Health Consultation

Evaluation of Onsite Surface Soil Exposures by Recreational Users

STANDARD MINE
GUNNISON COUNTY, COLORADO

EPA FACILITY ID: CO0002378230

MAY 8, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

ASHLAND MEMORIAL MEDICAL CENTER MERCURY SPILL

CITY OF ASHLAND, ASHLAND COUNTY, WISCONSIN

Prepared By:

Wisconsin Department of Health and Family Services
Under cooperative agreement with the
The Agency for Toxic Substances and Disease Registry

Table of Contents

Foreword

The Colorado Department of Public Health and Environment's (CDPHE) Environmental Epidemiology Section has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the US Department of Health and Human Services and is the principal federal public health agency responsible for the health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures so that the state or local department of public health can respond quickly to requests from concerned citizens or agencies regarding health information on hazardous substances. The Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) of the Environmental Epidemiology Section (EES) evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding the contents of this health consultation or the Environmental Epidemiology Section, please contact the authors of this document:

Thomas Simmons
Colorado Cooperative Program for Environmental Health Assessments
Disease Control and Environmental Epidemiology Division
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver Colorado, 80246-1530
(303) 692-2961
FAX (303) 782-0904
Email: tsimmons@cdphe.state.co.us

Summary and Statement of Issues

The Standard Mine is an abandoned mine site located in southwestern Colorado, near the Town of Crested Butte (Figure 1). The mine is part of the Ruby Mining District, which produced copper, gold, lead, and silver over a hundred-year period from the 1870's - 1970's. The former mining activities at the mine site have impacted approximately 5 acres of land. Acid mine drainage and waste rock/tailings piles are the primary sources of heavy metal contaminants such as arsenic, lead, manganese, and iron. The Standard Mine was listed on the National Priorities List in September 2005, primarily due to the potential impacts of mining contamination on the Town of Crested Butte's water supply and the surrounding environment.

The area encompassing the Standard Mine site is relatively rugged and only accessible by four-wheel drive vehicles, all terrain vehicles (ATV), mountain bikes, and hiking. The mine site is within the Gunnison National Forest and the surrounding land is both publicly and privately owned with the majority of the site administered by the U.S. Forest Service. No residential properties are located at the mine site and Crested Butte is the primary potentially affected residential population. Irwin Township is also in the vicinity of the mine. However, residents of Irwin are not expected to come into contact with contaminants from the mine site since the town lies in another basin separated by a large ridge. The major land use is recreational including mountain biking, hiking, ATV riding, and camping.

This document is the second health consultation prepared for the Standard Mine site, which examines the potential public health risks associated with surface soil exposures by recreational users. The potential impact of mining wastes on Crested Butte's water supply was evaluated in the initial health consultation, published in 2006 (ATSDR 2006).

After a through review of the available data, it was determined that the Standard Mine site constitutes a public health hazard due to exposure to lead by young children and pregnant women that visit the site more than 12 days per year for recreational purposes such as camping, ATV riding, and hiking. Recreational use of the site for less than 12 days per year is considered no apparent public health hazard, with the exception of acute copper exposures noted below. No chronic adverse health effects are expected to occur for recreational users from exposure to other non-cancer and carcinogenic contaminants found in surface soil at the Standard Mine site. However, acute exposure of young children based on pica behavior is considered a public health hazard. Less serious acute health hazards related to copper and arsenic exposures are possible for young children over a 1-day period. It is, however, important to note that young children (2-3 years of age) who generally exhibit pica are not likely to frequently visit the site. Also, there is uncertainty associated with acute health hazards for copper and arsenic due to the reduced relative bioavailability of metals from soils. In addition, theoretical cancer risks are at the high end of the acceptable cancer risk range for ATV riders. While these cancer risks do not appear to be an immediate concern, reducing onsite contaminant levels is

recommended to achieve CDPHE's target cancer risk level of 1 excess cancer case per 1,000,000 exposed individuals. Overall, it is recommended that the site be remediated to reduce current and potential exposures to contaminated soil. Health education activities should be conducted to inform recreational users of the potential health hazards associated with surface soil exposures at the mine site.

Background

Site Description and History

The Standard Mine is located in the Ruby Mining District of the Gunnison National Forest approximately 5 miles west of the Town of Crested Butte, Colorado. Heavy metal mining began in the southern Ruby Mining District in 1874 and continued until 1974. The Standard Mine was one of the three largest producing silver mines in the area along with the Forest Queen and Keystone Mine. A report published by the Colorado Geological Survey in 1996 called the mine the most environmentally degraded mine site in the entire Ruby Mining District.

The Standard Mine site is approximately 11,000 feet above sea level in a remote and isolated location on the south side of Mt. Emmons. It is only accessible in the summer by four-wheel-drive vehicles, all terrain vehicles (ATVs) and motorcycles, mountain bikes, or by foot. The site consists of 6 operating levels and the Level 1 adit (horizontal mine tunnel) releases 100-200 gallons of acid mine drainage per minute (gpm) during high flow season (early summer) and 1-10 gpm during low flow season (late fall) to Elk Creek (EPA 2008).

Historically, Elk Creek flowed through the mine site and along a surface impoundment depositing heavy metals into Coal Creek. Coal Creek runs through the town of Crested Butte until it meets the Slate River. The Crested Butte municipal drinking water intake is located on Coal Creek approximately 100 yards downstream of the confluence with Elk Creek. Thus, there is a potential threat to the Crested Butte water supply from heavy metals stemming from the Standard Mine. The contaminants of concern are heavy metals with samples showing elevated levels of arsenic, barium, lead, iron, zinc, cadmium, copper, and chromium. On September 14, 2005, the Standard Mine site was listed on the National Priorities List due to the potential impact of mine contaminants on Crested Butte's water supply and the surrounding environment.

In 2006, a health consultation was conducted by the ATSDR to evaluate the potential threat to Crested Butte's municipal water supply. It was found that the Standard Mine does not impact Crested Butte's drinking water supply (Coal Creek) to a degree that would pose a public health hazard to residents. In addition, the Environmental Protection Agency's (EPA) Emergency Response Branch began remediating critical areas of the site during the 2007 season, most notably, removal of the surface water impoundment and rerouting and treatment of the Level 1 adit drainage. These improvements are likely to decrease the impact to downstream receptors from mine drainage although it is too early to determine the effect of these actions at this time.

The site also consists of contaminated waste piles along with open and unmarked adits (horizontal) and shafts (vertical) with the following characteristics (UOS 2006):

- access to 8,400 feet of drifts on six levels
- 61,700 cubic yards of waste rock
- 29,000 cubic yards of mill tailings

Demographics

Figure 1 shows the demographic information for individuals living in the vicinity of the Standard Mine. The vast majority of people live in Crested Butte, a town of just over 1,500 residents (Census 2000). No residents have been identified in the immediate vicinity of the site. This figure is adopted from the initial ATSDR health consultation (ATSDR 2006).

Community Health Concerns

In February 2006, ATSDR participated in an EPA-sponsored public meeting in Crested Butte, CO. Approximately 20 residents, as well as several officials from city, state, and federal organizations attended the meeting. During this meeting, community members conveyed their health concerns regarding the site. These health concerns included: the potential accumulation of cadmium in human tissue from low dose exposures, fishing advisories on Coal Creek, the possibility of multiple sclerosis and other autoimmune diseases from exposure to site-related contaminants, and elevated risks of breast and skin cancers. Community members were also concerned about potential exposures from additional pathways to recreational users, which are evaluated in this health consultation and an additional health consultation on recreational exposures to surface water, sediment, and fish consumption, which will be published in the near future. The health concerns are presented in detail with responses from ATSDR in the initial health consultation on the Standard Mine (ATSDR 2006).

Discussion

Environmental Data Used

The U.S. EPA collected the data used in this evaluation in 2006 during the human health and ecological risk assessment process (SRC 2007). A total of 190 surface soil samples were collected and analyzed for the Contract Laboratory Program’s Target Analyte List (TAL) metals by the Region 8 Environmental Services Assistance Team (ESAT) Laboratory in Golden, CO. Complete summary statistics for surface soil samples is presented in Table 1 and a synopsis of major contaminants is presented below in Table 2. The sampling location of surface soil samples is presented in Figure 2.

All surface soil samples were collected onsite and no samples were collected from the drainage areas below the mine. However, the lack of offsite surface soil data is not considered a data gap since it is unlikely that contaminants are transported offsite with the exception of surface water, which will be evaluated in a future health consultation. Background soil data was not collected during this sampling event. Thus, it is not possible to determine the contribution of contamination from natural background sources. It should be noted that site-specific activity-based sampling for the exposure point concentration of dust inhalation during ATV riding was not conducted. Therefore, the data used in this evaluation was adopted from the EPA report (SRC 2007).

Table 2. Synopsis of Primary Surface Soil Contaminants at the Standard Mine Site

Surface Soil Contaminant	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)
Arsenic	4.6	680	75.5
Cadmium	0.26	107	7.8
Chromium	0.71	93.2	6.9
Copper	6.0	2730	243.5
Iron	5,600	195,999	32,635
Lead	28.4	63,500	3,658
Manganese	185	12,200	2,248

mg/kg = milligram contaminant per kilogram soil

Exposure Evaluation

Selection of Contaminants of Potential Concern

The first step in the exposure evaluation is to determine which contaminants (maximum detected concentrations) exceed the comparison value (CV). The screening, or comparisons values (CVs), used in this assessment are the EPA Region 9 Preliminary Remediation Goals (PRG) for soil (EPA 2004). PRGs are conservative, health-based environmental guidelines that consider carcinogenic and non-cancer health effects from exposure to contaminants through a variety of exposure pathways from each specific type of media. In this case, soil ingestion and inhalation of resuspended particulates are considered in the derivation of PRG values for soil. Adverse health effects are not likely to occur from exposure to site-related contaminants below the PRG value.

PRGs are the standard comparison value used at the CDPHE and in EPA Region 8 risk assessment. In accordance with the CDPHE and EPA Region 8 protocol for the selection of COPCs, if multiple contaminants exist on-site, the PRG values are multiplied by 0.1 (EPA, 1994). For non-carcinogenic contaminants, multiplying the PRG by 0.1 is thought to account for any potential additive adverse effects from multiple chemicals. Contaminants that do not exceed the respective CV are dropped from further analysis since they are unlikely to result in adverse health effects. For a detailed account of the derivation of PRGs, see http://www.epa.gov/region09/waste/sfund/prg/index.html. The surface soil COPC selection is summarized in Table 1.

All COPCs were detected in more than 5% of the surface soil samples so no contaminants were eliminated on this basis. The COPCs eliminated based on the comparison of the maximum detected soil concentration with the CV included: beryllium, cobalt, mercury, and nickel. The COPCs that were carried through for further evaluation included: aluminum, antimony, arsenic, cadmium, barium, chromium, copper, iron, lead, manganese, selenium, silver, thallium, vanadium, and zinc.

Conceptual Site Model

A conceptual site model identifies the 5 components of an exposure pathway. Three routes of exposure to contaminants in surface soil are possible: incidental ingestion of surface soil, dermal contact with surface soil, and inhalation of soil particles suspended in air. All three of these pathways are considered complete for recreational users at the Standard Mine site. However, dermal contact with metals is considered a relatively insignificant exposure pathway, in comparison to the ingestion pathway, due to the limited ability of metal contaminants to cross the skin barrier and enter the bloodstream. Therefore, dermal contact with metals in surface soil was not quantitatively addressed in this evaluation. Ingestion of surface soil and inhalation of particulates were evaluated quantitatively.

Land use information at the Standard Mine site is limited. However, a community survey was conducted by the EPA Region 8 (SRC, 2007) in the summer of 2006 to determine potential land use at the site (Appendix E). A total of 29 adults responded to the survey and identified recreational use as the primary land use. The recreational uses identified in the survey, from most popular response to least popular response, include hiking and mountain biking (28), skiing and snowmobiling (17), ATV and motorcycle riding (14), and camping (6). No one indicated they thought fishing, mining, or other activities were occurring on-site. Skiing and snowmobiling was not evaluated in this consultation since snowpack eliminates contact with surface soils. With this information, a conceptual site model, which describes the components of the exposure pathways, was developed and is detailed below.

The primary recreational users identified in the land use survey are hikers and mountain bikers, ATV and motocross riders, and campers. To simplify the exposure evaluation, hikers, ATV riders, and campers were used as the representative recreational activities. Child and adult recreational users were evaluated for each activity, however, the ages of children varied by activity. The assumed age for child ATV riders and hikers is ages 7-12 years since it is not likely that younger children would be riding ATVs or be able to hike the steep terrain encompassing the site. Child campers were assumed to be of ages 0-6 years since it is possible that they could be carried in packs by adults or be transported in an off-road vehicle. Based on the land use survey, the heavy-use scenario of >20 days is considered a potential exposure pathway because of the extremely low likelihood of people visiting the site for more than 20 days. Only 1 out of 29 people responded to visit the site for more than 20 days (Appendix E). The complete exposure parameters used to estimate exposure doses are presented in Appendix A.

Conceptual Site Model

Source	Transport Mechanism	Point of Exposure	Affected Environmental Medium	Timeframe of Exposure	Potentially Exposed Population	Route of Exposure
Mine Workings	Human transport and relocation of mine workings, Mine drainage	Surface Soils at Standard Mine	Surface Soil	Past, current, and Future	Recreational Users Including: Hikers, Campers, and ATV riders	Soil Ingestion Inhalation of Fugitive Dust Dermal Exposure to Soil Contaminants

Notes: 1) Dermal exposure to surface soil contaminants is considered an insignificant exposure pathway for metal contaminants and is not quantitatively evaluated in this consultation.
2) Inhalation of fugitive dusts is considered relevant only for ATV riders
3) Heavy site use scenario of >20 days is considered a potential exposure pathways based on the site-specific land use survey and site conditions.

