Health Consultation

Public Health Implications of Exposure to
Mining Related Surface Soil Contaminants

UTE-ULAY TOWNSITE, AN EPA TARGETED
BROWNFIELD ASSESSMENT SITE

LAKE CITY, HINSDALE COUNTY, COLORADO

Prepared by the
Colorado Department of Public Health and Environment

FEBRUARY 13, 2013

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

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Foreword

The Colorado Department of Public Health and Environment's (CDPHE) Colorado Cooperative Program for Environmental Health Assessments has prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the United States 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 public health departments 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) 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, please contact the author of this document or the Principal Investigator/Program Manager of the CCPEHA:

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Statement and Summary of Issues

Introduction

The Colorado Cooperative Program for Environmental Health Assessments' (CCPEHA) and the Agency for Toxic Substances and Disease Registry's (ATSDR) top priority is to ensure that all stakeholders have the best health information possible to protect the public from current and future health hazards associated with environmental contamination at the Ute-Ulay Townsite in Hinsdale County, Colorado.

The Ute-Ulay mine and mill complex is a historic mining camp located near Lake City in the San Juan Mountains in southwestern Colorado. Mining at the Ute-Ulay began around 1874 and continued intermittently through 1900. During the 20th century, the complex changed hands a number of times and was primarily used for milling material from surrounding mines. In 1983, LKA International Incorporated purchased the Ute-Ulay to conduct milling operations. Following a period of inactivity at the site, LKA International and Hinsdale County began discussing the potential renovation and restoration of the Ute-Ulay. The site then became the focus of a Targeted Brownfields Assessment (TBA).

Lake City Downtown Improvement and Revitalization Team (DIRT) and Colorado Art Ranch collaborated to establish a future vision for the Ute-Ulay. "The Hardrock Revision: A Transdisciplinary Collaboration Envisioning Uses for an Inactive Hard Rock Mine in Hinsdale County, CO", was published in April 2011 documenting the work of a group that consists of artists, poets, scientists, community members, landscape architects, and historians. Some of the proposed plans include transforming the historic miners' boardinghouse and cabins into a hostel, interpretive tours that focus on historic mine features, geology, native plants and animals; and converting the original redwood water tank into a camera obscura amongst a number of other ideas.

In January 2012, a 4-acre parcel of the total 285-acre complex that is referred to as the "Townsite", was officially announced for donation to Hinsdale County by LKA International. A Phase II Environmental Site Assessment (ESA) was conducted by the CDPHE Hazardous Materials and Waste Management Division (HMWMD) to characterize site related contamination in the Ute-Ulay "Townsite". The ESA identified a 1,500 cubic foot waste rock pile and an area of graded ore as the two major sources of contamination found at the site. The remainder of the site consists of the historic mine structures and what appears to be native soil. Due to the imminent reuse plans for the site and the increased potential for exposure after redevelopment, the HMWMD requested the assistance of the CCPEHA to evaluate the public health implications of future exposures to site-related contamination.

The purpose of this health consultation is to identify any potential public health hazards associated with future exposure to site-related contamination based on what is currently known about the future land-use at the site, and to make recommendations to protect public health and inform stakeholders. In this evaluation, child and adult short-term recreational users and adult hostel workers were used as the representative future exposure scenarios that are likely to occur. Estimated exposure to lead in surface soil, waste rock, and graded ore, based on lead uptake models, was identified as the primary contaminant of potential concern.

Overview

CCPEHA and ATSDR have reached four conclusions regarding future exposure to site-related contamination at the Ute-Ulay Townsite.

Conclusion 1

Exposure to lead in soil during recreational use of the Ute-Ulay Townsite could harm the health of children (age 0-84 months).

Basis for Decision

This conclusion was reached because the results of the Integrated Exposure Uptake Biokinetic (IEUBK) model predicted blood lead levels in young children that are well above CDC's reference blood lead level in all exposure units (EU). Exposure to lead in EU1 and EU3 during recreational activities presents the greatest concern for elevated blood lead levels in children at the site. CDC's new reference blood lead level is 5 µg/dL for children and the fetus of pregnant women. The EPA has currently 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 reference blood lead level. Thus, if the lead models predict that more than 5% of exposed children and the fetus of pregnant women have estimated blood levels greater than 5 µg/dL, it is expected to harm the health of young children. The predicted geometric mean blood lead level for recreational use by children at EU1 is 9.0 µg/dL with an estimated 89.6% of all children having blood lead levels greater than 5 µg/dL. In EU3, the model estimated that 48.4% of children using the site for recreational purposes would have blood lead levels greater than 5 µg/dL with an estimated geometric mean blood lead level of 4.9 µg/dL. In EU2 and EU4, the IEUBK model results were lower than those predicted for EUs 1and 3, but still exceeded CDC's reference blood lead level and/or EPA's 5% probability limit.

Conclusion 2

Exposure to lead in EU1 and EU3 could harm the health of the fetus of pregnant women using these areas for recreational purposes.

