnight Creek (RME)	Above CVs (Y/N)	Glory Hole, Northwest Dump and EFSFSR (RME)	Above CVs (Y/N)	Northeast Dump and Sugar Creek (RME)	Above CVs (Y/N)	Location UW-1 (Upgradient Wetland) (Max)	Above CVs (Y/N)	Smelter Stack (Max)	Above CVs (Y/N)	DMEA Dump (Max)	Above CVs (Y/N)	Location BD6 (Northwest Dump) (Max)	Above CVs (Y/N)
Aluminum	31567	4740	N	7920	N	11000	N	20200	N	13500	N	4400	N	6850	N
Antimony	11.75	0.7	N	368	Y	19.1	N	689	Y	292	Y	7.4	N	16400	Y
Arsenic	200	4970	Y	2720	Y	5630	Y	983	Y	9420[a]	Y	9460	Y	4790	Y
Cadmium	0.08	--	N	--	N	--	N	--	N	0.09	N	--	N	0.09	N
Chromium	25	5.7	N	10.9	N	16.2	N	10.1	N	6.1	N	6.4	N	8.57	N
Copper	9.15	7.27	N	9.49	N	11.1	N	286	N	8.3	N	6.3	N	26.5	N
Cyanide	--	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Lead	8.03	11.5	N	6.51	N	8.56	N	754	Y	16.6	N	9.2	N	34.7	N
Manganese	1563	56.1	N	2.53	N	359	N	147	N	370	N	885	N	130	N
Mercury	0.16	2.51	N	1.39	N	1.52	N	2.3	N	471	Y	9.9	N	13.6	N
Nickel	19.9	3.89	N	5.97	N	17.1	N	8.2	N	2.8	N	--	N	2.89	N
Selenium	<0.3	--	N	0.316	N	0.248	N	1.1	N	66.7	N	0.35	N	7.7	N

Silver	0.09	0.54	N	2.52	N	1.95	N	2.2	N	4.1	N	3.4	N	6.79	N
Zinc	71.9	53.9	N	40.5	N	30	N	48.2	N	47.3	N	42.7	N	150	N

RME = Reasonable Maximum Exposure Concentration (mg/kg)
MAX = Maximum Concentration (mg/kg)
[a] the arsenic concentration in the surface soil of Smelter Stack (9420 mg/kg) came from USFS confirmation soil sample results (email communication, USFS, Dec. 16, 2002).

Note: Highlighted concentrations indicate contaminant concentration is above the health-based comparison values

Table C-4. Contaminants of Corcern in Surface Water of different Exposure Locations

Table C-4.

Contaminants of Concern in Surface Water of Different Exposure Locations (mg/L)

Contaminant	**Lower Meadow Creak Valley (RME)**	**Y/N**	**Upgradient Wetland, (MAX)**	**Y/N**	**Keyway Wetland (MAX)**	**Y/N**	**Southeast Dump and Midnight Creek (RME)**	**Y/N**	**Glory Hole, Northwest Dump and EFSFSR (RME)**	**Y/N**	**Northeast Dump and Sugar Creek (RME)**	**Y/N**	**Location UW-1 (Upgradient Wetland) (Max)**	**Y/N**	**Bailey Tunnel Outlet**	**Y/N**
Aluminum	0.0831	N	0.153	N	0.12	N	0.079	N	0.047	N	0.137	N	--	N	--	N
Antimony	0.0112	Y	--	N	0.127	Y	0.0392	Y	0.0267	Y	0.0083	Y	0.069	Y	0.281	Y
Arsenic	0.0323	Y	--	N	0.463	Y	0.0577	Y	0.059	Y	0.012	Y	0.316	Y	0.535	Y
Cadmium	--	N	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Chromium III	--	N	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Copper	0.002	N	0.0017	N	--	N	--	N	--	N	--	N	0.004	N	--	N
Cyanide	0.0023	N	0.0021	N	0.0056	N	0.0021	N	--	N	--	N	--	N	--	N