Public Health Implications

<u>Lead Exposures</u>

Lead was the primary contaminant of concern identified in this evaluation. The concentration of lead in surface soil at the Standard Mine site is highly variable with a range of 28.5-63,500 parts per million (ppm) and an average concentration of 3,658 ppm. Both the maximum and average concentrations of lead in surface soils exceed the comparison value CV of 400 ppm, requiring further evaluation. To assess the health risks associated with lead exposure, modeling is used to predict the blood lead concentration of those exposed because individuals are exposed to lead from a variety of environmental sources and lead exposures, and the subsequent health effects, have traditionally been described in terms of blood lead concentrations. Young children (0-7 years) and developing fetuses are the most sensitive to the toxic effects of lead. These susceptible subpopulations are also considered protective of the general population. Therefore, the overall objective is to determine the blood lead concentration of young children and the fetus of pregnant women that use the mine site for recreational purposes.

To accomplish this goal in accordance with the ATSDR and CDPHE guidelines, EPA recommended predictive modeling was performed. The Integrated Exposure Uptake Biokinetic (IEUBK) model is used to predict blood lead levels in children and the Adult

Lead Model (ALM) is used to predict blood lead levels in the fetus of pregnant women. Blood lead levels as low as 10 μg/dL, which do not cause distinct symptoms, are associated with decreased intelligence and impaired neurobehavioral development (CDC, 1991). Blood lead levels of 10 μg/dL or greater is considered elevated, but there is no demonstrated safe level of lead in blood. A growing body of research has shown that there are measurable adverse neurological effects in children at blood lead concentrations as low as 1 μg/dL (EPA, 2003a).

It should be noted that 12 days is the minimum exposure frequency that is recommended for use in lead models. Thus, slightly different exposure frequencies were used to evaluate lead exposures. Average (12 days), above average (13-20 days), and heavy use (>20 days) scenarios were selected based on the land-use survey described above. However, the heavy-use scenario is considered a potential exposure pathway since there is some uncertainty regarding how often young children and pregnant women actually frequent the site. An extended discussion of the methods used to evaluate lead risks is contained in Appendix B.

The IEUBK model predicted elevated blood levels under the above average and heavy use scenarios (> 5% probability that blood lead is over 10 μg/dL). The model predicted that 50 to 93.0 % of young children will have elevated blood lead levels (above 10 μg/dL) under the above average and heavy use scenarios of more than 12 days exposure frequency (Appendix Table B1). According to the Adult Lead Model (ALM), elevated fetal blood levels are also predicted under the above-average and heavy use scenarios. As seen in Appendix Table B2, the probability that fetal blood lead will exceed target blood lead level of 10 μg/dL ranges from 21 to 60.5%, under the above-average and heavy use scenarios for the high-end soil ingestion rate of 100 mg/day. For the average soil ingestion rate of 50 mg/day, the probability that fetal blood lead will exceed target blood lead level of 10 μg/dL ranges from 7.5 to 30% for above average and heavy use scenarios (Appendix Table B2).

Overall, exposure to lead in surface soil at the Standard Mine site by young children (age 0-6 years) camping with their parents and pregnant women constitutes a public health hazard for the current above-average use exposure scenario and the potential heavy-use exposure scenario, under the EPA default assumptions used in the model. Lead is not likely to result in significant health hazards for the average-use scenario (up to 12 days/year) for either young children or pregnant women. It is important to note that the child and adult lead models rely on many input parameters to estimate blood lead levels as discussed in Appendix E. EPA developed default values for all parameters to allow the model to be used without performing costly and time-consuming site-specific studies. Several of these parameters can be measured more accurately on a site-specific basis. In the absence of site-specific data, this evaluation uses default values. These default values could lead the model to over predict or under predict actual blood lead levels. It should also be noted that the lead evaluation in this consultation does not account for other potential sources of lead at the Standard Mine site, namely surface water and sediment ingestion. These pathways will be evaluated in a future health consultation.

To determine the public health implications of exposure to non-lead COPCs that exceed the CVs for soil, exposure doses were calculated for the recreational scenarios outlined above in the conceptual site model. The resulting doses are compared to the appropriate non-cancer health-based guidelines for inhalation and oral exposures. Estimated doses that are below the applicable health-based guideline are not likely to result in adverse health effects. Additional information on exposure dose calculations is presented in Appendix A. A toxicological evaluation, which describes the health-based guidelines and other values used in this evaluation, is provided in Appendix D. The results of the health risk calculations for all non-lead exposure scenarios are presented in detail in Tables 3-7. The results are presented below by recreational activities.

Recreational Campers and Hikers

For campers and hikers, the estimated exposure doses for soil ingestion of each non-lead COPC are well below the non-cancer health-based guidelines for both the average or Central Tendency (CTE) and Reasonable Maximum Exposures (RME) (Table 3). Therefore, non-cancer adverse health effects are unlikely to occur from any individual non-lead COPCs under the exposure assumptions used in this evaluation for campers and hikers.

Arsenic related theoretical cancer risks were also estimated for hikers and campers at the Standard Mine site. The theoretical cancer risk estimates for oral ingestion of arsenic containing soils by campers or hikers range from $1.59 * 10^{-7}$ - $4.31 * 10^{-5}$ or 0.16 excess cancer cases per one million exposed individuals to 43.1 excess cancer cases per one million exposed individuals (Table 4). These theoretical cancer risks are within the EPA's acceptable risk range of $1 * 10^{-6}$ - $1 * 10^{-4}$. It is, however, important to note that these risks estimates are conservative and likely overestimated based on the assumption of 100% bioavailability of arsenic from soil. Therefore, excessive cancers are unlikely to occur from exposure to arsenic under the exposure assumptions used in this evaluation for campers and hikers. However, CDPHE strives to achieve long-term theoretical cancer risks of no more than 1 excess cancer case per 1,000,000 ($1* 10^{-6}$). Thus, remediation is recommended to reduce theoretical cancer risks to the CDPHE target level.

Recreational ATV Riders

ATV riders are unique in this evaluation in that both incidental ingestion of soil and inhalation of resuspended soil particles are pathways of potential concern for riders. The estimated soil ingestion and inhalation exposure doses for adults and children riding ATV for both average use (CTE) and high-end use (RME) are below the applicable health-based guidelines for both exposure pathways for all non-lead COPCs, except manganese (Table 5).

The high-end manganese exposure doses from the inhalation pathway for child and adult ATV riders are 21 and 13 times the health-based guideline for manganese, respectively (Table 5). The largest manganese doses for child and adult RME ATV riders are 0.00031 mg/kg-day and 0.00019 mg/kg-day and the health-based guideline is 0.0000143 mg/kg-day (Table A3). The largest estimated inhalation manganese dose of 0.00031 mg/kg/day was compared to the Lowest Observed Adverse Effect Level (LOAEL) of 0.097 mg/kg/day for manganese oxide and salts (EPA IRIS 2007). A No Observable Adverse Health Effect Level was not identified for inhalation of manganese. The largest dose is below the LOAEL, indicating that non-cancer adverse health effects are not likely to occur from inhalation of manganese. The combined exposure dose for manganese from the inhalation and ingestion pathway also remained below the LOAEL. Therefore, non-cancer adverse health effects are not likely to occur to ATV riders from any of the non-lead COPCs at the Standard Mine site.

Theoretical cancer risks to average and high-end ATV riders were also calculated for the ingestion and inhalation of contaminated soils. A slightly different exposure dose calculation is performed for carcinogenic risk, which is described in detail in Appendix A. First, exposure to arsenic, the only oral carcinogen, results in theoretical cancer risks ranging from $6.6 * 10^{-7}$ for average and $4.3 * 10^{-5}$ for high-end ATV riders (Table 7). Literally, the theoretical cancer risk range is equal to 0.66 excess cancer cases per 1,000,000 individuals to 43 excess cancer cases per 1,000,000 individuals. Secondly, three carcinogens were evaluated for the inhalation pathway for ATV riders, arsenic, cadmium, and chromium. The combined theoretical cancer risk from all inhaled carcinogens is $7.0 * 10^{-7}$ (0.7 excess cancer cases per 1,000,000 individuals) and $7.4 * 10^{-5}$ (74 excess cancer cases per 1,000,000 individuals) for average and high-end use ATV riders, respectively (Table 6). Third, since ATV riders would be exposed via ingestion and inhalation simultaneously, the theoretical cancer risk from both pathways needs to be combined. Thus, the total theoretical cancer risk is $1.4 * 10^{-6}$ (1.4 excess cancer cases per 1,000,000 individuals) for average use ATV riders and $1.2 * 10^{-4}$ (120 excess cancer cases per 1,000,000 individuals) for high-end use ATV riders (Table 7).

The theoretical cancer risks to individuals that ride ATVs at the Standard Mine site is within the EPA acceptable theoretical cancer risk range of $1 * 10^{-6}$ (1 excess cancer case per 1,000,000 individuals) to $1 * 10^{-4}$ (100 excess cancer cases per 1,000,000 individuals). However, these cancer risk estimates are associated with uncertainty related to the estimation of dust concentration for inhalation pathway, particularly in regards to the PM_{10} fraction in total dust. In the absence of site-specific data, all dust is assumed to be PM_{10} fraction (discussed in more detail in Appendix C). This is a conservative assumption since the actual PM_{10} is likely less than 100%. In addition, the risks may be overestimated based on the assumption of 100% bioavailability of metals from soils and the assumption of all chromium as being in the hexavalent form. Therefore, excessive cancers are unlikely to occur to ATV riders at the Standard Mine site. However, CDPHE strives to achieve theoretical cancer risks of no more than $1 * 10^{-6}$ and it is recommended that remediation and/or institutional controls be applied to the site to attain CDPHE's target theoretical cancer risk level in the future.

Acute Health Hazards for Children

Acute health hazard exposures are evaluated over a short period of time (1-day) and could apply to young children (0-6 years of age) as recreational users. The maximum detected levels of aluminum, arsenic, copper, vanadium, and zinc are significantly above the ATSDR acute comparison value for pica children indicating that adverse health effects are likely to occur from pica ingestion of soil. Pica is an eating disorder associated with the consumption of large amounts of non-nutritive substances such as soil. The ATSDR (ATDSR 2005) recommends evaluating acute exposures for pica behavior based on the consumption of a large amount of soil (5,000 mg/day). Because the acute exposure for pica children is based on a very high rate of soil intake, which may not occur frequently, this consultation also estimates acute risks using a more realistic soil ingestion rate of 400 mg/day for arsenic and copper as indicator chemicals. Please note that the soil intake rate of 400 mg/day represents the EPA recommended upper percentile soil ingestion rate value based on a short-term study (EPA, 1997).

Copper and arsenic were used as indicator chemicals for acute exposures because they were found in high concentrations and acute health guidelines (ATSDR Acute Oral MRL) are available for these contaminants. The acute health hazards for aluminum, vanadium and zinc were not evaluated because acute health guidelines are not available for these contaminants (ATSDR pica comparison values are based on intermediate-duration oral MRLs). The resulting estimated acute non-cancer dose and health hazards from exposure of recreational children (0-6 years of age) to arsenic and copper in surface soils are shown in Tables 8 and 9.

Based on the soil intake rate of 400 mg/day, acute health hazards related to copper exposure are possible at the maximum detected concentration. The maximum concentration was detected in a highly contaminated area, or a hot spot, where the maximum value is about 10-times higher than the Exposure Point Concentration (95% Upper Confidence Limit on the mean). The estimated exposure dose based on the maximum detected level of copper exceeds the NOAEL for copper and is equal to the LOAEL (Table 8). Based on the soil intake rate of 5000 mg/day for pica behavior, less serious acute health hazards related to copper and arsenic exposures are possible at the Exposure Point Concentration (95% Upper Confidence Limit on the mean) as well as the maximum detected concentration (Table 9).

The acute NOAEL value for copper (Cu) is based on a 2-week exposure study conducted by Pizarro et al (1999). In this study, gastrointestinal symptoms (e.g., nausea, vomiting, and/or abdominal pain) were observed in humans orally exposed to 0.0731 mg Cu/kg-day and 0.124 mg Cu/kg-day of copper sulfate in drinking water, but not at 0.0272 mg Cu/kg-day. The acute oral LOAEL for arsenic is based on 220 poisoning cases associated with an episode of arsenic contaminated soy sauce in Japan (ATSDR, 2007). Arsenic intake in these cases was estimated to be 0.05 mg/kg/day. The duration of exposure was 2-3 weeks in most cases. The primary symptoms were edema of the face, and gastrointestinal and upper respiratory symptoms initially, followed by skin lesions and neuropathy in some patients. For the derivation of the acute oral MRL, facial edema and gastrointestinal symptoms, which were characteristics of initial poisoning and then subsided, were considered to be the critical effects. Thus, if children are consuming a large amount of soil from highly contaminated areas, less serious acute health hazards are possible from copper and arsenic. It is, however, important to note that young children (2-3 years of age) who commonly exhibit pica are not likely to frequently visit the site. As discussed earlier, there is uncertainty associated with acute health hazards for copper and arsenic due to the reduced relative bioavailability of metals from soils. For example, the EPA Region 8 has utilized a default bioavailability factor of 50% for arsenic in soil. However, the available information is not yet adequate to derive reliable conclusions regarding the default assumption of relative bioavailability of arsenic from site soils.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical and behavioral differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Health effects for children were considered in this evaluation and were found to be a concern for young campers and ATV riders from exposure to lead at the Standard Mine site. Children and women of childbearing age should limit contact with surface soils at the Standard Mine site. Fetal and child exposure to lead can cause permanent damage to the central nervous system during critical growth stages.

Conclusions

The major conclusions of this evaluation are summarized below:

- Exposure to lead in surface soils presents a public health hazard for young children and pregnant women who visit the Standard Mine site for recreational use on the above-average basis (more than 12 days per year). Specifically, the potential non-cancer health hazards from exposure to lead are of concern to child and adult recreational users such as campers, hikers, and ATV riders visiting the site under the current above- average use scenario and potential heavy use scenario.