Basis for Decision

This conclusion was reached because the EPA Adult Lead Model (ALM) predicted elevated blood lead levels in the fetus of pregnant women exposed to lead during recreational activities in EU1 and EU3. In EU1, the ALM predicted a geometric mean blood lead concentration in the fetus of 5.6 µg/dL and that 44.2% of all pregnant women would have fetal blood lead concentrations greater than 5 µg/dL. In EU3, the ALM predicted a geometric mean blood lead concentration in the fetus of 2.8 µg/dL and that 14.0% of all pregnant women would have fetal blood lead concentrations greater than 5 µg/dL. Both of these outputs are above CDC's target for lead. On the contrary, exposure to lead in EU2 and EU4 during recreational activities did not predict >5% probability of elevated fetal blood lead levels (i.e., not expected to harm the health of the fetus of pregnant).

Conclusion 3

Exposure to lead in all EUs at the Ute-Ulay Townsite could harm the health of the fetus of pregnant hostel workers.

Basis for Decision

This conclusion was reached because the ALM predicted >5% probability of fetal blood lead levels of pregnant hostel workers well above CDC's reference blood lead level in all exposure units. Specifically, exposure to lead in EU1 and EU3 presents the greatest concern for elevated fetal blood lead levels. In EU1, the ALM predicted a geometric mean blood lead concentration in the fetus of 46.9 µg/dL and that 99.7% of all pregnant female hostel workers would have fetal blood lead concentrations greater than 5 µg/dL. In EU3, the ALM predicted a geometric mean blood lead concentration in the fetus of 14.6 µg/dL and that 87.6% of all pregnant female hostel workers would have fetal blood lead concentrations greater than 5 µg/dL. In EU2 and EU4 the estimated fetal blood lead levels of pregnant hostel workers is lower than those predicted for EUs 1 and 3, but are still in excess of CDC's reference blood lead level.

Conclusion 4

Exposure to metal contaminants other than lead at the Ute-Ulay site is not expected to harm the health of recreational users or hostel workers.

Basis for Decision

This conclusion was reached because the estimated non-cancer health hazards and cancer risks for both receptor populations considered in this evaluation are associated with a low increased risk of developing cancer and non-cancer health effects.

Next Steps

Based on the results of this evaluation, the following recommendations have been made in regard to potential exposure pathways associated with future redevelopment at the Ute-Ulay Townsite. To be protective of public health, the Hazardous Materials and Waste Management Division of CDPHE should address the following:

- Exposure to Lead in all EUs should be reduced to protect the health of the young children (0-7 years or 0-84 months) using the site for recreational purposes.

- Exposure to Lead in EU1 and EU3 should be reduced to protect the health of the fetuses of pregnant women using the site for recreational purposes, and in all EUs to protect the fetuses of pregnant hostel workers.

- Ensure the water supply for the future development is not impacted by the mine site in a way that would threaten public health.

- Ensure that hostel workers are non-residential (i.e., not using the hostel as their primary residence); especially, ensure that children are not staying onsite with their worker parents. If the proposed land-use were to change in the future to include year-round hostel workers or commercial workers, the site should be reevaluated from a public health perspective.

For More Information	If you have concerns about your health, you should contact your health care provider. For questions or concerns regarding this evaluation, please contact Thomas Simmons at 303-692-2961 or Raj Goyal at 303-692-2634.

Purpose

The purpose of this health consultation is to evaluate the future public health implications of exposure to mining related surface soil contamination at the "Townsite of the Ute-Ulay Mine and Mill" in southwestern Colorado.

Site Background

The Townsite of the Ute-Ulay Mine and Mill is a historic mining camp located approximately 4 miles west of Lake City, Hinsdale County, Colorado (Figure 1). The site is the former location of a hard rock mining and milling operation that dates back to 1874. The Ute-Ulay Townsite is one of the most intact mining camps remaining in Colorado and consists of the original boarding house, cabins, storage buildings, mine headframe, and redwood water tank.

In the summer of 2011, work began on planning the future uses of the Ute-Ulay mine and mill complex if the current owner of the site were to donate the land to Hinsdale County for restoration and preservation. A Phase II ESA was also completed in the summer of 2011 by the CDPHE for the Targeted Brownfields Assessment of the site. The area under consideration in this evaluation ("Townsite") is a 4-acre parcel of the total 285-acre Ute-Ulay Mine and Mill complex. In January 2012, LKA International, Incorporated announced a potential donation of the Townsite area to Hinsdale County for preservation and public display purposes (WSJ 2012). The purpose of this evaluation is to determine the public health implications of current and future uses of the Ute-Ulay "Townsite", hereupon referred to as "the site".

Site Description

The site is located in the San Juan Mountains of southwestern Colorado at approximate coordinates of 38.0209^{o} North, 107.3774^{o} West (CDPHE 2011). The general area surrounding the site is best described as unaltered wooded and mountainous terrain at an elevation of approximately 9,200 to 9,800 feet above mean sea level. The site is on the "Alpine Loop", a 65 mile backcountry loop that connects Lake City, Silverton, and Ouray. Site access is relatively easy via passenger vehicle traveling west on Hinsdale County Road 20 (CR20) out of Lake City towards Engineer Pass. Approaching from the west would require a high clearance 4-wheel drive vehicle.

The Ute-Ulay site is one of the most intact historic mining camps remaining in Colorado. Major historic site features include the original boarding house, cabins, storage buildings, mine headframe, and redwood water tank. The major environmental features include a large waste rock pile and graded ore remnants, both of which contain large amounts of heavy metals. The waste rock pile is approximately 1,500 cubic yards and is characterized by a grey angular waste rock on the western half of the pile and a more weathered, orange colored waste rock on the eastern side of the pile. Generally speaking, the waste rock appears to be stable, but there are areas where waste rock pile has slid downhill towards the site buildings over the past several years. In addition, there are two to three areas near the toe of the waste rock pile where the remaining wood cribbing has deteriorated and the waste rock has overtopped or pushed out the cribbing in these areas. The remaining grounds of the site are best characterized as native soils.