Lead	0.00143	N	0.001	N	--	N	0.0046	N	0.00032	N	--	N	0.0053	N	0.0064	N
Manganese-w	0.0314	N	0.0072	N	0.785	Y	0.0154	N	0.0282	N	0.005	N	0.0491	N	0.181	N
Mercury	0.0000054	N	--	N	0.000118	N	0.000131	N	0.00039	N	0.000255	N	--	N	--	N
Nickel	--	N	--	N	--	N	--	N	0.0144	N	--	N	--	N	--	N
Selenium	--	N	--	N	--	N	--	N	--	N	--	N	--	N	--	N
Silver	--	N	--	N	--	N	--	N	0.000129	N	--	N	--	N	0.000106	N
Zinc	0.00252	N	--	N	0.0044	N	0.0159	N	0.00385	N	0.008	N	--	N	0.0075	N

RME = Reasonable Maximum Exposure Concentration (mg/L)
MAX = Maximum Concentration (mg/L)

Note: Highlighted concentrations indicate contaminant concentration is above the health-based comparison values

Table C-5. Estimated Daily Exposure Dose of Concerned Contaminants from Consumption of Fish by Recreational Users

Table C-5.

Estimated Daily Exposure Dose of Concerned Contaminants from Consumption of Fish by Recreational Users

Contaminant	**Lower Meadow Creak Valley (RME)**	**Exposure Dose (mg/kg/d)**			**Southeast Dump and Midnight Creek (RME)**	**Exposure Dose (mg/kg/d)**			**Glory Hole, Northwest Dump and EFSFSR (RME)**	**Exposure Dose (mg/kg/d)**		
		Children	**Adult**	**Workers**		**Children**	**Adult**	**Workers**		**Children**	**Adult**	**Workers**
Aluminum	--				--				--			
Antimony	--				--				--			
Arsenic	0.0728	5.3E-07	3.2E-07	3.6E-06	0.0728	5.3E-07	3.2E-07	3.6E-06	0.0739	5.4E-07	3.2E-07	3.6E-06

Cadmium	--				--				--			
Chromium III	--				--				--			
Copper	--				--				--			
Cyanide	--				--				--			
Lead	--				--				0.042	5.1142 E-07	3.068 5E-07	3.5E-06
Manganese	0.599	7.3E-06	4.4 E-06	4.9E-05	0.599	7.3E-06	4.4 E-06	4.9E-05	0.353	4.3E-06	2.6E-06	2.9E-05
Mercury	--				--				--			
Methyl Mercury	0.218	2.7E-06	1.6 E-06	1.8E-05	0.218	2.7E-06	1.6 E-06	1.8E-05	0.117	1.4E-06	8.5E-07	9.6E-06
Nickel	--				--				--			
Selenium	0.706	8.6E-06	5.2 E-06	5.8E-05	0.706	8.6E-06	5.2 E-06	5.8E-05	0.615	7.5E-06	4.5E-06	5.1E-05
Silver	--				--				--			
Zinc	7.05	8.6E-05	5.2 E-05	5.8E-04	7.05	8.6E-05	5.2 E-05	5.8E-04	7.83	9.5E-05	5.7E-05	6.4E-04

RME = Reasonable Maximum Exposure Concentration (mg/kg)

Note: There is no comparison value available for lead

Table C-6. Health Guidelines Values

Table C-6.

Health Guidelines Values

Contaminant	ATSDR's Chronic Oral MRL mg/kg/day	ATSDR's Intermediate Oral MRL mg/kg/day	ATSDR's Acute Oral MRL mg/kg/day	EPA's Chronic Oral RfD mg/kg/day	EPA's Oral Slope Factor $(mg/kg/day)^{-1}$
Aluminum		2			
Antimony				0.0004	
Arsenic	0.0003		0.005	0.0003	1.5
Cadmium	0.0002				

Chromium				1.5	
Copper					
Cyanide				0.02	
Lead					
Manganese (environmental)				0.05	
Manganese (food)				0.14	
Mercury		0.002	0.007	0.0003	
Methyl Mercury	0.0003			0.0001	
Nickel				0.02	
Selenium	0.005			0.005	
Silver				0.005	
Zinc	0.3	0.3		0.3	

MRL: Minimal Risk Level
RfD: Reference Dose

Table C-7. Estimated Daily Exposure of Concerned Contaminants from Ingestion of Surface Soil and Inhalation of Air Borne Particulate in Meadow Creek Exposure Areass

Table C-7.