- Average recreational exposures to lead (i.e., up to 12 days) are considered to pose no apparent public health hazard.

- Recreational exposure to all other non-lead contaminants is not likely to result in chronic, non-cancer adverse health effects.

- Acute exposures based on pica behavior are considered a public health hazards for copper and arsenic. Less serious acute health hazards from copper and arsenic are possible for young children who consume a large amount of soil from highly contaminated areas found onsite. It is, however, important to note that young children (2-3 years of age) who generally exhibit pica are not likely to frequently visit the site. Also, there is uncertainty associated with acute health hazards for copper and arsenic due to the reduced relative bioavailability of metals from soils.

- Theoretical cancer risks from the dust inhalation and soil ingestion pathways for ATV riders are at the high-end of the acceptable cancer risk range (100 excess cancers in a million people exposed). Theoretical cancer risks for recreational hikers and campers are within the acceptable cancer risk range. In both cases, the theoretical cancer risks are not of significant concern considering the conservative exposure assumptions and parameters used to calculate risk. However, remedial activities are recommended to reduce theoretical cancer risks to CDPHE's target cancer risk level.

Recommendations

Based on the available data and the information reviewed, CDPHE makes the following recommendations to reduce the likelihood of adverse health effects from exposure to surface soil contaminants at the Standard Mine Site:

- Frequent visits to the Standard Mine site by young children for recreational use should be discouraged and/or prohibited.

- ATVs should not be used at the site especially through areas containing mine tailings and waste rock.

- EPA should remediate the site to reduce contaminant levels. In particular, lead, copper, and arsenic concentrations should be decreased.

- CDPHE should conduct an additional health consultation, which examines recreational use of surface water draining from the site including camping and fishing.

Public Health Action Plan

The Public Health Action Plan describes the actions that are necessary to reduce exposure to site-related contaminants and how these actions can be executed. The CCPEHA of EES will work in conjunction with CDPHE and EPA risk managers to carry out the Public Health Action Plan as described below.

- Signs will be installed by CDPHE to warn recreational users of the potential hazards associated with exposure to surface soils. The sign will specifically address ATV riders and small children.

- CCPEHA will conduct the appropriate health education activities including the presentation of findings of this document in a public meeting, distributing the document to the information repositories, and the production of fact sheets and verbal communication to relay this information to the public.

Acknowledgments

Special thanks to Dr. Jill Dyken of the Agency for Toxic Substances and Disease Registry for her contributions to this document and her previous work at this site.

Preparers of Report

Thomas Simmons
Health Assessor
Environmental Epidemiology Section
Colorado Dept. of Public Health and Environment
Phone: 303-692-2961
Fax: 303-782-0904
E-mail: tom.simmons@state.co.us

CDPHE Designated Reviewer :

Raj Goyal Ph.D
Principal Investigator
Environmental Epidemiology Section
Colorado Dept. of Public Health and Environment
Phone: 303-692-2634
Fax: 303-782-0904
E-mail: raj.goyal@state.co.us

ATSDR Designated Reviewer:

Jennifer Freed MPH
Technical Project Officer
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

References

Agency for Toxic Substances and Disease Registry (ATSDR 2005). *Public Health Assessment Guidance Manual,* Revised January 2005. Available on the Internet at: http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html, accessed November 2007.

Agency for Toxic Substances and Disease Registry (ATSDR 2006). *Evaluation of Potential Public Health Impact of Surface Water Contamination*, November 13, 2006. Available on the Internet at: http://www.atsdr.cdc.gov/HAC/pha/StandardMineNPLSite/StandardMineHC111306.pdf, accessed November 2007.

Agency for Toxic Substances and Disease Registry (ATSDR 2007). *Toxicological Profile for Arsenic,* September 2007. Available on the Internet at: http://www.atsdr.cdc.gov/toxprofiles/tp151.html, Accessed September 2007.

Agency for Toxic Substances and Disease Registry (ATSDR 2007). *Toxicological Profile for Lead,* August 2007. Available on the Internet at: http://www.atsdr.cdc.gov/toxprofiles/tp13.html, Accessed November 2007.

Syracuse Research Corporation (SRC 2007). *Baseline Human Health Risk Assessment for the Standard Mine Site (External Review Draft),* April 16, 2007. Prepared for and with oversight by the USEPA.

URS Operating Services, (UOS 2006). *Sampling Activities Report on the Standard Mine Site*, March 20, 2006.

U.S. Environmental Protection Agency, (EPA 1993). *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure (Draft),* November 1993.

U.S. Environmental Protection Agency, Region 9 (EPA 2004). *Preliminary Remediation Goals*, last update October 2004. Available on the Internet at: http://www.epa.gov/reg3hwmd/risk/human/rbc/RBCoct07.pdf, Accessed September 2007.

U. S. Environmental Protection Agency, Region 3 (EPA 2007a). *Human Health Risk Assessment, Risk-Based Concentration Table,* last update October 11, 2007. Available on the Internet at: http://www.epa.gov/reg3hwmd/risk/human/index.htm, Accessed November 2007.

U.S. Environmental Protection Agency, National Center for Environmental Assessment (EPA 1997). *Exposure Factors Handbook*, last update August 1997. Available on the Internet at: http://www.epa.gov/ncea/efh/, Accessed November 2007.

U.S. Environmental Protection Agency, Integrated Risk Information System (2007b). *Manganese Profile 0373*, last update November 1, 1995. Available on the Internet at: http://www.epa.gov/iris/subst/0373.htm, Accessed October 2007.

U.S Environmental Protection Agency (EPA 2008). Standard Mine Superfund Webpage, last update February 5, 2008. Available on the Internet at: http://www.epa.gov/Region8/sf/co/standard/, Accessed February 2008.

Tables and Figure

Table 1. Standard Mine Surface Soil Summary Statistics and Contaminant of Potential Concern Selection

Contaminant	Maximum (mg/kg)	Minimum (mg/kg)	Mean (mg/kg)	Detection Frequency	Number of Samples	Comparison Value* (mg/kg)	COPC
Aluminum	18000	966	7068	100%	190	7600	X
Antimony	28.8	0.8	6.61	32.6%	190	3.1	X
Arsenic	680	4.6	75.53	100%	190	0.039	X
Barium	580	24.3	118.9	100%	190	540	X
Beryllium	6.1	0.02	0.84	95.3%	190	15	
Cadmium	107	0.26	7.77	93.7%	190	3.7	X
Calcium	16100	99.9	1908.1	100%	190	NA	
Chromium	93.2	0.71	6.94	100%	190	3	X
Cobalt	35.1	0.065	7.57	98.4%	190	90	
Copper	2730	6	243.5	100%	190	310	X
Iron	195999	5600	32635	100%	190	2300	X
Lead	63500	28.4	3658	99.5%	190	40	X
Magnesium	3060	120	1503	100%	190	NA	
Manganese	12200	185	2248	100%	190	180	X
Mercury	0.33	0.0095	0.067	79.5%	190	2.3	
Nickel	20	0.041	6.13	98.4%	190	160	
Potassium	2550	663	1354.13	100%	190	NA	
Selenium	66.3	0.99	12.59	50.0%	190	39	X
Silver	106	0.36	11.75	98.4%	190	39	X
Sodium	1060	0.42	100.28	92.1%	190	NA	
Thallium	6.5	1	2.54	5.8%	190	0.52	X
Vanadium	31	3	13.39	100%	190	7.8	X
Zinc	20100	48	1370	100%	190	2300	X

*Comparison Value is 10% of the EPA Region 9 Preliminary Remediation Goal, NA= Not Available, mg/kg = milligram contaminant per kilogram soil

Table 3. Recreational Hikers and Campers Hazard Quotients from Soil Ingestion

COPC	Child Hiker Noncancer HQs		Adult Hiker Noncancer HQs		Child Camper Noncancer HQs		Adult Camper Noncancer HQs	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Aluminum	1.23E-04	3.20E-03	2.91E-05	7.55E-04	6.16E-04	6.41E-03	7.26E-05	1.51E-03
Antimony	1.35E-04	3.52E-03	3.19E-05	8.29E-04	6.77E-04	7.04E-03	7.97E-05	1.66E-03
Arsenic	6.83E-03	1.78E-01	1.61E-03	4.19E-02	3.41E-02	3.55E-01	4.02E-03	8.37E-02
Barium	1.05E-05	2.74E-04	2.48E-06	6.46E-05	5.27E-05	5.48E-04	6.21E-06	1.29E-04
Cadmium	1.90E-04	4.94E-03	4.48E-05	1.16E-03	9.50E-04	9.88E-03	1.12E-04	2.33E-03
Chromium	5.28E-05	1.37E-03	1.24E-05	3.24E-04	2.64E-04	2.75E-03	3.11E-05	6.47E-04
Copper	1.74E-04	4.52E-03	4.10E-05	1.06E-03	8.69E-04	9.04E-03	1.02E-04	2.13E-03
Iron	9.87E-04	2.57E-02	2.33E-04	6.05E-03	4.93E-03	5.13E-02	5.81E-04	1.21E-02
Manganese	2.40E-03	6.23E-02	5.65E-04	1.47E-02	1.20E-02	1.25E-01	1.41E-03	2.94E-02
Selenium	2.71E-05	7.04E-04	6.38E-06	1.66E-04	1.35E-04	1.41E-03	1.59E-05	3.32E-04
Silver	5.80E-05	1.51E-03	1.37E-05	3.55E-04	2.90E-04	3.02E-03	3.42E-05	7.11E-04
Thallium	2.75E-04	7.15E-03	6.49E-05	1.69E-03	1.38E-03	1.43E-02	1.62E-04	3.37E-03
Vanadium	2.32E-04	6.03E-03	5.46E-05	1.42E-03	1.16E-03	1.21E-02	1.37E-04	2.84E-03
Zinc	1.34E-04	3.47E-03	3.15E-05	8.18E-04	6.68E-04	6.94E-03	7.87E-05	1.64E-03
All COPCs	1.16E-02	3.02E-01	2.74E-03	7.12E-02	5.81E-02	6.05E-01	6.85E-03	1.42E-01

CTE: Central Tendency (average) Exposure
RME: Reasonably Maximum Exposure
Hazard Quotients (HQs) are a numerical indicator of risk. To calculate hazard quotients, the estimated dose is divided by the health-based guideline. HQs greater than one indicate a need for further evaluation. HQs less than 1 are not likely to result in adverse health effects.

Table 4. Age-Adjusted Theoretical Cancer Risks from Soil Ingestion

Carcinogen	Hiker		Camper		ATV Rider	
	CTE	RME	CTE	RME	CTE	RME
Arsenic	$1.59 * 10^{-7}$	$2.56 * 10^{-7}$	$6.63 * 10^{-7}$	$4.31 * 10^{-5}$	$6.63 * 10^{-7}$	$4.31 * 10^{-5}$

CTE: Central Tendency Exposure (Average)
RME: Reasonable Maximum Exposure (High-end)
ATV: All-Terrain Vehicle

Table 5. ATV Rider Hazard Quotients (HQs) for Dust Inhalation and Soil Ingestion

COPC	Adult ATV Rider Soil Ingestion Noncancer HQs		Adult ATV Rider Particulate Inhalation Noncancer HQs		Adult ATV Rider Total Noncancer HQs		Child ATV Rider Soil Ingestion Noncancer HQs		Child ATV Rider Particulate Inhalation Noncancer HQs		Child ATV Rider Total Dose Noncancer HQs	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Aluminum	7.26E-05	1.51E-03	1.13E-02	3.52E-01	1.14E-02	3.54E-01	3.08E-04	6.41E-03	1.80E-02	5.60E-01	1.83E-02	5.67E-01
Antimony	7.97E-05	1.66E-03	N/a	N/a	7.97E-05	1.66E-03	3.38E-04	7.04E-03	N/a	N/a	3.38E-04	7.04E-03
Arsenic	4.02E-03	8.37E-02	N/a	N/a	4.02E-03	8.37E-02	1.71E-02	3.55E-01	N/a	N/a	1.71E-02	3.55E-01
Barium	6.21E-06	1.29E-04	1.93E-03	N/a	1.94E-03	6.03E-02	2.63E-05	5.48E-04	3.07E-03	9.58E-02	3.10E-03	9.63E-02
Cadmium	1.12E-04	2.33E-03	4.27E-04	1.33E-02	5.39E-04	1.57E-02	4.75E-04	9.88E-03	6.80E-04	2.12E-02	1.15E-03	3.11E-02
Chromium	3.11E-05	6.47E-04	6.77E-04	2.11E-02	7.08E-04	2.18E-02	1.32E-04	2.75E-03	1.08E-03	3.36E-02	1.21E-03	3.64E-02
Copper	1.02E-04	2.13E-03	N/a	N/a	1.02E-04	2.13E-03	4.34E-04	9.04E-03	N/a	N/a	4.34E-04	9.04E-03
Iron	5.81E-04	1.21E-02	N/a	N/a	5.81E-04	1.21E-02	2.47E-03	5.13E-02	N/a	N/a	2.47E-03	5.13E-02
Manganese	1.41E-03	2.94E-02	4.30E-01	1.34E+01	4.31E-01	1.34E+01	5.99E-03	1.25E-01	6.84E-01	2.13E+01	6.90E-01	2.15E+01
Selenium	1.59E-05	3.32E-04	N/a	N/a	1.59E-05	3.32E-04	6.77E-05	1.41E-03	N/a	N/a	6.77E-05	1.41E-03
Silver	3.42E-05	7.11E-04	N/a	N/a	3.42E-05	7.11E-04	1.45E-04	3.02E-03	N/a	N/a	1.45E-04	3.02E-03
Thallium	1.62E-04	3.37E-03	N/a	N/a	1.62E-04	3.37E-03	6.88E-04	1.43E-02	N/a	N/a	6.88E-04	1.43E-02
Vanadium	1.37E-04	2.84E-03	N/a	N/a	1.37E-04	2.84E-03	5.79E-04	1.21E-02	N/a	N/a	5.79E-04	1.21E-02
Zinc	7.87E-05	1.64E-03	N/a	N/a	7.87E-05	1.64E-03	3.34E-04	6.94E-03	N/a	N/a	3.34E-04	6.94E-03
All COPCs	6.85E-03	1.42E-01	4.44E-01	1.39E+01	4.51E-01	1.40E+01	2.91E-02	6.05E-01	7.07E-01	2.21E+01	7.36E-01	2.27E+01

Values in red indicate HQs > 1

ATV: All-Terrain Vehicle

CTE: Central Tendency (average) Exposure

RME: Reasonably Maximum Exposure

Hazard Quotients (HQs) are a numerical indicator of risk. To calculate hazard quotients, the estimated dose is divided by the health-based guideline. HQs greater than one indicate a need for further evaluation. HQs less than 1 are not likely to result in adverse health effects.