The nearest surface water body of note is Henson Creek, which is located south and adjacent to the site across CR20. The site is located on a bedrock outcropping approximately 100 feet above Henson Creek. Based on topography and geologic formations, the ground water flow direction in the vicinity of the site is inferred to be east/south east in the direction of Henson Creek. A small seasonal creek (Ute Creek) intersects the 4-acre site parcel in a roughly north-south trajectory. At the northern most portion of the site, Ute Creek disappears into what appears to be fill and waste rock material and then re-reports at the down gradient portion of this waste rock pile. Ute Creek also reports along CR20 in the form of numerous seeps at the toe of the waste rock pile. These seeps and creek pass under CR20 in a culvert and down to Henson Creek (CDPHE 2011). Henson Creek flows in an easterly direction for approximately 4 miles to Lake City and joins with the Lake Fork of the Gunnison River and flows in a northerly direction for approximately 30 miles before connecting with Blue Mesa Reservoir and the Gunnison River.

Groundwater is present in the alluvium associated with Henson Creek at a depth of 12-70 feet based on groundwater wells drilled in the area. Groundwater may also be present onsite in limited quantity in joints and faults associated with volcanic intrusion. The extent of the alluvial aquifer in this area is thought to be extremely limited due to the extensive presence of bedrock outcrops (CDPHE 2011). The Lake City municipal water supply draws water from two groundwater wells. One of the wells is located at the mouth of Henson Creek to Lake City and is 75 feet deep. The other well is located at Memorial Park and is approximately 80 feet deep. The water supply for rural residents of Hinsdale County comes from private groundwater wells drilled at varying depths and formations. The closest private groundwater well to the site is approximately 2.4 miles downgradient of the site (CDPHE 2011). The potential for the site to impact groundwater is minimal because groundwater is thought to occur only in limited quantities onsite based on the hydrology and geologic features of the area. Due to the limited potential impact of site wastes on groundwater and the distance to the nearest groundwater well, CDPHE does not feel groundwater investigations are warranted at this site (CDPHE 2011).

As mentioned previously, Ute Creek disappears into what appears to be fill and waste rock material at the northernmost portion of the site, and re-reports at the down gradient portion of the waste rock pile. Ute Creek also reports along CR20 in the form of numerous seeps at the toe of the waste rock pile. These seeps and creek pass under CR20 in a culvert and down to Henson Creek, approximately 100 feet below. Based on the proposed plans for the site, it does not appear that Ute Creek is going to be used for drinking water. However, to evaluate the potential environmental impact of site related wastes on surface water, three surface water samples were collected from Ute Creek. The samples were collected to characterize Ute Creek upgradient of the site, Ute Creek downgradient of the site, and the seeps reporting at the toe of the waste rock pile.

Surface water collected from Ute Creek upgradient of the site compared to down gradient was slightly elevated in comparison but none of the downgradient samples exceeded any Drinking

Water Maximum Contaminant Level (MCL) or either the Acute or Chronic Ambient Water Quality Criteria (AWQC). Background/upgradient sample UTS SW1 had one detection of zinc at 203 milligrams per liter (mg/l) which was greater than the Acute and Chronic AWQC (117 mg/l). The MCL for zinc is 5,000 mg/l. This sampling data does not indicate that the site has any significant impact on Ute Creek. Since there is no indication that Ute Creek will be utilized for drinking water or recreational purposes and there appears to be minimal, if any, site impact on Ute Creek, surface water was considered an incomplete pathway of exposure at this time (CDPHE 2011). If Ute Creek is utilized in the future for drinking or recreational purposes, these pathways should be reevaluated by collecting additional samples at that time.

Site History

The Ute and Ulay mines were formally located and claimed in 1874 following the Brunot Treaty, which ceded the San Juan Mountains from the Ute Indians to the United States (CAW 2011). The first significant influx of eastern investment occurred in 1876 when the Crooke Brothers purchased the Ute-Ulay complex. The mill, mining structures, and housing quarters were constructed around 1878 and the Ute-Ulay prospered for a time until a drop in silver prices inevitably ceased production. The Ute-Ulay continued on this boom and bust cycle for most of its history with the claims to the property changing hands numerous times over the years. Very little mining took place at the site throughout the 20th century and in 1983, LKA International Incorporated purchased the property primarily for milling purposes.

Following a period of inactivity at the Ute-Ulay in recent years, LKA International and Hinsdale County began discussing the potential transfer of the mine and mill site to the county for historical preservation and public viewing. In the summer of 2011, a Targeted Brownfields Assessment was conducted on the Townsite portion of the complex. The data collected for the TBA is used as the basis for this evaluation. In January 2012, it was officially announced that there is a potential donation of the Townsite portion of the Ute-Ulay complex to Hinsdale County. The second phase of the donation, expected in 2013, includes the Ute-Ulay "Millsite", which contains the blacksmith shop, assay lab, powerhouse, and mill buildings (WSJ 2012).