Estimated Daily Exposure Dose (mg/kg/d) of Concerned Contaminants from Ingestion of Surface Soil and Inhalation of Airborne Particulate in Meadow Creek Exposure Areas

Population	Contaminant	Bradley Tailings and Neutralied Ore Disposal Area (RME)	Dose	Meadow Creek Mine Hillside (RME)	Dose	Lower Meadow Creak Valley (RME)	Dose	Upgradient Wetland (MAX)	Dose	Keyway Wetland (MAX)	Dose	Meadow Creek Forested Wetland (MAX)	Dose
Children (7 years old) Recreational Users	Antimony	133	2.6 E-05			1320	2.6 E-04			333	6.5 E-05	1550	3.0 E-04
	Arsenic	1620	1.9 E-04	1460	1.7 E-04	955	1.1 E-04	24.4	2.9 E-06	634	7.4 E-05	1230	1.4 E-04

Adult Recreational Users	Antimony	133	7.8E-06			1320	7.7E-05			333	1.9E-05	1550	9.1E-05
	Arsenic	1620	5.7E-05	1460	5.1E-05	955	3.3E-05	24.4	8.6E-07	634	2.2E-05	1230	4.3E-05
Reclamation Workers	Antimony	133	8.7E-05			1320	8.7E-04			333	2.2E-04	1550	1.0E-03
	Arsenic	1620	6.4E-04	1460	5.8E-04	955	3.8E-04	24.4	9.6E-06	634	2.5E-04	1230	4.9E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-8. Estimated Daily Exposure of Concerned Contaminants from Ingestion of Surface Soil and Inhalation of Air Borne Particulate in Bradely Waste Rock Dumps and Hot Spots

Table C-8.

Estimated Daily Exposure Dose (mg/kg/d) of Concerned Contaminants from Ingestion of Surface Soil and Inhalation of Airborne Particulate in Bradley Waste Rock Dumps and Hot Spots

Population	Contaminant	Southeast Dump and Midnight Creek (RME)	Dose	Glory Hole, Northwest Dump and EFSFSR (RME)	Dose	Northeast Dump and Sugar Creek (RME)	Dose	Location UW-1 (Upgradient Wetland) (Max)	Dose	Smelter Stack (Max)	Dose	DMEA Dump (Max)	Dose	Location BD-6 (Northwest Dump) (Max)	Dose
Children (7 years old) Recreational Users	Antimony			368	7.2E-05			689	1.7E-05	292	7.1E-06			16400	4.0E-04
	Arsenic	4970	5.8E-04	2720	3.2E-04	5630	6.6E-04	983	1.4E-05	9420	1.8E-04	9460	1.5E-04	4790	7.0E-05
	Lead							754	1.8E-05						
	Mercury									471	1.1E-05				

Adult Recreational Users	Antimony			368	2.2E-05			689	5.0E-06	292	2.1E-06			16400	1.2E-04
	Arsenic	4970	1.7E-04	2720	9.5E-05	5630	2.0E-04	983	4.3E-06	9420	5.5E-05	9460	4.1E-05	4790	2.1E-05
	Lead							754	5.5E-06						
	Mercury									471	3.4E-06				
Reclamation Workers	Antimony			368	2.4E-04			689	7.0E-05	292	3.0E-05			16400	1.7E-03
	Arsenic	4970	2.0E-03	2720	1.1E-03	5630	2.2E-03	983	6.0E-05	9420	7.7E-04	9460	5.8E-04	4790	2.9E-04
	Lead							754	7.7E-05						
	Mercury									471	4.8E-05				

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD. No MRL or RfD available for lead.

Table C-9. Estimated Daily Exposure Dose of Concerned Contaminants from Ingestion of Surface water

Table C-9.