Table 6. Age-Adjusted Theoretical Cancer Risks from Particulate Inhalation by ATV Riders

Carcinogen	ATV Rider	
	CTE	RME
Arsenic	$5.67 * 10^{-7}$	$5.89 * 10^{-5}$
Cadmium	$2.21 * 10^{-8}$	$2.29 * 10^{-6}$
Chromium[a]	$1.20 * 10^{-7}$	$1.25 * 10^{-5}$
Total	*$7.08 * 10^{-7}$*	*$7.37 * 10^{-5}$*

[a] Chromium conservatively evaluated as chromium 6+ using the cancer slope factor of 41.0 per mg/kg/day.
ATV: All-Terrain Vehicle
CTE: Central Tendency (average) Exposure
RME: Reasonably Maximum Exposure

Table 7. Total Age-Adjusted Theoretical Cancer Risks for ATV Riders

Carcinogen	Route of Exposure	ATV Riders	
		CTE	RME
Arsenic	Soil Ingestion	$6.63 *10^{-7}$	$4.31 * 10^{-5}$
Arsenic	Particulate Inhalation	$5.67 * 10^{-7}$	$5.89 * 10^{-5}$
Cadmium	Particulate Inhalation	$2.21 * 10^{-8}$	$2.29 * 10^{-6}$
Chromium	Particulate Inhalation	$1.20 * 10^{-7}$	$1.25 * 10^{-5}$
All	Total Cancer Risk	*$1.37 * 10^{-6}$*	*$1.17 * 10^{-4}$*

ATV: All-Terrain Vehicle
CTE: Central Tendency (average) Exposure
RME: Reasonably Maximum Exposure

Table 8. Evaluation of arsenic and copper acute exposure (400 mg/day) to surface soil for young children (0-6 years)

Chemical	EPC (mg/kg)	Exposure dose[a] (mg/kg/day)	Health Guideline (mg/kg/day)	Health Guideline based HQ	NOAEL[b] based HQ	LOAEL[c] based HQ
Acute Risks with EPC= 95% UCL on the mean (Site-wide)						
Arsenic	123.4	0.00329	0.005[d]	0.7	NA	NA
Copper	310.0	0.0083	0.01[e]	0.8	NA	NA
Acute Risks with EPC=Maximum Detected Concentration (hot spots)						
Arsenic	680.0	0.0181	0.005[d]	**3.6**	NA	0.36
Copper	2730.0	0.0728	0.01[e]	**7.3**	**2.7**	0.99

[a] *Exposure dose* = Soil Concentration (mg/kg) x Soil Intake Rate (mg/day) x Exposure Frequency x Conversion Factor/ Child Body Weight (kg) x Averaging Time;
Where: Soil Intake Rate = 400 mg/day; EF= 1 day; CF = 0.000001 kg/mg; AT = 1 day, Body Weight = 15 kg.

[b] No acute No Observable Adverse Effect Level (NOAEL) value for arsenic was identified. An acute NOAEL value for copper of 0.0272 mg/kg-day was selected by the Agency for Toxic Substance and Disease Registry (ATSDR) for the Minimal Risk Level (MRL) derivation.

[c] Arsenic Acute Lowest Observable Adverse Effect Level (LOAEL) for ATSDR MRL = 0.05 mg/kg/day based on the primary critical effects of facial edema gastrointestinal symptoms (nausea, vomiting, diarrhea). Copper acute LOAEL for ATSDR MRL = 0.0731 mg/kg/day based on gastrointestinal effects (nausea, vomiting, abdominal pain and/or diarrhea).

[d] ATSDR Acute Oral MRL

[e] ATSDR Acute Oral MRL

NA- not applicable because NOAEL is not available or health guideline based HQ is less than or equal to 1.0.

EPC = Exposure Point Concentration
UCL = Upper Confidence Limit
HQ = Hazard Quotient (Estimated dose divided by health guideline or adverse effect levels)
mg/kg = milligram contaminant per kilogram soil
mg/kg-day = milligram contaminant per kilogram body weight daily
mg/day = milligram soil per day

Table 9. Evaluation of arsenic and copper acute exposure (5000mg/day) to surface soil for young children (0-6 years), based on pica behavior.

Chemical	EPC (mg/kg)	Exposure dose[a] (mg/kg/day)	Health Guideline (mg/kg/day)	Health Guideline based HQ	NOAEL[b] based HQ	LOAEL[c] based HQ
Acute Risks with EPC= 95% UCL on the mean (Site-wide)						
Arsenic	123.4	0.0411	0.005[d]	**8.2**	NA	0.8
Copper	310.0	0.1038	0.01[e]	**10.4**	**3.8**	**1.4**
Acute Risks with EPC=Maximum Detected Concentration (hot spots)						
Arsenic	680.0	0.2263	0.005[d]	**45.0**	NA	**4.5**
Copper	2730.0	0.9100	0.01[e]	**91.0**	**2.7**	**12.4**

[a] *Exposure dose* = Soil Concentration (mg/kg) x Soil Intake Rate (mg/day) x Exposure Frequency x Conversion Factor/ Child Body Weight (kg) x Averaging Time;
Where: Soil Intake Rate = 5000 mg/day; EF= 1 day; CF = 0.000001 kg/mg; AT = 1 day, Body Weight = 15 kg.

[b] No acute No Observable Adverse Effect Level (NOAEL) value for arsenic was identified. An acute NOAEL value for copper of 0.0272 mg/kg-day was selected by the Agency for Toxic Substance and Disease Registry (ATSDR) for the Minimal Risk Level (MRL) derivation.

[c] Arsenic Acute Lowest Observable Adverse Effect Level (LOAEL) for ATSDR MRL = 0.05 mg/kg/day based on the primary critical effects of facial edema gastrointestinal symptoms (nausea, vomiting, diarrhea). Copper acute LOAEL for ATSDR MRL = 0.0731 mg/kg/day based on gastrointestinal effects (nausea, vomiting, abdominal pain and/or diarrhea).

[d] ATSDR Acute Oral MRL

[e] ATSDR Acute Oral MRL

NA- not applicable because NOAEL is not available or health guideline based HQ is less than or equal to 1.0.

EPC = Exposure Point Concentration
UCL = Upper Confidence Limit
HQ = Hazard Quotient (Estimated dose divided by health guideline or adverse effect levels)
mg/kg = milligram contaminant per kilogram soil
mg/kg-day = milligram contaminant per kilogram body weight daily
mg/day = milligram soil per day

Figure 1. Site Location and Demographic Information (from ATSDR 2006)

Figure 1. Site Location and Demographic Information

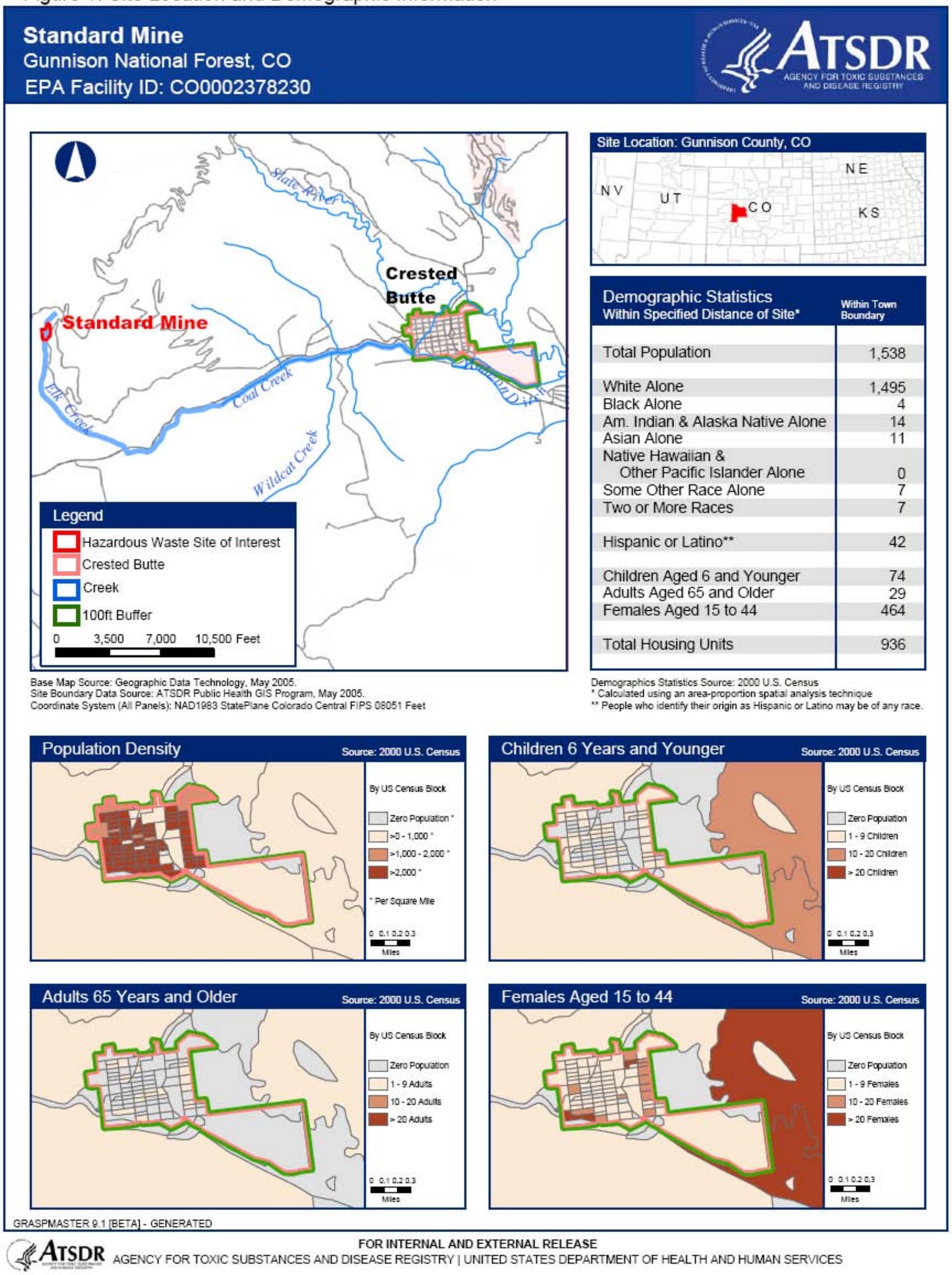
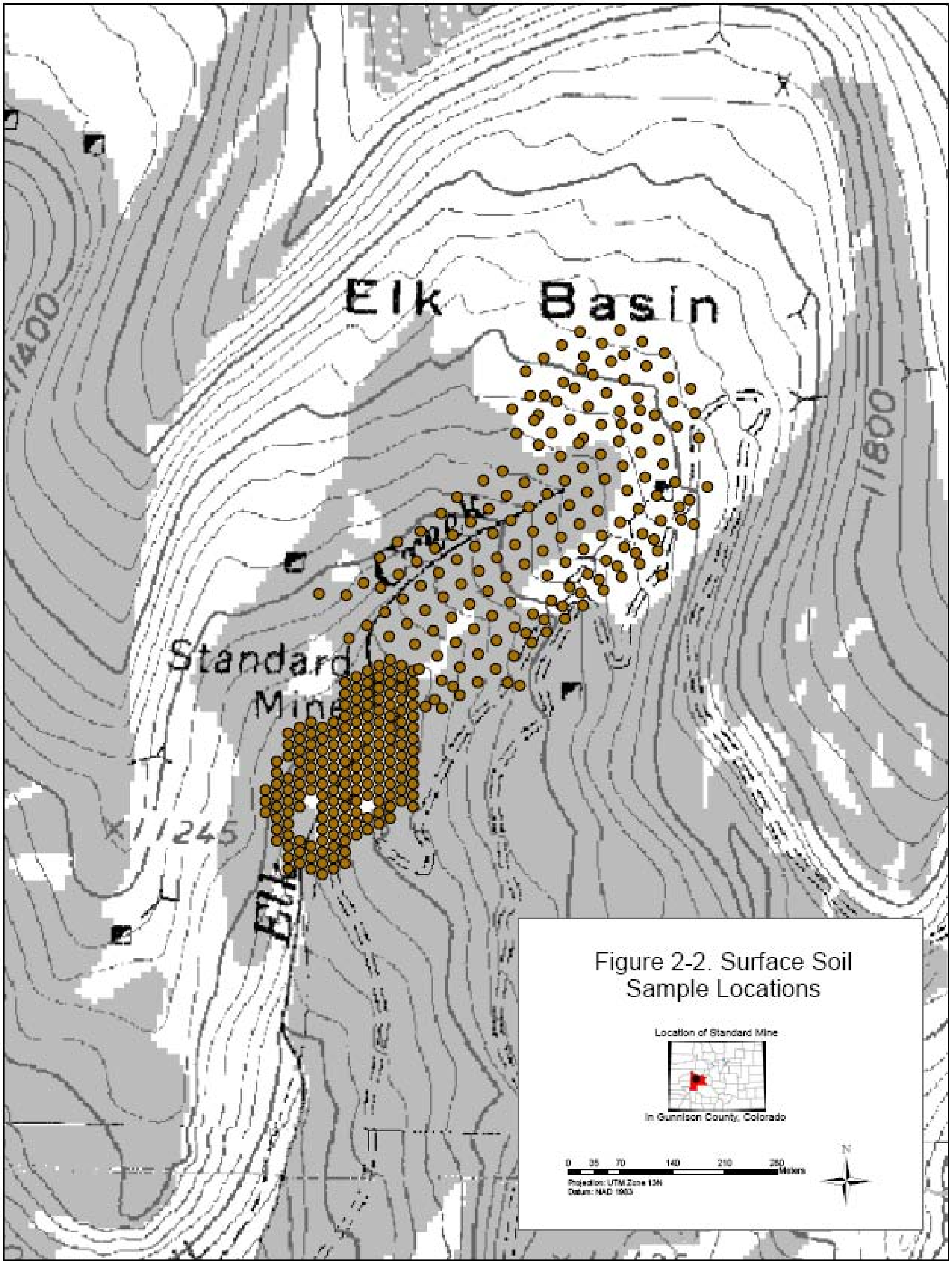