Demographics

The nearest population center to the site is the town of Lake City, Colorado, which is located approximately 4 miles to the east. Lake City is the county seat and only town in Hinsdale County with a population of approximately 408 full-time residents according to the 2010 U.S. Census. In the summer months, the population nearly doubles with the seasonal influx of temporary residents and recreational users (CDPHE 2011). The median age of the Lake City population is 46 years with 8.8% of the population ages less than 5 years and 17.9% of the population over the age of 65 years (Census 2010). There are slightly more males (54.4%) than females (45.6%) in Lake City. Women of child-bearing age (defined as 15-49 years due to Census age brackets) constitute approximately 38% (71/186) percent of the female population. The racial make-up is White (94.6%), Hispanic or Latino (2.7%), American Indian and Alaska Native (1.0%), Black or African American (0.2%), Asian (0.2%), and 1.5% of people reported "some other race". Everyone that participated in the latest Census reported that they spoke English very well or better, which indicates that health education materials in different languages may not be necessary, but can be provided upon request. In addition, the population appears to be educated with 92% of individuals reporting they earned a high school diploma or higher and 40.9% of people stated they earned a Bachelor's degree or higher. Both of these educational statistics are higher than state and national values. The median household income is $73,295, which is also well above the median household income in Colorado and the United States.

Discussion

The overall goal of this health consultation is to determine if exposure to mining-related soil contamination at the Ute-Ulay Townsite poses a public health hazard and, if so, make recommendations to protect public health. The first steps of the health consultation process include an examination of the currently available environmental data and how individuals could be exposed to site-related contaminants of potential concern (COPCs). If people can come into contact with COPCs, exposure doses are estimated and compared to health-based guidelines established by the ATSDR, EPA, or other state agencies. This is followed by a more in-depth evaluation if the estimated exposure doses exceed health-based guidelines.

Exposure Analysis

Environmental Data

In general, soil and surface water data have been collected from the site during the site assessment by CDPHE (CDPHE 2011). Soil is the primary environmental medium evaluated in this health consultation because no contaminants of concern have been identified in surface water at this time (CDPHE 2011). If any contamination is identified by CDPHE in the future, a separate health consultation will be conducted for surface water. Due to the limited potential impact of site wastes on groundwater and the distance to the nearest groundwater well, CDPHE does not feel groundwater investigations are warranted at this site and no groundwater data has been collected from the site (CDPHE 2011). Therefore groundwater and surface water were not considered complete exposure scenarios in this evaluation.

Soil Data

Surface soils at the Ute-Ulay Townsite are characterized by native looking soils, a grey angular inert waste rock or an orange weathered waste rock. A total of 15 composite surface soil samples were collected as part of Phase II ESA (CDPHE 2011). Soil samples were collected from 0-4 inches below ground surface in a five-point composite pattern. All of the samples were analyzed for total metals including aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, magnesium, nickel, mercury, selenium, silver, and zinc. This surface soil data is presented in Table A1. The concentration of contaminants of potential concern is discussed below.

The sampling locations, shown in Figure 2, were selected based on the composition of the waste materials found at the site and the proximity to historic mine structures.

Selection of Contaminants of Potential Concern

To identify surface soil contaminants of potential concern (COPCs), the surface soil data was screened against comparison values established by the ATSDR and EPA. The screening values from both agencies were reviewed and the most conservative value was selected as the

Comparison Value (CV) (Table A2). The screening values used to identify COPCs in surface soil were derived for residential soil exposures. ATSDR's soil comparison values for chronic exposures are based on daily exposure to soil over a period longer than 1 year. The EPA's residential soil screening values are based on 350 days of exposure per year over a period of 30 years (assumes 15 days away from the home per year). Using these screening values is considered conservative and protective of individuals that might come into contact with surface soil contaminants at the Ute-Ulay Townsite. Therefore, if the maximum concentration of a particular contaminant is below the screening value, it is dropped from further evaluation. If the maximum concentration of the contaminant is above the screening value; it is generally retained for further analysis as a COPC. However, exceeding the CV does not indicate that a health hazard exists; only that additional evaluation is warranted. It should be noted that the EPA screening value for lead has not yet been revised to reflect recent changes in CDC's reference blood lead level. Therefore, the EPA screening value of 400 mg/kg may no longer be protective of young children and the developing fetus of pregnant women exposed to lead in a residential setting. Therefore lead is retained as a COPC at all detected concentrations found in soil at this site.

The surface soil COPC selection is shown in Table A2. Arsenic, cadmium, chromium, copper, and lead had maximum detected concentrations greater than the residential CVs used in this evaluation and were selected as COPCs. The concentration ranges for these COPCs are shown in Table A1. The concentration of arsenic ranged from 5.8 mg/kg to 271 mg/kg. The concentration of cadmium ranged from 2.2 mg/kg to 130mg/kg. The concentration of chromium ranged from 0.38 mg/kg to 9.2 mg/kg. The concentration of copper ranged from 20.3 mg/kg to 1000.0 mg/kg. The concentration of lead ranged from 51.9 mg/kg to 44200.0 mg/kg.