Estimated Daily Exposure Dose (mg/kg/d) of Concerned Contaminants from Ingestion of Surface Water

	Contaminant	**Lower Meadow Creak Valley**	**Dose**	**Keyway Wetland (MAX)**	**Dose**	**Southeast Dump and Midnight**	**Dose**	**Glory Hole, Northwest Dump and**	**Dose**	**Northeast Dump and Sugar**	**Dose**	**Location UW-1 (Upgradient Wetland) (Max)**	**Dose**	**Bailey Tunnel Outlet**	**Dose**

		(RME)				**Creek (RME)**		**EFSFSR (RME)**		**Creek (RME)**					
Children (7 years old) Recreational Users	Antimony	0.0112	1.1E-05	0.127	1.2E-04	0.0392	3.8E-05	0.0267	2.6E-05	0.0083	8.1E-06	0.069	8.4E-06	0.281	2.7E-04
	Arsenic	0.0323	1.9E-05	0.463	2.7E-04	0.0577	3.4E-05	0.059	3.4E-05	0.012	7.0E-06	0.316	2.3E-05	0.535	3.1E-04
	Manganese-w			0.785	7.6E-04										
Adult Recreational Users	Antimony	0.0112	6.5E-06	0.127	7.4E-05	0.0392	2.3E-05	0.0267	1.6E-05	0.0083	4.9E-06	0.069	5.0E-06	0.281	1.6E-04
	Arsenic	0.0323	1.1E-05	0.463	1.6E-04	0.0577	2.0E-05	0.059	2.1E-05	0.012	4.2E-06	0.316	1.4E-05	0.535	1.9E-04
	Manganese-w			0.785	4.6E-04										

Note: No estimated daily contaminant exposure dose is above the health guidelines values

Table C-10. Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	**Exposure Media**	**Area 1 (Bradley Tailings and Naturalized Ore Disposal Area)**			**Area 1 (Meadow Creek Mine Hillside)**			**Lower Meadow Creek Valley**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**		**Children**	**Adults**	
		Exposure Dose (mg/kg/day)			**Exposure Dose (mg/kg/day)**			**Exposure Dose (mg/kg/day)**		

Antimony	Surface Soil	2.6E-05	7.8E-06	8.7E-05				2.6E-04	7.7E-05	8.7E-04
	Surface Water							1.1E-05	6.5E-06	
	Fish									
	Total	2.6E-05	7.8E-06	8.7E-05				2.7E-04	8.4E-05	8.7E-04
Arsenic	Surface Soil	1.9E-04	5.7E-05	6.4E-04	1.7E-04	5.1E-05	5.8E-04	1.1E-05	3.3E-05	3.8E-04
	Surface Water							1.9E-05	1.1E-05	
	Fish							5.3E-07	3.2E-07	3.6E-06
	Total	1.9E-04	5.7E-05	6.4E-04	1.7E-04	5.1E-05	5.8E-04	3.1E-04	4.4E-05	3.8E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	**Exposure Media**	**Area 1 (Upgradient Wetland, excl. the UW-1 Hot Spot)**			**Area 1 (Keyway Wetland)**			**Area1 (Meadow Creek Forested Wetland)**		
		Recreational Users		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**	**Recreational Users**		**Reclamation Workers**
		Children	**Adults**		**Children**	**Adults**		**Children**	**Adults**	
		Exposure Dose (mg/kg/day)			**Exposure Dose (mg/kg/day)**			**Exposure Dose (mg/kg/day)**		
Antimony	Surface Soil				6.5E-05	1.9E-05	2.2E-04	3.0E-04	9.1E-05	1.0E-03
	Surface Water				1.2E-04	7.4E-05				
	Fish									
	Total				1.9E-04	9.3E-05	2.2E-04	3.0E-04	9.1E-05	1.0E-03
Arsenic	Surface Soil	2.9E-06	8.6E-07	9.6E-06	7.4E-05	2.2E-05	2.5E-04	1.4E-04	4.3E-05	4.9E-04

	Surface Water				2.7E-04	1.6E-04				
	Fish									
	Total	2.9E-06	8.6E-07	9.6E-06	3.4E-04	1.8E-04	2.5E-04	1.4E-04	4.3E-05	4.9E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Southeast Dump and Midnight Creek)			Glory Hole, Northwest Dump and EFSFSR			Northeast Dump and Sugar Creek		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		
Antimony	Surface Soil				7.2E-05	2.2E-05	2.4E-04			
	Surface Water	3.8E-05	2.3E-05		2.6E-05	1.6E-05		8.1E-06	4.9E-06	
	Fish									
	Total	3.8E-05	2.3E-05		9.8E-05	3.8E-05	2.4E-04	8.1E-06	4.9E-06	
Arsenic	Surface Soil	5.8E-04	1.7E-04	2.0E-03	3.2E-04	9.5E-05	1.1E-03	6.6E-04	2.0E-04	2.2E-03
	Surface Water	3.4E-05	2.0E-05		3.4E-05	2.1E-05		7.0E-06	4.2E-06	
	Fish	5.3E-07	3.2E-07	3.6E-06	5.4E-07	3.2E-07	3.6E-06			
	Total	6.1E-04	1.9E-04	2.0E-03	3.5E-04	1.2E-04	1.1E-03	6.6E-04	2.0E-04	2.2E-03