Figure 2. Surface Soil Sampling Locations



Source: SRC 2007

Appendix A. Detailed Exposure Dose Information for all Non-Lead COPCs

Appendix A1. Exposure Dose Assumptions

To calculate exposure doses, assumptions have to be made regarding various exposure parameters such as frequency of activity, duration of exposure to site-related contaminants, and the amount of a particular substance that is taken in by the body during a given activity. Generally, default parameters that are established by the EPA and ATSDR are used in health consultations when site-specific data is unavailable. In this case, many of the default parameters overestimate potential exposures to on-site contaminants because the location and rugged terrain of the site limits the number and types of people that typically visit. A land use survey that was described previously in this document was conducted by the EPA to determine the types of activities that occur at the site and how often. The survey was advertised in the local newspaper and announced at public meetings, yet only a small percentage of the surrounding population responded. A number of activities were identified in the survey with a wide range in frequency and duration of exposure. To the extent possible, this data was used for the exposure assumptions used to calculate exposure doses. Personal judgment and the default exposure parameters were also used when necessary.

Three primary receptors were identified that are considered “typical” users for this consultation. The primary receptors are hikers, campers, and ATV riders. These receptors were identified in the land use survey and are considered representative of all potential users (i.e. hiker exposures closely resemble mountain biking exposures; ATV riders closely resemble motorcycle riders, etc.). A wide range of potential exposure conditions was also identified in the land use survey. To account for the varying exposure parameters mentioned in the survey, a central tendency (CTE) or average (50th percentile of the population distribution) exposure condition and a reasonable maximum exposure (RME) condition (high-end or above the 90th percentile of the population distribution) were used for each receptor. The exposure parameters are listed in the tables below for each receptor. Generally speaking, the exposure frequency for CTE was 5 days per year over a period of 2 years for children and 9 years for adults. RME was assumed to occur 52 days per year over 6 years for children and 30 years for adults. Default exposure assumptions for CTE and RME soil ingestion were used as the baseline for this pathway. Hiker exposures were adjusted (fraction ingested from contaminated source) since nearly all respondents of the survey indicated that most people would just be passing through the site on their way to other areas and not hanging around the site for long periods of time. The inhalation pathway was only examined for ATV riders since other receptors are not expected to generate a significant amount of dust. The EPA’s exposure factors handbook was the reference for the inhalation rate that was used in this consultation, which is for moderate activities (Table A4). Theoretical cancer risks were calculated using an age-adjusted equation that combines child and adult cancer risk into one equation. The exposure dose equations are listed in Appendix A2.

Table A1. Surface Soil Exposure Point Concentration

Analyte	Exposure Point Concentration* (mg/kg)	EPC Method
Aluminum	7423	95% Students t-UCL
Antimony	3.26	95% KM (t) UCL
Arsenic	123.4	97.5% Chebyshev UCL
Barium	126.9	95% Approx. Gamma UCL
Cadmium	11.44	95% KM (Chebyshev) UCL
Chromium	9.54	95% Chebyshev UCL
Copper	418.6	97.5% Chebyshev UCL
Iron	41599	95% Chebyshev UCL
Lead	6746	97.5% KM (Chebyshev) UCL
Manganese	2888	95% Chebyshev UCL
Selenium	8.15	95% KM (BCA) UCL
Silver	17.46	95% KM (Chebyshev) UCL
Thallium	1.16	95% KM (t) UCL
Vanadium	13.96	95% Students t-UCL
Zinc	2413	97.5% Chebyshev UCL

*As calculated by ProUCL Version 4.0
mg/kg = milligram contaminant per kilogram soil

Table A2. Recreational Hiker Exposure Parameters

Exposure Pathway	Exposure Parameter	Units	Receptor			
			Child		Adult	
			CTE	RME	CTE	RME
General	Body Weight (BW)	kg	33	33	70	70
	Exposure Frequency (EF)	days/yr	5	52	5	52
	Exposure Duration$_{Non\text{-}cancer}$ (ED$_{Non\text{-}cancer}$)	years	2	6	9	30
	Exposure Duration$_{Cancer}$ (ED$_{Cancer}$)	years	N/a	N/a	9*	30*
	Averaging Time$_{Non\text{-}cancer}$ (AT$_{Non\text{-}cancer}$)	days	730	2190	3285	10950
	Averaging Time$_{Cancer}$ (AT$_{Cancer}$)	days	N/a	N/a	25550*	25550*
Incidental Ingestion of Soil	Ingestion Rate$_{Non\text{-}cancer}$ (IR$_{Non\text{-}cancer}$)	mg/day	100	200	100	100
	Ingestion Rate$_{Cancer}$ (IR$_{Cancer}$)	(mg-yr)/(kg-day)	N/a	N/a	4.4*	35.3*
	Fraction Ingested from Contaminated Source	unitless	0.4	0.5	0.4	0.5

* Age-adjusted equation was used to evaluate theoretical carcinogenic risks
CTE: Central Tendency Exposure (Average)
RME: Reasonable Maximum Exposure (High-end)

Table A3. Recreational Camper Exposure Parameters

Exposure Pathway	Exposure Parameter	Units	Receptor			
			Child		Adult	
			CTE	RME	CTE	RME
General	Body Weight (BW)	kg	15	15	70	70
	Exposure Frequency (EF)	days/yr	5	52	5	52
	Exposure Duration$_{Non\text{-}cancer}$ ($ED_{Non\text{-}cancer}$)	years	2	6	9	30
	Exposure Duration$_{Cancer}$ (ED_{Cancer})	years	N/a	N/a	9*	30*
	Averaging Time$_{Non\text{-}cancer}$ ($AT_{Non\text{-}cancer}$)	days	730	2190	3285	10950
	Averaging Time$_{Cancer}$ (AT_{Cancer})	days	N/a	N/a	25550*	25550*
Incidental Ingestion of Soil	Ingestion Rate Soil (IRS)	mg/day	100	200	50	100
	Ingestion Rate Soil Adjusted (IRS_{adj})	(mg-yr)/(kg-day)	N/a	N/a	18.3*	114.3*
	Fraction Ingested (FI)	unitless	1.0	1.0	1.0	1.0

* Age-adjusted equation was used to evaluate theoretical carcinogenic risks
CTE: Central Tendency Exposure (Average)
RME: Reasonable Maximum Exposure (High-end)

Table A4. Recreational ATV Rider Exposure Parameters

Exposure Pathway	Exposure Parameter	Units	Receptor			
			Child		Adult	
			CTE	RME	CTE	RME
General	Body Weight (BW)	kg	33	33	70	70
	Exposure Frequency (EF)	days/yr	5	52	5	52
	Exposure Duration$_{Non\text{-}cancer}$ (ED$_{Non\text{-}cancer}$)	years	2	6	9	30
	Exposure Duration$_{Cancer}$ (ED$_{Cancer}$)	years	N/a	N/a	9*	30*
	Averaging Time$_{Non\text{-}cancer}$ (AT$_{Non\text{-}cancer}$)	days	730	2190	3285	10950
	Averaging Time$_{Cancer}$ (AT$_{Cancer}$)	days	N/a	N/a	25550*	25550*
Incidental Ingestion of Soil	Ingestion Rate (IRS)	mg/day	100	200	50	100
	Ingestion Rate Adjusted (IRS$_{adj}$)	(mg-yr)/(kg-day)	N/a	N/a	11.1*	70.6*
Inhalation of Particulates	Inhalation Rate (IRA)	m^3/hour	1.2	1.2	1.6	1.6
	Exposure Frequency	days/yr	5	52	5	52

*Age adjusted equation was used to evaluate theoretical carcinogenic risks
CTE: Central Tendency Exposure (Average)
RME: Reasonable Maximum Exposure (High-end)

Appendix A2. Exposure Dose Equations

Non-Cancer Surface Soil Ingestion Dose

Non-cancer Dose = $(C_s * IRS * EF * CF) / BW$

Where: $EF = (F * ED) / AT_{noncancer}$

Age-Adjusted Soil Ingestion Cancer Dose

Age-Adjusted Cancer Dose = $(C_s * IRS_{adj} * CF * EF) / 25{,}550 \text{ Days}$

Where: $IRS_{adj} = [(ED_{child} * IRS_c) / BW_c] + [(ED_{adult} * IRS_a) / BW_a]$

Non-cancer Particulate Inhalation Dose

Non-cancer Dose = $(C_a * IRA * ET * EF * ED) / BW * AT_{noncancer}$

Age-adjusted Particulate Inhalation Dose

Age-Adjusted Cancer Dose = $(C_s * IR_{adj} * CF * EF) / 25{,}550 \text{ Days}$

Where: $IR_{adj} = [(ED_c * IR_c) / BW_c] + [(ED_a * IR_a) / BW_a]$

Appendix A3. Exposure Dose Results

Table A5. Hiker and Camper Exposure Dose Results

COPC	Child Hiker Dose (mg/kg-day)		Adult Hiker Dose (mg/kg-day)		Child Camper Dose (mg/kg-day)		Adult Camper Dose (mg/kg-day)	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Aluminum	1.23E-04	3.20E-03	2.91E-05	7.55E-04	1.36E-03	1.41E-02	7.26E-05	1.51E-03
Antimony	5.41E-08	1.41E-06	1.28E-08	3.32E-07	5.95E-07	6.19E-06	3.19E-08	6.63E-07
Arsenic	2.05E-06	5.33E-05	4.83E-07	1.26E-05	2.25E-05	2.34E-04	1.21E-06	2.51E-05
Barium	2.11E-06	5.48E-05	4.97E-07	1.29E-05	2.32E-05	2.41E-04	1.24E-06	2.58E-05
Cadmium	1.90E-07	4.94E-06	4.48E-08	1.16E-06	2.09E-06	2.17E-05	1.12E-07	2.33E-06
Chromium	1.58E-07	4.12E-06	3.73E-08	9.71E-07	1.74E-06	1.81E-05	9.33E-08	1.94E-06
Copper	6.95E-06	1.81E-04	1.64E-06	4.26E-05	7.65E-05	7.95E-04	4.10E-06	8.52E-05
Iron	6.91E-04	1.80E-02	1.63E-04	4.23E-03	7.60E-03	7.90E-02	4.07E-04	8.47E-03
Manganese	4.80E-05	1.25E-03	1.13E-05	2.94E-04	5.27E-04	5.49E-03	2.83E-05	5.88E-04
Selenium	1.35E-07	3.52E-06	3.19E-08	8.29E-07	1.49E-06	1.55E-05	7.97E-08	1.66E-06
Silver	2.90E-07	7.54E-06	6.83E-08	1.78E-06	3.19E-06	3.32E-05	1.71E-07	3.55E-06
Thallium	1.93E-08	5.01E-07	4.54E-09	1.18E-07	2.12E-07	2.20E-06	1.14E-08	2.36E-07
Vanadium	2.32E-07	6.03E-06	5.46E-08	1.42E-06	2.55E-06	2.65E-05	1.37E-07	2.84E-06
Zinc	4.01E-05	1.04E-03	9.44E-06	2.46E-04	4.41E-04	4.58E-03	2.36E-05	4.91E-04

CTE: Central Tendency Exposure (Average)
RME: Reasonable Maximum Exposure (High-end)

Table A6. ATV Riders Exposure Dose Results

COPC	Adult ATV Rider Soil Ingestion Dose (mg/kg-day)		Adult ATV Rider Particulate Inhalation Dose (mg/kg-day)		Child ATV Rider Soil Ingestion Dose (mg/kg-day)		Child ATV Rider Particulate Inhalation Dose (mg/kg-day)	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Aluminum	7.26E-05	1.51E-03	1.58E-05	4.93E-04	3.08E-04	6.41E-03	2.51E-05	7.84E-04
Antimony	3.19E-08	6.63E-07	6.94E-09	2.17E-07	1.35E-07	2.81E-06	1.10E-08	3.45E-07
Arsenic	1.21E-06	2.51E-05	2.63E-07	8.20E-06	5.12E-06	1.07E-04	4.18E-07	1.30E-05
Barium	1.24E-06	2.58E-05	2.70E-07	8.43E-06	5.27E-06	1.10E-04	4.30E-07	1.34E-05
Cadmium	1.12E-07	2.33E-06	2.44E-08	7.60E-07	4.75E-07	9.88E-06	3.88E-08	1.21E-06
Chromium	9.33E-08	1.94E-06	2.03E-08	6.34E-07	3.96E-07	8.24E-06	3.23E-08	1.01E-06
Copper	4.10E-06	8.52E-05	8.91E-07	2.78E-05	1.74E-05	3.61E-04	1.42E-06	4.42E-05
Iron	4.07E-04	8.47E-03	8.86E-05	2.76E-03	1.73E-03	3.59E-02	1.41E-04	4.40E-03
Manganese	2.83E-05	5.88E-04	6.16E-06	1.92E-04	1.20E-04	2.49E-03	9.78E-06	3.05E-04
Selenium	7.97E-08	1.66E-06	1.74E-08	5.41E-07	3.38E-07	7.04E-06	2.76E-08	8.61E-07
Silver	1.71E-07	3.55E-06	3.72E-08	1.16E-06	7.25E-07	1.51E-05	5.91E-08	1.85E-06
Thallium	1.14E-08	2.36E-07	2.47E-09	7.71E-08	4.82E-08	1.00E-06	3.93E-09	1.23E-07
Vanadium	1.37E-07	2.84E-06	2.97E-08	9.27E-07	5.79E-07	1.21E-05	4.73E-08	1.48E-06
Zinc	2.36E-05	4.91E-04	5.14E-06	1.60E-04	1.00E-04	2.08E-03	8.17E-06	2.44E-04

CTE: Central Tendency Exposure (Average)
RME: Reasonable Maximum Exposure (High-end)

Appendix B. Lead Health Risk Assessment

Lead is naturally occurring element found at low levels in soils. However, lead is ubiquitous in the environment as a result of industrial operations, which have resulted in substantially higher levels in many areas of the state. For example, lead levels in surface soils in the Standard Mine area ranges between 0.22 ppm and 64,000 ppm. These lead levels and the exposure point concentration of 6746 ppm at the Standard Mine are significantly higher than the EPA and CDPHE lead screening level of 400 ppm. Therefore, lead uptake modeling is required for the recreational exposure scenario at the Standard Mine.