Conceptual Site Model

A conceptual site model helps to visualize how contaminants of potential concern move in the environment at the site and how people might come into contact with these contaminants. Surface soil is the primary environmental medium under consideration in this health consultation and three routes of exposure to surface soil contaminants are likely to occur under any given scenario: 1) incidental ingestion of surface soil, 2) dermal contact with surface soil, and 3) inhalation of soil particles suspended in air (fugitive dust). However, dermal contact with metals is considered a relatively insignificant exposure 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. Inhalation of resuspended soil particulates (dust) is typically not considered an important pathway in terms of public health unless there is evidence to suggest a significant mechanical disturbance of the soil as in ATV riding and/or high, sustained winds. At this site, no such evidence exists and this pathway was also not quantitatively evaluated in this health consultation. While there may be some additional exposure that is unaccounted for from dermal exposure and inhalation of fugitive dusts, these pathways are not likely to significantly alter the body burden of doses received from incidental ingestion. Incidental ingestion of surface soil is considered the primary pathway of exposure to soil contaminants at the Ute-Ulay site.

Exposure Units or Areas

For this evaluation, the site was divided into four Exposure Units (EU1) based on the location, level of contamination, and type of material that people could possibly be exposed to. EU1 is the graded ore material located in the western portion of the site with high level of contamination. EU2 is the inert grey, angular waste rock on the western portion of the waste rock pile. EU3 is the weathered, orange colored waste rock composing the eastern portion of the waste rock pile. EU4 consists of the apparent native soils that are found in the remaining areas of the site. However, mining related wastes have infiltrated small areas in this EU4. It is likely that exposure to surface soil contaminants would occur randomly throughout the entire site area rather than at one EU every day. However, this randomness cannot be accurately accounted for in a health protective manner. Therefore it is useful to establish the EUs by types of material to isolate areas of potential concern. Based on the proposed future land-use at the site, it is likely that exposure to soil in EU4 is the most representative of the typical exposures that will occur in the future.

Exposure Scenarios/Receptors

Based on the proposed future use of the site, two exposure scenarios were developed to evaluate the potential public health implications of exposure to surface soil contaminants at the site: hostel workers and recreational users. Each exposure scenario is discussed in more detail in the following subsections including the primary exposure assumptions used for each scenario. Additional information of the exposure scenarios used in this evaluation can be found in Appendix B. The exposure assumptions could be a major source of uncertainty in this evaluation because there is no site-specific information available on the frequency, duration, or specific activities conducted at the Ute-Ulay site. However, based on the site-specific information that is available, the exposure assumptions used in the evaluation were deemed appropriate for describing infrequent recreational users and seasonal or year round hostel workers.

Recreational Users (Future Potential Exposures)

Currently, tourists visit the Ute-Ulay site to view or take pictures of the historic features of the mining camp. Although there is no concrete site-specific data available on the frequency any particular user visits the site, it is reasonable to assume that people would only visit for a brief period of time perhaps an hour or two per year. Unless they are accidentally swallowing significant amounts of dirt during their stay, the extremely short-term exposure is not expected to be a health concern. Therefore, current exposures are not evaluated in this health consultation. Once the site is redeveloped, it is likely that people will visit more often; however, it is still reasonable to assume that the stays would still be for relatively short periods of time. For the purpose of this evaluation, it was assumed that children (ages 0-6 years) and adults would visit the site for 12 days per year for recreational use once the site has been redeveloped. The exposure duration for children using the site for recreational purposes is 6 years and the assumed exposure duration for adults using the site for recreational purposes is 30 years. However, it should be noted that the model used to evaluate lead exposures for young children is based on children ages 0-7 years old (or 0-84 months). All other exposure factors, which are typically default values for recreational exposures, are presented in Appendix Table B1.

Hostel Workers (Future Potential Exposure)

If the proposed plan developed by Colorado Art Ranch and Hinsdale County becomes reality, one or more individuals will be necessary to operate the hostel and cabins. It should be noted that the future plans for a hostel were not final at the time this evaluation was conducted. Therefore, hostel workers are considered a future potential exposure scenario at this time. It was assumed that a non-residential hostel worker(s) would be present onsite throughout the year. However, during the winter months (November through March), snowpack would eliminate their contact with surface soil. In addition, it is reasonable to assume that the hostel workers would be away from the site for short periods of time during the year for travel, vacations, etc. Thus, it was assumed that adult hostel workers could be exposed to surface soil for a period of 140 days per year over the course of 25 years. The remaining exposure assumptions that are shown in Appendix Table B1 are typically default values for residential exposures. Based on what is currently known about the future land use, children of hostel workers were not evaluated because young children would not be staying at the hostel or going to work with their parents. If the proposed land-use were to change in the future to include year-round hostel workers or commercial workers, the site should be reevaluated from a public health perspective.

The exposure scenarios discussed above and the likely routes of exposure used in this evaluation are summarized below in Table 1, the Conceptual Site Model (CSM).

Table 1. Conceptual Site Model

Source	Area of Exposure	Affected Environmental Medium	Timeframe of Exposure	Potentially Exposed Population	Route of Exposure	Pathway Designation
Mining related waste	Ute-Ulay Townsite	Surface Soil	Future	Adult Hostel Workers and Child and Adult Recreational Users	Incidental Soil Ingestion	Potential
					Inhalation of Fugitive Dust	Potential*
					Dermal Exposure to Soil Contaminants	Potential**

NOTE:
* Inhalation of fugitive dusts is not considered an important exposure scenario in this evaluation because there is no evidence to suggest any significant mechanical disturbance of soil at the site. Therefore, the concentration of soil contaminants in dust is likely to be low.
** Dermal exposure to surface soil contaminants is a potential exposure pathway. Since metals have a limited ability to cross the skin barrier and enter the blood stream, this pathway is considered insignificant and is not quantitatively evaluated in this health consultation.