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Location UW-1 (Upgradient Wetland)			Smelter Stack			DMEA Dump		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		
Antimony	Surface Soil	1.7E-05	5.0E-06	7.0E-05	7.1E-06	2.1E-06	3.0E-05			
	Surface Water	8.4E-06	5.0E-06							
	Fish									
	Total	2.5E-05	1.0E-05	7.0E-05	7.1E-06	2.1E-06	3.0E-05			
Arsenic	Surface Soil	1.4E-05	4.3E-06	6.0E-05	1.8E-04	5.5E-05	7.7E-04	1.5E-04	4.1E-05	5.8E-04
	Surface Water	2.3E-05	1.4E-05							
	Fish									
	Total	3.7E-05	1.8E-05	6.0E-05	1.8E-04	5.5E-05	7.7E-04	1.5E-04	4.1E-05	5.8E-04

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table C-10.

Summary of Non-Carcinogenic Exposure Dose of the Concerned Contaminants in Different Areas

Contaminant	Exposure Media	Location BD6 (Northwest Dump)			Bailey Tunnel Outlet					
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	

		Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)			Exposure Dose (mg/kg/day)		
Antimony	Surface Soil	4.0E-04	1.2E-04	1.7E-03						
	Surface Water				2.7E-04	1.6E-04				
	Fish									
	Total	4.0E-04	1.2E-04	1.7E-03	2.7E-04	1.6E-04				
Arsenic	Surface Soil	7.0E-05	2.1E-05	2.9E-04						
	Surface Water				3.1E-04	1.9E-04				
	Fish									
	Total	7.0E-05	2.1E-05	2.9E-04	3.1E-04	1.9E-04				

Note: Highlighted exposure doses indicate estimated daily contaminant exposure dose is above the ATSDR's Chronic Oral MRL or EPA's Chronic Oral RfD

Table D-1. Summary of Carcinogenic Expsoure Dose and Cancer Risk of Arsenic in Different Areas

Table D-1.

Summary of Carcinogenic Exposure Dose and Cancer Risk of Arsenic in Different Areas

Contaminant	Exposure Media	Area 1 (Bradley Tailings and Naturalized Ore Disposal Area)			Area 1 (Meadow Creek Mine Hillside)			Lower Meadow Creek Valley		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	3.2E-05	2.4E-05	9.1E-06	2.9E-05	2.2E-05	8.2E-06	1.9E-05	1.4E-05	5.4E-06
	Surface Water							3.2E-06	4.9E-06	
	Fish							9.1E-08	1.4E-07	5.1E-08
	Total	3.2E-05	2.4E-05	9.1E-06	2.9E-05	2.2E-05	8.2E-06	2.2E-05	1.9E-05	5.5E-06
Total Cancer Risk		4.8E-05	3.6E-05	1.4E-05	4.4E-05	3.3E-05	1.2E-05	3.3E-05	2.9E-05	8.3E-06

Contaminant	Exposure Media	Area 1 (Upgradient Wetland, excl. the UW-1 Hot Spot)			Area 1 (Keyway Wetland)			Area1 (Meadow Creek Forested Wetland)		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	4.9E-07	3.7E-07	1.4E-07	1.3E-05	9.5E-06	3.6E-06	2.5E-05	1.8E-05	6.9E-06
	Surface Water				4.6E-05	7.0E-05				
	Fish									
	Total	4.9E-07	3.7E-07	1.4E-07	5.9E-05	8.0E-05	3.6E-06	2.5E-05	1.8E-05	6.9E-06
Total Cancer Risk		7.4E-07	5.6E-07	2.1E-07	8.9E-05	1.2E-04	5.4E-06	3.8E-05	2.7E-05	1.0E-05

Table D-1.