Exposure Assessment

Lead exposure can occur via multiple pathways (air inhalation and ingestion of water, food, and soil). Therefore, exposure to lead is assessed based on total exposure through all pathways rather than site-specific exposures. However, a primary human exposure pathway to lead is through ingestion of soil and dust. Current knowledge of lead pharmacokinetics indicates that risk values derived by standard procedures would not truly indicate the potential risk, because of the difficulty in accounting for pre-existing body burdens of lead. Lead bioaccumulates in the body, primarily in the skeleton. Lead body burdens vary significantly with age, health status, nutritional state, maternal body burden during gestation and lactation, etc. For this reason, and because of the continued apparent lack of threshold, it is still inappropriate to develop reference values for lead.(CDC, 2004: http://www.cdc.gov/nceh/lead/spotLights/changeBLL.htm, EPA IRIS 2004). Therefore, estimation of exposure and risk from lead in soil also requires assumptions about the level of lead in other media, and also requires use of pharmacokinetic parameters and assumptions that are not needed traditionally. Thus, EPA has adopted a method that entails modeling total lead exposure (uptake/biokinetic) by incorporating input data on the levels of lead in soil, dust, water, air, and diet from multiple sources in addition to site soils. These models are discussed in later sections.

Lead has particularly significant effects in children, well before the usual term of chronic exposure can take place (EPA 2004). Children under 6 years old have a high risk of exposure because of their more frequent hand-to-mouth behavior and they absorb more lead than adults (CDC 1991). Pregnant women and women of child bearing age should also be aware of lead in their environment because lead ingested by a mother can affect the fetus. Thus, the population of most concern is young children for residential and recreational use, and pregnant women for nonresidential use (e.g., occupational and recreational.

Health Effects/Blood Lead Levels of Concern

It is important to note that risks of lead exposure are not based on theoretical calculations and are not extrapolated from data on lab animals or high-dose occupational exposures. Health effects of lead are well known from studies of children. Lead affects virtually every organ and system in the body and exhibits a broad range of health effects. The most sensitive among these are the central nervous system, hematological, and cardiovascular systems, and the kidney. However, it is particularly harmful to the developing brain and nervous system of fetuses and young children (CDC, 1991, ATSDR, 2007). It should be noted that many health effects of lead may occur without overt signs of toxicity: most poisoned children have no symptoms. Extremely high levels of lead in children (BLL of 380 ug/dL) can cause coma, convulsions, and even death. Lower levels of blood lead cause effects on the central nervous system, kidney, and hematopoietic system. Blood lead levels as low as 10 μg/dL, which do not cause distinct symptoms, are associated with decreased intelligence and impaired neurobehavioral development (CDC, 1991). Blood lead levels of 10 μg/dL or greater is considered elevated but there is no demonstrated safe level of lead in blood. A growing body of research has shown that there are measurable adverse neurological effects in children at blood lead concentrations as low as 1 μg/dL (EPA, 2003a). EPA believes that effects may occur at blood levels so low that there is essentially no threshold or "safe" level of lead (EPA IRIS, 2004). Although the concentration of lead in blood is an important indicator of risk, it reflects only current exposures. Lead is also accumulated in bone. Recent research suggests that lead concentrations in bone may be related to adverse health effects in children.

Lead is classified as a probable human carcinogen by the EPA based on sufficient evidence of carcinogenicity in animals and inadequate evidence in humans. However, no toxicity value has been derived for cancer effects and EPA has determined that noncancer effects discussed above provide a more sensitive endpoint than cancer effects to assess health risks from exposure to lead.

Health Risk Assessment

Health risks of exposure to lead are determined using predictive modeling. EPA uses two predictive lead models for risk assessment purposes: the Integrated Exposure Uptake Biokinetic (IEUBK) model for children up to the age of 7 years (EPA, 2002), and the adult lead model; ALM (EPA, 2003b) for adolescents and adults for assessing nonresidential exposures. The ALM model is designed for nonresidential exposures to lead such as female workers and recreationalists. The model is thought to be protective of the fetus, which the EPA considers the most sensitive health endpoint for adults. Whether lead risk is deemed acceptable or unacceptable is determined by comparing the predicted BLLs with target BLLs of 10 μg/dL (for fetuses and young children), established by the CDC (1991). The EPA has set a goal that there should be no more than a 5% chance that a typical (or hypothetical) child or group of similarly exposed children will exceed a blood lead value of 10 μg/dL. This approach focuses on the risk to a child at the upper bound of the distribution (i.e., 95^{th} percentile).

The IEUBK Model for Young Children (Age 0-6 years) Camping with Parents

The IEUBK model is designed to estimate the percentage of children that could have elevated blood lead levels as a result of exposure to lead in soil and dust. The model calculates the expected distribution of blood lead and estimates the probability that any random child might have a blood lead value over10 ug/dL. As shown in Table B1, Blood lead levels were estimated for children exposed 52 days/year, 20 days/year, or 12 days/year to the weighted soil lead concentrations of 2622, 1116, 763, 527, or 396 ppm, based on the site EPC of 6746 ppm and the background levels of lead at home (default assumption of 200 ppm). Thus, under the camping exposure scenario and using the calculated weighted site soil lead concentrations, the IEUBK model predicts elevated blood lead levels (above 10 ug/dL) in 4.8 to 93.0 % of young children for exposure frequencies of 12, 20, and 52 days/year evaluated in this investigation (Table B1). Therefore, exposure to lead is considered a "*public health hazard*" for young children in this assessment under the EPA default assumptions used in the model (Table B4).

The ALM Model for Outdoor Adults

The ALM model is designed to express the probability that the fetal blood lead concentration will be greater than the target blood lead value of 10 ug/dL. Table B2 shows results of the ALM using the default input parameters (Table B4) and site-specific surface soil lead concentration of 6746 ppm. For recreational activities involving the high-end soil exposures (100 mg/day soil ingestion rate), the probability that fetal blood lead will exceed target blood lead level of 10 ug/dL ranges from 2.4% to 60.5% based on the exposure frequencies of 52, 20, or 12 days/year. As already noted, based on the Technical Review Workgroup (TRW) recommendation, 3 months of exposure duration (and a minimum EF of 1day/week) is required to achieve a quasi-steady state blood lead concentration. Therefore, the minimum exposure frequency of 12 days per year is evaluated in this investigation. Therefore, exposure to lead is considered a "*public health hazard*" for outdoor adults (pregnant women) in this assessment under the EPA default assumptions used in the model. Only the exposure frequency of 12 days/year with the averaging time of 365 days result in less than a 5% probability of fetal blood lead exceeding 10 μg/dL target level (i.e., 2.4%) and can be considered a "*no apparent public health hazard*". These conclusions based on the averaging time of 365 days/year, however, are uncertain because of the uncertainty associated with a determination whether the duration of site exposure could reasonably produce a body burden of lead that results in an adverse health effect.

As shown in Table B3, for recreational activities involving the average soil exposures (50 mg/day soil ingestion rate), the probability that fetal blood lead will exceed target blood lead level of 10 ug/dL ranges from 1.1% to 29.9% based on the exposure frequencies of 52, 20, or 12 days/year. Therefore, exposure to lead for 52 or 20 days/year is considered a "*public health hazard*" for outdoor adults (pregnant women) in this evaluation under the EPA default assumptions used in the model. Only the exposure frequency of 12 days/year result in less than a 5% probability of fetal blood lead exceeding 10 μg/dL target level (i.e., 1.1% or 3.5%) and is considered a "*no apparent public health hazard*".

Uncertainty in Risks Predicted by the IEUBK and ALM Lead Models

Reliable estimates of exposure and risk using the IEUBK and ALM models depend on site-specific information for a number of key parameters, including lead concentration in outdoor soil (fine fraction) and indoor dust, soil ingestion rate, individual variability in child blood lead concentrations called Geometric Standard Deviation (GSD), and the rate and extent of lead absorption from soil. Therefore, uncertainties are discussed qualitatively here. For example, lead risks may be over- or underestimated based on the unavailable site-specific relative bioavailability of lead from soil. In assessing risks from lead exposure, the EPA assumes 60% relative bioavailability of lead in soils, which is a measure of the difference in absorption between different forms of chemical or between different dosing vehicles (e.g., lead in water, or soil). However, in the absence of site-specific data, it is prudent to use the default bioavailability assumption in order to ensure public health protection. In summary, without site-specific data, there will be uncertainty about how well the risk estimates predicted by computer modeling based on the default parameters reflect the true conditions at a site.

In addition, it is important to keep in mind that evidence is growing that there are measurable adverse neurological effects in children at blood lead concentrations as low as 1 ug/dL (EPA, 2003a). This suggests that the target blood lead level of 10 ug/dL in fetuses and young children for the IEUBK model and ALM model may result in underestimation of lead hazards at the Standard Mine site.

Appendix B References

ATSDR (2007). Toxicological Profile for Lead.

CDC (1991). Preventing lead poisoning in young children. Atlanta, GA: Us Depaertment of Health and Human Services, PHS, Centers for Disease Control and Prevention. (http://www.cdc.gov/nceh/lead/publications/books/plpyc/contents.htm
Environmental Protection Agency (EPA, 2002).

User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). OSWER Directive 9285.7-42. EPA 540-K-01-005. USEPA, Office of Emergency and Remedial Response, Washington, DC.

Environmental Protection Agency (EPA, 2003a). *America's Children and the Environment: Measures of Contaminants, Body Burden and Illnesses, Second Edition*.

Environmental Protection Agency (EPA 2003b). *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*. EPA-540-R-03-001. USEPA, Technical Review Workgroup, Washington, DC.

Environmental Protection Agency, Integrated Risk Information System (EPA IRIS 2004). *Lead and Compounds*. http://www.epa.gov.iris.

Table B1. The IEUBK Model Estimated Risk to Young Children (0-84 months) from Exposure to Site-Specific Surface Soil and Dust During Seasonal Camping with Parents: Percentage of Children that Exceed the Target Average Blood Lead Level of 10 μg/dL for variable exposure frequency and averaging time, Based on the Default Assumptions.

Exposure Frequency [a] (Days/Year)	Averaging Time [b] (Days/Year)	Weighted Site Soil Lead Concentration [c] (PPM)	Age Group (Months)	Geometric Mean PbB Concentration (μg/dL)	Percent of Population > 10 μg/dL
52	140	2622	0-84	20.03	93.03*
52	365	1116	0-84	9.82	48.46*
20	140	1116	0-84	9.82	48.46*
20	365	527	0-84	5.36	11.12*
12	140	763	0-84	7.42	26.23*
12	365	396	0-84	4.57	4.82
12	140		0-12	7.42	26.31*
12	140		12-24	9.40	44.72*
12	140		24-36	8.78	39.12*
12	140		36-48	8.42	35.70*
12	140		48-60	6.95	21.92*
12	140		60-72	5.82	12.48*
12	140		72-84	5.12	7.70*

Note: Please see Table F4 for details of exposure/input parameters for the IEUBK model. It should be noted that a variable GSD of 1.4 (vs. default of 1.6) did not change the conclusions for different categories of exposure frequency as presented in the last column of %population >10μg /dL(data not shown).

*Indicates blood lead levels exceed EPA's goal of 5% (i.e., No hypothetical child to have more than a 5% chance of exceeding a blood lead level of 10μg /dL).

[a] For example, Exposure frequency of 52 days/year = 2.7 days/week for 4 weeks/month over 5 months.

[b] Averaging Time of 140 days = 7days/week x 4 week/month x 5months, and the "washout" period of the 7 months is not considered based on the assumption that the exposure to high lead during the exposure season of 5 months could reasonably produce a body burden of lead that results in adverse health effects. Note that the AT of 365 days/year was also used in order to address the effect of the 7 months of the year when site exposure does not occur, and the uncertainty associated with a determination whether the duration of site exposure could reasonably produce a body burden of lead that results in an adverse health effect. Note that based on the TRW recommendation, 3 months of exposure duration (and a minimum EF of 1day/week) is adequate to achieve a quasi-steady state blood lead concentration.