Exposure Point Concentrations

The exposure point concentration (EPC) describes the concentration of soil contaminants that people are likely to come into contact within the exposure unit. As per CDPHE and EPA Region 8 protocols, for data sets with less than ten samples, the maximum detected concentration is used as the EPC. For Exposure Units 1 and 2, there was only one composite soil sample collected from each area. Therefore, the results of the composite soil sample collected from each exposure unit (EU) were used as the EPCs in EU1 and EU2. Two composite surface soil samples were collected from EU3 and the maximum detected concentration of the two samples was used as the EPC for EU3. In EU4, eleven composite surface soil samples were collected, which is a sufficient number of sample to analyze statistically. Therefore, the surface soil data collected from EU4 was used to estimate the EPC by using EPA's ProUCL 4.1 software (EPA 2011a). On a normally distributed data set, ProUCL will calculate the 95th percentile Upper Confidence Limit (95% UCL) to be used as the EPC. In other cases, ProUCL uses rigorous statistical methods to determine the appropriate EPC. The surface soil EPC for each exposure unit is shown in Appendix Table B2.

Public Health Implications

The public health implications of exposure to surface soil contaminants at the site were determined using a combination of exposure dose estimations and biokinetic modeling. To assess the public health implications of metal contaminants of potential concern other than lead, the estimated doses for non-cancer health effects were divided by the appropriate health-based guidelines to calculate the Hazard Quotient (HQ). The cumulative non-cancer hazard (or hazard index; HI) of multiple contaminants is estimated by adding all HQs together. A HQ or HI greater than one indicates the estimated exposure exceeds the non-cancer health-based guideline and requires further evaluation by comparison of estimated exposure doses or concentrations with health effects levels known to be associated with harmful effects in animal and/or human studies (see Appendix D for more details). The non-cancer health effect levels are referred to as the No-Observed- Adverse -Effect Level (NOAEL) and the Lowest- Observed -Adverse -Effect Level (LOAEL). It should, however, be noted that because of the uncertainties regarding exposure conditions and the adverse health effects associated with environmental levels of exposure, definitive answers on whether health effects actually will occur or will not occur are not possible. The in-depth analysis only serves as a means of gaining a better perspective on how strongly the available toxicological information in the scientific literature suggests potential for harmful exposures (i.e., could harm people's health).

The estimated doses for cancer health effects are used in conjunction with carcinogenic slope factors and inhalation unit risks to calculate the lifetime excess cancer risks from exposure to site-related contamination. The estimated lifetime excess cancer risk is compared to the EPA target cancer risk level of 1×10^{-6} to 1×10^{-4}, or 1 excess cancer case per million exposed individuals to 100 excess cancer cases per million exposed individuals.
The non-cancer exposure concentration estimation is equivalent for child and adult receptors. This is not true for the exposure concentration estimation for cancer health effects because of the difference in lifetime averaging time between children and adults. Appendix B contains additional information on the exposure doses calculated for this evaluation. Appendix D contains additional information on the toxicological evaluation and toxicity values used in this evaluation.

To assess the public health implications of lead, exposures during recreational use were evaluated using the EPA's Integrated Exposure Uptake Biokinetic (IEUBK) lead model for children and the EPA Adult Lead Model (ALM) to estimate the blood lead level in pregnant women working at the site and/or using the site for recreational purposes. Essentially the lead models are designed to predict the blood lead levels of fetuses or children exposed to lead in the environment. Until recently, the U.S. Centers for Disease Control and Prevention (CDC) had established a level of concern for case management of 10 micrograms lead per deciliter of blood (µg/dL) (CDC 2005). Recent scientific research, however, has clearly shown that blood lead levels below 10 µg/dL can cause serious and irreversible effects in children. Blood lead levels below 10 µg/dL have been shown to cause neurological, behavioral, immunological, and developmental effects in young children. Specifically, lead causes or is associated with decreases in intelligent quotient (IQ); attention deficit hyperactivity disorder (ADHD); deficits in reaction time; problems with visual-motor integration and fine motor skills; withdrawn behavior; lack of concentration; issues with sociability; decreased height; and delays in puberty, such as breast and pubic hair development, and delays in menarche (CDC 2011; CDC 2012a; CDC 2012b). On January 4, 2012, CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended that CDC adopt the 97.5 percentile blood lead level of children in the United States (ages 1 to 5 years old) as the reference value for designating elevated blood lead levels in children. Based on the latest National Health and Nutrition Examination Survey (NHANES) data, the 97.5% currently is 5 µg/dL (CDC 2012a). On June 7, 2012, the CDC released a statement indicating concurrence with the recommendations of the ACCLPP (CDC 2012b). CDC plans to use the reference value as defined to identify high-risk childhood populations and geographic areas most in need of primary prevention.

Yet still, there may be an underestimation of risk for lead because there is no proven safe level of lead in the blood. Appendix C contains additional information on the health risk evaluation of exposures to lead using the IEUBK and ALM models at the site. Chronic exposures to lead and other metal contaminants of concern are described below.