Summary of Carcinogenic Exposure Dose and Cancer Risk of Arsenic in Different Areas

Contaminant	Exposure Media	Southeast Dump and Midnight Creek)			Glory Hole, Northwest Dump and EFSFSR			Northeast Dump and Sugar Creek		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	1.0E-04	7.5E-05	2.8E-05	5.5E-05	4.1E-05	1.5E-05	1.1E-04	8.5E-05	3.2E-05
	Surface Water	5.8E-06	8.7E-06		5.9E-06	8.9E-06		1.2E-06	1.8E-06	
	Fish	9.1E-08	1.4E-07	5.1E-08	9.3E-08	1.4E-07	5.2E-08			
	Total	1.1E-04	8.4E-05	2.8E-05	6.1E-05	5.0E-05	1.5E-05	1.1E-04	8.7E-05	3.2E-05
Total Cancer Risk		1.7E-04	1.3E-04	4.2E-05	9.2E-05	7.5E-05	2.3E-05	1.7E-04	1.3E-04	4.8E-05

Contaminant	Exposure Media	Location UW-1 (Upgradient Wetland)			Smelter Stack			DMEA Dump		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults		Children	Adults	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	2.1E-07	6.2E-08	8.6E-07	2.6E-06	7.9E-07	1.1E-05	2.0E-06	5.9E-07	8.3E-06
	Surface Water	3.3E-07	2.0E-07							
	Fish									
	Total	5.4E-07	2.6E-07	8.6E-07	2.6E-06	7.9E-07	1.1E-05	2.0E-06	5.9E-07	8.3E-06
Total Cancer Risk		8.1E-07	3.9E-07	1.3E-06	3.9E-06	1.2E-06	1.7E-05	3.0E-06	1.4E-06	1.2E-05

Table D-1.

Summary of Carcinogenic Exposure Dose and Cancer Risk of Arsenic in Different Areas

Contaminant	Exposure Media	Location BD6 (Northwest Dump)			Bailey Tunnel Outlet		
		Recreational Users		Reclamation Workers	Recreational Users		Reclamation Workers
		Children	Adults		Children	Adults	
Carcinogenic Exposure Dose (mg/kg/day)	Surface Soil	1.0E-06	3.0E-07	4.2E-06			
	Surface Water				5.4E-05	8.0E-05	
	Fish						
	Total	1.0E-06	3.0E-07	4.2E-06	5.4E-05	8.0E-05	
Total Cancer Risk		1.5E-06	4.5E-07	6.3E-06	8.1E-05	1.2E-04	

ACROMYMS

AL	Action Level
AOC	Administrative Order of Consent

ATV	All Terrain Vehicle
ATSDR	Agency of Toxic Substances and Disease Registry
BEHS	Bureau of Environmental Health and Safety
C-EMEG	Chronic Environmental Media Evaluation Guide
CEL	Cancer Effect Level
CERCLA	Comprehensive Emergency Response Cleanup and Liability Act
CREG	Cancer Risk Evaluation Guide
CV	Comparison Value
EFSFSR	East Fork of the South Fork of the Salmon River
EMEG	Environmental Media Evaluation Guide
EPA	United States Environmental Protection Agency
g/day	grams per day
HOD	Health Outcome Data
HRS	Hazard Ranking System
I-EMEG	Intermediate Environmental Media Evaluation Guide
IDEQ	Idaho Department of Environmental Quality
L/day	liters per day
LOAEL	Lowest Observed Adverse Effect Level
LTHA	Lifetime Health Advisory (for drinking water)
MAX	Maximum Concentration
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MRL	Minimal Risk Level
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
mg/L	milligrams per liter
NPL	National Priorities List
NOAEL	No Observed Adverse Effect Level

PA	Preliminary Assessment
PRG	Preliminary Remediation Goal
PWS	Public Water System
QA/QC	Quality Assurance/Quality Control
RfD	Reference Dose
RME	Reasonable Maximum Exposure Concentration
RMEG	Reference Dose Media Evaluation Guide
RS-PRG	Residential Soil Preliminary Remediation Goal
SI	Site Investigation
SMI	Stibnite Mine Incorporated
TW-PRG	Tap Water Preliminary Remediation Goal
µg/g	micrograms per gram
µg/L	micrograms per liter
USFS	United States Forest Service