[c] Weighted Site Soil Lead concentration calculated in accordance with the intermittent exposure guidance (EPA, 2003b), based on the site EPC of 6746 ppm and the assumption of home lead concentration of 200 ppm (default for the IEUBK model). For example, lead site concentration of 2622 ppm is calculated as follow:
F_{site} = 52 days/140 days = 0.37
F_{home} = 1-0.37 = 0.63
Lead site = 0.37 x 6746 (lead EPC) = 2496 ppm
Lead home = 0.63 x 200 ppm (default) = 126 ppm
Lead site weighted (PbS w) = 2496+126 = 2622 ppm

Table B2. The ALM Model Results for Adults Recreational Activities with The <u>High-End Exposure to Soil (100 mg/day)</u>: Probability of Fetal Blood Lead (PbB) >10 μg /dL and the 95th Percentile PbB among Fetuses of Adult Recreationalists

Exposure Frequency [a] **(days/year)**	**Averaging Time** [b] **(days/year)**	**95th percentile fetal PbB (μg/dL)**	**Probability of fetal PbB >10 μg/dL**
52	140	41.3	60.5%*
52	365	18.6	21.0%*
20	140	18.7	21.1%*
20	365	10.0	5%
12	140	13.0	9.9%*
12	365	7.8	2.4%

Note: Please see Table F5 for details of exposure/input parameters for the ALM model.

*Indicates fetal blood lead levels exceed EPA's goal of 5% (i.e., EPA's goal is that the probability of a fetal blood lead concentration exceeding health based level of 10μg /dL is less than or equal to 5%)

[a] For example, Exposure frequency of 52 days/year = 2.7 days/week for 4 weeks/month over 5 months.

[b] Averaging Time of 140 days = 7days/week x 4 week/month x 5months, and the "washout" period of the 7 months is not considered based on the assumption that the exposure to high lead during the exposure season of 5 months could reasonably produce a body burden of lead that results in adverse health effects. Note that the AT of 365 days/year was also used in order to address the "washout" effect of the 7 months of the year when site exposure does not occur, and the uncertainty associated with a determination whether the duration of site exposure could reasonably produce a body burden of lead that results in an adverse health effect

Table B3. The ALM Model Results for Adults Recreational Activities With The Average Exposure to Soil (50 mg/day): Probability of Fetal Blood Lead (PbB) >10 μg /dL and the 95th Percentile PbB among Fetuses of Adult Recreationalists

Exposure Frequency [a] (days/year)	Averaging Time [b] (days/year)	95th percentile fetal PbB (μg/dL)	Probability of fetal PbB >10 μg/dL
52	140	22.9	29.9%*
52	365	11.6	7.4%*
20	140	11.6	7.5%*
20	365	7.3	1.9%
12	140	8.8	3.5%
12	365	6.2	1.1%

Note: Please see Table F5 for details of exposure/input parameters for the ALM model.
* Indicates fetal blood lead levels exceed EPA's goal of 5% (i.e.,EPA's goal is that the probability of a fetal blood lead concentration exceeding health based level of 10μg /dL is less than or equal to 5%).
[a] For example, Exposure frequency of 52 days/year = 2.7 days/week for 4 weeks/month over 5 months.
[b] Averaging Time of 140 days = 7days/week x 4 week/month x 5months, and the "washout" period of the 7 months is not considered based on the assumption that the exposure to high lead during the exposure season of 5 months could reasonably produce a body burden of lead that results in adverse health effects. Note that the AT of 365 days/year was also used in order to address the "washout" effect of the 7 months of the year when site exposure does not occur, and the uncertainty associated with a determination whether the duration of site exposure could reasonably produce a body burden of lead that results in an adverse health effect

Table B4. Default Input Parameters for the IEUBK Model for exposure to Residential Children

Exposure variable	EPA Default Value
Groundwater concentration (Cgw)	4.0 μg/L
Dust Fraction	70% (0.70)
Geometric standard deviation (GSD) or interindividual variability	1.6
Soil Concentration (ppm)	Site-specific Time-Weighted
FDA dietary parameters	Downloaded from the EPA TRW website
Relative bioavailability	60%

Table B5. Input Parameters for the ALM Model for Adult Outdoor Recreational Activities

Exposure Variable	Equation 1		Description of Exposure Variable	Units	Using Equation 1
	1*	2**			GSDi = Hom
PbS	X	X	Soil lead concentration	ug/g or ppm	6746
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.1
PbB_0	X	X	Baseline PbB	ug/dL	1.5
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05 or 0.100
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	5, 20, or 52 (site-specific)
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/yr	140 or 365 (site-specific)

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S.D}) + PbB_0$
$PbB_{fetal, 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

Appendix C. Derivation of Particulate Emission Factor for ATV Riders

The calculation for inhalation of resuspended soil particles during ATV riding requires that a particulate emission factor (PEF) be estimated, which describes the amount of dust generated by an ATV. The amount of dust generated is dependent on a number of factors including, but not limited to, speed, type of vehicle, and the type of soil. Without site-specific sampling data, it is very difficult to determine the actual amount of dust generated by ATVs at the site. An extensive amount of research was conducted to identify sources, which could be used to derive the PEF. Only one source of sampling data was found that could be used to derive the PEF for ATVs. This data set was collected at the former Quincy Smelter Site in Houghton, Michigan by the USEPA (ATSDR 2006). The same dataset has been used in the EPA Region 8 Draft Risk Assessment for this site (SRC, 2007). It should be noted that the soils encountered in this study are likely very different from the soils at the Standard Mine site. However, it was concluded that the use of this data set would most accurately represent the PEF since the data was collected while ATVs were in use.

The data was collected by equipping an ATV with a dust-sampling device while following another ATV up and down a trail over a period of approximately 4.5 hrs. The total dust sampling ranged from 18.7 $\mu g/m^3$ to 23,359 $\mu g/m^3$ during this time. A number of factors could contribute to the large variation in total dust concentration including distance from the lead ATV, speed, and wind conditions. The mean concentration of the data was utilized to account for this variation. This is a conservative approach since the arithmetic mean is biased high in this case. The mean total dust concentration is 3,375 $\mu g/m^3$ (SRC 2007). This concentration was converted to kg/m^3 for the dose calculation as shown below.

Another issue with calculating the PEF is the percentage of particulate matter that is considered inhalable in total dust. The inhalable fraction generally refers to particulate matter with a geometric diameter of 10 μm or less (PM_{10}). Larger particles are typically filtered out in the nose and mouth prior to entering the airways and are not particularly relevant in terms of public health. The PM_{10} fraction is largely dependant on soil type, the silt content of the soil, and the soil moisture content (EPA 2006). Again, without site-specific data to determine the concentration of PM_{10} in the total dusts samples, it is impossible to determine the actual fraction of PM_{10}. Therefore, it was assumed that the concentration of PM_{10} is 100% of the total dust samples. This is thought to be a conservative assumption since the actual concentration of PM_{10} is likely less than 100%. However, it is possible that the concentration of PM_{10} is more than the mean value if the sampling is not representative of the actual dust concentration at the Standard Mine Site. With these data and assumptions in hand, the PEF for ATV riding can be calculated as shown below.

$PEF_{ATV} = C_{PM10} * CF$
Where $CF = 1 * 10^{-9}$ kg/µg
$C_{PM10} =$ 3,375 µg/m^3

Thus,
$PEF_{ATV} =$ 3.37E-06kg/m^3

Once the PEF has been calculated, the chemical concentration in air is derived by multiplying the exposure point concentration of surface soil COPCs by the PEF as shown below.

$C_a = C_s * PEF$

Where C_s = Exposure Point Concentration in Surface Soil
For example,
Cs for Mn= 2888 mg/kg
Ca for Mn = 2888 x 3.37E-06kg/ m^3 = 9.82E-03 mg/m^3

USEPA (2006). Office of Air and Radiation. Compilation of Air Pollutant Emission Factors. AP-42 5th Edition Section 13 Unpaved Roads, January 1995. Updated November 2006.

Appendix D. Toxicological Evaluation

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on dose. The toxic effects of a chemical also depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (acute, subchronic, chronic or lifetime). The major contaminants of concern identified in this consultation are lead and arsenic. Lead can affect nearly every system of the body with the main target organ systems being the nervous system. Lead health effects are particularly important for young children and pregnant mothers. Arsenic is classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC) meaning that it is a known human carcinogen. It is important to note that estimates of human health risks may be based on evidence of health effects in humans and/or animals depending upon the availability of data. The toxicity assessment process is usually divided into two parts: the cancer effects and the non-cancer effects of the chemical.

The USEPA and the ATSDR has established oral reference dose (RfD) and minimal risk levels (MRL) for non-cancer effects. An RfD is the daily dose in humans (with uncertainty spanning perhaps an order of magnitude), including sensitive subpopulations, that is likely to be without an appreciable risk of non-cancer adverse health effects during a lifetime of exposure to a particular contaminated substance. An MRL is the dose of a compound that is an estimate of daily human exposure that is likely to be without an appreciable risk of adverse non-cancer effects of a specified duration of exposure. The acute, intermediate, and chronic MRLs address exposures of 14 days or less, 14 days to 365 days, and 1-year to lifetime, respectively.

The USEPA has also established in the EPA Integrated Risk Information System an oral cancer slope factor of 1.5 per mg/kg/day for lifetime exposures to arsenic. In addition, cadmium and chromium (VI) are considered Class 1 carcinogens by the IARC for inhalation exposures. Estimating the cancer slope factor is often complicated by the fact that observable increases in cancer incidence usually occur only at relatively high doses. Therefore, it is necessary to use mathematical models to extrapolate from the observed high dose data to the desired slope at low dose. In order to account for the uncertainty in this extrapolation process, EPA typically chooses to employ the upper 95th confidence limit of the cancer slope as the Slope Factor. That is, there is a 95% probability that the true cancer potency is lower than the value chosen for the Slope Factor.

The health-based guidelines and cancer slope factors used for this evaluation are listed below.

Oral Health-based Guidelines

Contaminant	Health-based Guideline (mg/kg-day)	Source
Aluminum	1.0	NCEA Provisional Value
Antimony	0.0004	EPA IRIS
Arsenic	0.0003	EPA IRIS
Barium	0.2	EPA IRIS
Cadmium	0.001	ATSDR Chronic MRL (food)
Chromium	0.003	EPA IRIS
Copper	0.04	HEAST
Iron	0.7	NCEA Provisional Value
Manganese	0.02	EPA IRIS
Selenium	0.005	EPA IRIS
Silver	0.005	EPA IRIS
Thallium	0.000066	EPA Region 9 Cal-adjusted value
Vanadium	0.001	NCEA Provisional Value
Zinc	0.3	EPA IRIS

NCEA: National Center for Environmental Assessments
HEAST: Health Effects Summary Tables

Inhalation Health-Based Guidelines

Contaminant	Health-based Guideline (mg/kg-day)	Source
Aluminum	0.0014	NCEA Provisional Value
Barium	0.00014	HEAST
Cadmium	0.000057	NCEA Provisional Value
Chromium	0.00003	EPA IRIS
Manganese	0.0000143	EPA IRIS

NCEA: National Center for Environmental Assessments
HEAST: Health Effects Summary Tables

Cancer Slope Factors

Contaminant	Route of Exposure	Cancer Slope Factor (mg/kg-day^{-1})	Source
Arsenic	Oral	1.5	EPA IRIS
Arsenic	Inhalation	15	EPA IRIS
Cadmium	Inhalation	6.3	EPA IRIS
Chromium	Inhalation	41	EPA IRIS

Appendix E. Standard Mine Community Land Use Survey

Reproduced here from Author's permission
Community Interviews for Determining
Land Use at the Standard Mine Site
Crested Butte, Colorado – July 27, 2006
Written by Libby Faulk of the EPA (Region 8)

Interview Summary and Area Statistics

Interviews were voluntary and done by phone, email, and in person. There were three public notices in the newspaper and fact sheets posted throughout the town to make the community aware of EPA's interest in information about recreational use at the Standard Mine. The following is a summary of the responses to the 9 questions as well as information on the demographics of those that responded:

Total Adult Responders – 29
20 to 29 – 4
30 to 39 – 2
40 to 49 – 6
50 to 59 – 8
60 to 69 – 1
70 to 69 – 1
No age given – 7

Number of Males responders – 11
Number of Female responders – 18

According to the 2000 U.S. Census, Crested Butte population breakout was the following:

Crested Butte town, Colorado Statistics and Demographics (US Census 2000)

	Number	Percent
Crested Butte Population:	1529	100.00%
Sex and Age		
Male	848	55.46%
Female	681	44.54%
Under 5 years	59	3.86%
5 to 9 years	46	3.01%
10 to 14 years	60	3.92%
15 to 19 years	56	3.66%
20 to 24 years	162	10.6%
25 to 34 years	590	38.59%
35 to 44 years	260	17%
45 to 54 years	207	13.54%
55 to 59 years	43	2.81%
60 to 64 years	17	1.11%
65 to 74 years	22	1.44%
75 to 84 years	7	0.46%
85 years and over	0	0%
Median age (years)	30.6	

<u>Questions and Responses</u>

Current Land Use

1. What are the current land uses at the Standard Mine Site? (check all that apply)

    - Residential
    - Commercial/Industrial
    - Recreational
    - Other (Please specify)

All 29 responders believed recreational was one of the current land uses taking place at our around the Standard Mine Site. Of the responses received, 6 believed there was some level of commercial activity taking place in the area such as hiking tours. Of the responses received, 4 responders believed there's current residential use in the area.

2. For those land uses checked above, except residential, what type of activities do people engage in?

- ATV and motorcycle riding
- Hiking, mountain biking
- Camping
- Skiing, Snowmobiling
- Fishing
- Mining
- Other (please specify)

Of the choices above, we received the following response:

- ATV and motorcycle riding – 14
- Hiking, mountain biking – 28
- Camping – 6
- Skiing, Snowmobiling – 17
- Fishing – 0
- Mining – 0
- Other (please specify)
    1. horseback riding
    2. rock hounding
    3. biomonitoring
    4. snowboarding
    5. hiking with dog who may be drinking the water
    6. One responder witnessed a jeep in the area.