Public Health Implications of Recreational Use of the Ute-UIay Townsite

Evaluation of Contaminants of Concern (Other than Lead)

Non-cancer Hazards

Arsenic, cadmium, chromium, and copper were identified as contaminants of concern in soil at the site because the maximum detected site concentrations exceeded the residential screening value for these contaminants. All other metals (except for lead) that were analyzed were dropped from further evaluation because the maximum detected concentration did not exceed the residential screening values. The non-cancer exposure dose results for recreational users are shown in Table B3 and the associated HQs are shown in Table A3. As shown in these tables, the non-cancer HQs are below 1 for both child and adult recreational users in each exposure unit considered in this evaluation. Therefore, in all cases, the estimated exposure dose for recreational users is below the health-based guideline. In addition, the combined non-cancer HI for multiple contaminants of potential concern is also below or equal to 1 in each exposure unit (HI = 0.02 to 1.0) with the maximum child HI of 1.0 in EU1. This indicates that non-cancer adverse health effects are not likely to occur from coming into contact with all metal contaminants of concern other than lead, even based on the assumption of additivity for multiple chemical exposures.

Cancer Risk

Arsenic and chromium VI are the only known carcinogens identified as contaminants of potential concern at this site. It should be noted that the species of chromium has not been determined at this site, the common, and conservative, approach is to assume that all chromium is in the hexavalent form even though chromium at this site is most likely in a lower valence state, less toxic form, which is non-carcinogenic. Nonetheless exposure doses for arsenic and chromium were calculated for carcinogenic health effects and the results are shown in Appendix Tables B5 and the associated theoretical cancer risks are shown in Table A4.

Cancer risks were estimated for children, adults, and were also combined to evaluate cancer risks from exposures occurring as a child and into adulthood. The combined lifetime estimated cancer risks are the most conservative values, followed by childhood exposures, and exposure occurring as an adult. As shown in Table A4, the maximum combined (child and adult) estimated cancer risk from exposure to arsenic and chromium is 2.2×10^{-5} (EU1). This level of risk is largely attributable to exposure to arsenic in EU1 soil with chromium contributing very little to the overall combined cancer risk. The estimated combined cancer risk in EU1 translates to 22 excess cancer cases per million people exposed. Relative to the EPA's target cancer risk range of $1 \times 10^{-6} – 1 \times 10^{-4}$, or one excess cancer case per million exposed individuals to 100 excess cancer cases per million exposed individuals, the estimated cancer risks from recreational use of the Ute-Ulay site are associated with a low increased risk of developing cancer.

Evaluation of Lead Exposures

As mentioned previously lead exposures to children and adults during recreational activities were evaluated using EPA models, the IEUBK and the ALM, respectively. The recreational use results of the IEUBK model for children are shown below in Table 2 and the ALM results for recreational use of the site by adults are shown in Table 3. The IEUBK model results indicate that lead exposures occurring in all exposure units at the site are a concern for recreational use bychildren. In EU1, the predicted geometric mean blood lead level for children using the site for recreational purposes is 9.0 µg/dL with an estimated 89.6% of all children having blood lead levels greater than or equal to 5 µg/dL. In EU3, the model estimated that 48.4% of children using the site for recreational purposes would have blood lead levels greater than or equal to 5 µg/dL with an estimated geometric mean blood lead level of 4.9 µg/dL. The estimated blood lead levels from exposure to lead in soil at EU2 and EU4 are lower, but still indicate a potential concern. In EU2, the estimated geometric mean blood lead concentration in children is 3.3 µg/dL with an estimated 18.3% of all exposed children having blood lead levels greater than 5 µg/dL. In EU4, the estimated geometric mean blood lead level is 3.2 µg/dL with an estimated 17.6% of children using the site for recreational purposes with blood lead levels greater than 5µg/dL. All of the results show more than 5% of children have predicted blood lead levels above CDC's reference value of 5 µg/dL for designating elevated blood lead levels in young children.

The results of the ALM also indicate elevated fetal blood lead levels in EU 1 and EU3 for pregnant women during recreational use. Specifically, the ALM estimated that 44.2% of adults would have fetal blood lead levels greater than or equal to 5 µg/dL with a geometric mean fetal blood level of 5.6 µg/dL following exposure to lead in soil during recreational use of EU1. In EU3, the estimated geometric mean fetal blood lead level is 2.8 µg/dL and an estimated14.0% of fetal blood lead levels greater than or equal to 5µg/dL. However, it should be noted that the ALM results for EU2 and EU4 do not indicate >5% probability of elevated fetal blood lead levels (i.e.>5 µg/dL) for pregnant women during recreational use. Therefore, exposure to lead during recreational use of the site is expected to harm the health of young children and the developing fetus of pregnant adults in EU1 and EU3. Exposure to lead during recreational use of EU2 and EU4 is also expected to harm the health of young children (0-84 months).

Overall, to protect the health of young children and the fetus of pregnant women, exposures to lead in soil during recreational use at the Ute-Ulay Townsite should be reduced.

Table 2. IEUBK Model Results for Recreational Use by Children

	Time Weighted Site Soil Lead Concentration (in mg/kg)	Age Group (Months)	Geometric Mean Blood Lead Concentration of Children (µg/dL)	Percent of Child Population with a predicted Blood Lead Level greater than 5 µg/dL
EU1	1,652	0-84	9	89.60%
EU2	250.5	0-84	3.3	18.30%
EU3	609.2	0-84	4.9	48.40%
EU4	242.1	0-84	3.2	17.60%

NOTE: mg/kg = milligram lead per kilogram soil, µg/dL = micrograms lead per deciliter of blood
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 reference blood lead value.