3. How often do people engage in the activities checked above? (please specify for all activities checked above)

- Number of hours per event
- Number of days per year
- Number of years

Many responders were not sure how long people spend time in the Standard Mine area but most responders felt that the time spent would be very little. The reason stated for this is because they believed most people would just be passing through the site and not hanging around the site itself. For those that did respond, they responded with the following:

- Number of hours per event – under 5 hours per event with the exception of one response that state 10 hours per event and another 24 hours or more. The person that responded with 24 hours or more has property in the area.
- Number of days per year
  - Under 5 days – 11
  - 6 to 10 days – 3
  - 11 to 15 days – 2
  - 16 to 20 days – 0
  - Over 20 days – 1

  * One person that responded stated she was up there 250 to 300 times per year.
- Number of years
  - 1 to 5 yrs. – 9
  - 6 to 10 yrs. – 3
  - 11 to 20 yrs. – 3
  - Over 20 yrs. – 5

General Comments Received:

- The numbers may be increasing because of the interest around the clean-up of the mine and people wanting to see what the ruckus is all about.
- For mountain bikers under an hour and for motorized users maybe more time.
- Some probably just pass right on through or turnaround because they missed the trail head to Copley Lake.

4. Do you bring your children with you? If so, what are their ages?

Of those that responded to this question, 12 do not have children. For those that have children, 11 of them said they do not take their children with them to that area and one said their child has only been to Copley Lake which is below the Standard Mine, another responder said she took her daughter there once at age 11 but she’s now 28, and one responder said that her kids have been up in the area a long time ago but not recently. Her children are now ages 14 and 18. I did not get the ages of the children where the parents stated that they have never taken their children up to the Standard Mine site.

General Comments:

- The area of hiking is too steep for children to hike.
- Don’t have any and have never seen any up there when I’ve been up there. It seems that the hike would be too steep for children.
- Too far up and steep.
- Only up to Copley Lake

- We shouldn't assume that children are not hiking in the area because there are quite a few families that do lots of hiking in the area.
- You'll see kids on ATVs and motorbikes riding around.

5. If you fish, where do you fish? (Please describe location of where on site fishing is occurring, for example, at the site itself, along Elk Creek below the site, Coal Creek).

No one responded as having fished in the area.

6. How many fish do you catch each year from this site? Do you eat all of the fish you catch? When you prepare the fish, do you prepare just the fillets or do you include other parts of the fish?

See response to #5 above.

Future Land Use

1. What do you think are the most likely land uses for the Standard Mine site in the future? (Check all that apply)

    - Residential
    - Commercial/Industrial
    - Recreational
    - Other (please specify)

All 29 responders believed that in the future, recreational use would continue to be the main use in and around the Standard Mine area. Of all the responders, 9 of the responders felt that residential development could occur in the area, 7 felt there could be commercial interest such as tours in the area.

2. For each of the land uses checked above, please explain the basis for your answer. For example, if residential land use is checked, is this based on zoning ordinances, county planning, recent property purchases, development plans, etc.

Many of the responses received to this question were the same from each responder. The comments received were the following:

- Continue to be the same recreational activities as is occurring in the area now.
- There could be an increase in commercial activity for touring in the area.
- The Township of Irwin is close by and growing and so residential development is bound to spill over into the Elk Basin area.

- There's private property in the area so there will probably be an increase in residential development at some point.
- You may see more tours for historical and educational purposes.
- Recreational only - Climate, location and elevation.
- Will depend on road improvements to the area that would make it more accessible.
- Doubts much due to steepness of the area and difficulty in getting to the mine site.
- Recreational only - Location, terrain, and precipitation.
- Recreational only – location, accessibility, and demand.

3. For those land uses checked above, except residential, what are the most likely activities you think people may engage in?

    - ATV and motorcycle riding
    - Hiking, mountain biking
    - Camping
    - Skiing, Snowmobiling
    - Fishing
    - Mining
    - Other (please specify)

Of the choices above, we received the following response:

- ATV and motorcycle riding – 17
- Hiking, mountain biking – 29
- Camping – 10
- Skiing, Snowmobiling – 19
- Fishing – 0
- Mining – 0
- Other (please specify)
    1. horseback riding
    2. biomonitoring
    3. educational tours (hiking)
    4. Jeeps 4-wheeling
    5. rock hounding
    6. hunting

General Comments Received:

- Camping may increase but probably around Copley Lake and not up at the mine site itself.

Other general suggestions or comments that responder's mentioned during the interviews or on their interview sheet were:

1. If the U.S.F.S would clearly mark the trail head to Copley Lake, less people would end up at the Standard Mine site.

2. Someone should evaluate the risk of hunting wildlife in and around the Standard Mine site because the elk and deer in the area probably drink out of the creek and pond. What would the mean for someone who eventually ate the elk or deer?

3. People probably don't typically come across the mine because it's not easy to stumble across.

4. There's a lot of private property in the area making it difficult to get to the site without crossing over someone's property.

5. There are gates in various areas making it difficult to get to the site.

6. We think that somewhere between 175 to 200 mountain bikers visit the Gunsight Pass/Standard Mine/Scarps Ridge area in a summer. If there was a more defined route from the top of Gunsight through the Standard Mine site down Elk Creek to Kebler the area would probably see more use. I think many folks believe there are private property issues through the area.

Appendix F. ToxFAQs

Appendix F1. Arsenic ToxFAQ

Highlights

Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of “pins and needles” in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small “corns” or “warts” on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys.

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How does arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce their risk for exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to show whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

- The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.
- The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic *(Update)*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-32
Atlanta, GA 30333
Phone: 1-800-CDC-INFO • 888-232-6348 (TTY)

FAX: 770-488-4178
Email: cdcinfo@cdc.gov

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Appendix F2. Copper ToxFAQ

Highlights

Copper is a metal that occurs naturally in the environment, and also in plants and animals. Low levels of copper are essential for maintaining good health. High levels can cause harmful effects such as irritation of the nose, mouth and eyes, vomiting, diarrhea, stomach cramps, nausea, and even death. Copper has been found in at least 906 of the 1,647 National Priority Sites identified by the Environmental Protection Agency (EPA).

What is copper?

Copper is a metal that occurs naturally throughout the environment, in rocks, soil, water, and air. Copper is an essential element in plants and animals (including humans), which means it is necessary for us to live. Therefore, plants and animals must absorb some copper from eating, drinking, and breathing.

Copper is used to make many different kinds of products like wire, plumbing pipes, and sheet metal. U.S. pennies made before 1982 are made of copper, while those made after 1982 are only coated with copper. Copper is also combined with other metals to make brass and bronze pipes and faucets.

Copper compounds are commonly used in agriculture to treat plant diseases like mildew, for water treatment and, as preservatives for wood, leather, and fabrics.

What happens to copper when it enters the environment?

- Copper is released into the environment by mining, farming, and manufacturing operations and through waste water releases into rivers and lakes. Copper is also released from natural sources, like volcanoes, windblown dusts, decaying vegetation, and forest fires.
- Copper released into the environment usually attaches to particles made of organic matter, clay, soil, or sand.
- Copper does not break down in the environment. Copper compounds can break down and release free copper into the air, water, and foods.

How might I be exposed to copper?

- You may be exposed to copper from breathing air, drinking water, eating foods, or having skin contact with copper, particulates attached to copper, or copper-containing compounds.
- Drinking water may have high levels of copper if your house has copper pipes and acidic water.
- Lakes and rivers that have been treated with copper compounds to control algae, or that receive cooling water from power plants, can have high levels of copper.

Soils can also contain high levels of copper, especially if they are near copper smelting plants.

- You may be exposed to copper by ingesting copper-containing fungicides, or if you live near a copper mine or where copper is processed into bronze or brass.
- You may be exposed to copper if you work in copper mines or if you grind metals containing copper.

How can copper affect my health?

Everyone must absorb small amounts of copper every day because copper is essential for good health. High levels of copper can be harmful. Breathing high levels of copper can cause irritation of your nose and throat. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very-high doses of copper can cause damage to your liver and kidneys, and can even cause death.

How likely is copper to cause cancer?

We do not know whether copper can cause cancer in humans. The EPA has determined that copper is not classifiable as to human carcinogenicity.

How can copper affect children?

Exposure to high levels of copper will result in the same type of effects in children and adults. We do not know if these effects would occur at the same dose level in children and adults. Studies in animals suggest that the young children may have more severe effects than adults, but we don't know if this would also be true in humans. There is a very small percentage of infants and children who are unusually sensitive to copper.

We do not know if copper can cause birth defects or other developmental effects in humans. Studies in animals suggest that high levels of copper may cause a decrease in fetal growth.

How can families reduce the risk of exposure to copper?

The most likely place to be exposed to copper is through drinking water, especially if your water is corrosive and you have copper pipes in your house. The best way to lower the level of copper in your drinking water is to let the water run for at least 15 seconds first thing in the morning before drinking or using it. This reduces the levels of copper in tap water dramatically.

If you work with copper, wear the necessary protective clothing and equipment, and always follow safety procedures. Shower and change your clothes before going home each day.

Is there a medical test to show whether I've been exposed to Copper?

Copper is found throughout the body; in hair, nails, blood, urine, and other tissues. High levels of copper in these samples can show that you have been exposed to higher- than normal levels of copper. These tests cannot tell whether you will experience harmful effects. Tests to measure copper levels in the body are not usually available at a doctor's office because they require special equipment, but the doctor can send samples to a specialty laboratory.

Has the federal government made recommendations to protect human health?

- The EPA requires that levels of copper in drinking water be less than 1.3 mg of copper per one liter of drinking water (1.3 mg/L).
- The U.S. Department of Agriculture has set the recommended daily allowance for copper at 900 micrograms of copper per day (µg/day) for people older than eight years old.
- The Occupational Safety and Health Administration (OSHA) requires that levels of copper in the air in workplaces not exceed 0.1 mg of copper fumes per cubic meter of air (0.1 mg/m3) and 1.0 mg/m^3 for copper dusts.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological Profile for Copper. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

For more information, contact:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-32
Atlanta, GA 30333

Phone: 1-800-CDC-INFO • 888-232-6348 (TTY)
FAX: 770-488-4178
Email: cdcinfo@cdc.gov

Appendix F3. Lead ToxFAQs

Highlights

Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Children can be exposed from eating lead-based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system. Lead has been found in at least 1,272 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is lead?

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing.

Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States.

What happens to lead when it enters the environment?

- Lead itself does not break down, but lead compounds are changed by sunlight, air, and water.
- When lead is released to the air, it may travel long distances before settling to the ground.
- Once lead falls onto soil, it usually sticks to soil particles.
- Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil.

How might I be exposed to lead?

- Eating food or drinking water that contains lead. Water pipes in some older homes may contain lead solder. Lead can leach out into the water.
- Spending time in areas where lead-based paints have been used and are deteriorating. Deteriorating lead paint can contribute to lead dust.

- Working in a job where lead is used or engaging in certain hobbies in which lead is used, such as making stained glass.
- Using health-care products or folk remedies that contain lead.

How can lead affect my health?

The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. Highlevel exposure in men can damage the organs responsible for sperm production.

How likely is lead to cause cancer?

We have no conclusive proof that lead causes cancer in humans. Kidney tumors have developed in rats and mice that had been given large doses of some kind of lead compounds. The Department of Health and Human Services (DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans.

How does lead affect children?

Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint, or swallowing house dust or soil that contains lead.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child’s mental and physical growth.

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

How can families reduce the risk of exposure to lead?

- Avoid exposure to sources of lead.
- Do not allow children to chew or mouth surfaces that may have been painted with lead-based paint.
- If you have a water lead problem, run or flush water that has been standing overnight before drinking or cooking with it.
- Some types of paints and pigments that are used as make-up or hair coloring contain lead. Keep these kinds of products away from children.
- If your home contains lead-based paint or you live in an area contaminated with lead, wash children’s hands and faces often to remove lead dusts and soil, and regularly clean the house of dust and tracked in soil.

Is there a medical test to show whether I've been exposed to lead?

A blood test is available to measure the amount of lead in your blood and to estimate the amount of your recent exposure to lead. Blood tests are commonly used to screen children for lead poisoning. Lead in teeth or bones can be measured by X-ray techniques, but these methods are not widely available. Exposure to lead also can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. EP is a part of red blood cells known to increase when the amount of lead in the blood is high. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below about 25 micrograms per deciliter (μg/dL). These tests usually require special analytical equipment that is not available in a doctor's office. However, your doctor can draw blood samples and send them to appropriate laboratories for analysis.

Has the federal government made recommendations to protect human health?

The Centers for Disease Control and Prevention (CDC) recommends that states test children at ages 1 and 2 years. Children should be tested at ages 3–6 years if they have never been tested for lead, if they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and

Children, if they live in a building or frequently visit a house built before 1950; if they visit a home (house or apartment) built before 1978 that has been recently remodeled; and/or if they have a brother, sister, or playmate who has had lead poisoning. CDC considers a blood lead level of 10 µg/dL to be a level of concern for children.

EPA limits lead in drinking water to 15 µg per liter.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Lead *(Update)*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE, Mailstop F-32
Atlanta, GA 30333
Phone: 1-888-42-ATSDR (1-888-422-8737)
FAX: (770)-488-4178
Email: ATSDRIC@cdc.gov

For more information, contact:

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Appendix G: ATSDR Public Health Hazard Categories

Category / Definition	Data Sufficiency	Criteria
A. Urgent Public Health Hazard This category is used for sites where short-term exposures (< 1 yr) 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* indicates 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 presence of serious physical or safety hazards.
B. Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) 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 or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.**
C. Indeterminate Public Health Hazard **This category is used for sites in which "*critical*" data are *insufficient* with regard to extent of exposure and/or toxicologic 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 must 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.**
D. No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated 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 to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
E: 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 contaminated media have occurred, none are now occurring, and none are likely to occur in the future**	

CERTIFICATION

This Health Consultation was prepared by the Colorado Department of Public Health and Environment 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 health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Jennifer A Freed

Jennifer Freed
Technical Project Officer
CAT, SPAB, DHAC, ATSDR

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

Alan W. Yarbrough

Alan Yarbrough
Team Lead
CAT, SPAB, DHAC, ATSDR