Table 3. Adult Lead Model Results for Recreational Use by Adults

Exposure Unit (EU)	Soil lead Concentration (in mg/kg)	Geometric Mean Fetal Blood Lead Concentration (µg/dL)	Probability of fetal Blood Lead Exceeding 5µg/dL
EU1	44,200	5.6	44.2%
EU2	1,730	1.8	5.0%
EU3	12,600	2.8	14.0%
EU4	1,470	1.8	4.8%

NOTE: µg/dL = micrograms per deciliter of blood. The EPA has set a goal that there should be no more than a 5% chance that the fetal blood levels will exceed a reference blood lead value.

Public Health Implications of Surface Soil Exposures to Hostel Workers

Evaluation of Contaminants of Concern (Other than Lead)

The non-cancer exposure doses that were estimated for hostel workers are shown in Appendix Table B4 and the resulting HQs are shown in Table A5. As indicated in these tables, the estimated exposure doses for non-cancer health effects in each EU are below the health-based guideline for all contaminants of concern that were identified in this evaluation (all HQs < 1). The highest potential for non-cancer health effects occurs in EU1 (i.e. graded ore) from exposure to cadmium and arsenic with respective HQs of 0.7 (approximately 1.4 times lower than the health based guideline for cadmium) and 0.5 (approximately 2 times lower than the health-based guideline for arsenic). In addition, the combined HI for all four EUs from exposure to all contaminants of concern ranges from 0.03 to 1.2, assuming 100% bioavailability of all contaminants. The maximum HI of 1.2 was estimated for EU1. Considering the reduced bioavailability of metals in soil and HI of up to 1, the potential for non-cancer health effects is not likely to be of concern for hostel workers at the site based on the assumption of additivity for multiple chemicals and exposure factors used in this evaluation.

As shown in Table A6, the estimated cancer risks for hostel workers are within the EPA target cancer risk range for each EU considered in this evaluation. However, the maximum estimated cancer risks in EU1 are approaching the high-end of the range at 8.0×10^{-5}, or 80 excess cancer cases per million exposed individuals. In all EUs, arsenic is the major risk driver for carcinogenic health effects. The estimated cancer risk from chromium exposures is lower than 1 excess cancer case in a million exposed individuals. Thus, there is little difference between the estimated cancer risk from arsenic exposure and the total cumulative cancer risk from exposure to arsenic and chromium since chromium contributes only a small fraction. Overall, the estimated cancer risks are associated with a low increased risk of developing cancer. However, CDPHE's long-term target cancer risk level is 1 excess cancer case per million exposed individuals. To achieve this goal, exposure to arsenic in site-soils should be reduced in Exposure Units 1 and 3.

Evaluation of Lead Exposures

As noted above, details on lead risk evaluation using the ALM are provided in Appendix C and the results of the ALM model performed for hostel workers are shown below in Table 4. The ALM model was performed for pregnant female hostel workers, which is thought to be protective of non-pregnant females and male adult workers. The results of the ALM indicate a potential for excessive lead exposure in all exposure units at the site. EU1 (graded ore) and EU3 (weathered waste rock) pose the greatest risk of elevated blood lead in the fetuses of pregnant hostel workers. In EU1, the ALM predicted a geometric mean blood lead concentration in the fetus of 46.9 µg/dL and that 99.7% of all pregnant female hostel workers would have fetal blood lead concentrations greater than 5 µg/dL. In EU3, the ALM predicted a geometric mean blood lead concentration in the fetus of 14.6 µg/dL and that 87.6% of all pregnant female hostel workers would have fetal blood lead concentrations greater than 5 µg/dL. Both of these outputs are well above CDC's reference level of 5 µg/dL for designating elevated blood lead levels in young children.

In EU2 and EU4, which are more characteristic of the common areas, the ALM also indicates >5% probability of elevated fetal blood lead levels for pregnant hostel workers; however, the estimated blood lead levels are lower than those predicted in EUs 1 and 3. In EU2, the ALM estimated that 21.5 % of recreational adults would have fetal blood lead levels greater than

CDC's reference level for blood lead of 5µg/dL with a geometric mean fetal blood level of 3.4 µg/dL. In EU4, the estimated geometric mean fetal blood lead levels is 3.2 µg/dL and 18.5% of fetal blood lead levels greater than 5 µg/dL (Table 4). Therefore, exposure to lead while working at the hostel is expected to harm the health of the developing fetuses of pregnant women

Table 4. Adult Lead Model Results for Hostel Workers

Exposure Unit (EU)	Soil lead Concentration (in mg/kg)	Geometric Mean Fetal Blood Lead Concentration (µg/dL)	Probability of fetal Blood Lead Exceeding 5 µg/dL
EU1	44,200	46.9	99.7%
EU2	1,730	3.4	21.5%
EU3	12,600	14.6	87.6%
EU4	1,470	3.2	18.5%

NOTE: µg/dL = micrograms lead per deciliter of blood. The EPA has set a goal that there should be no more than a 5% chance that the fetal blood levels will exceed a reference blood lead value.

Uncertainty/Limitations

In general, the uncertainties associated with any risk-based health consultation are likely to over- or underestimate environmental exposures and the associated health hazards because all aspects of the exposure are typically unknown. This section of the discussion is not intended to be an in-depth description of all the uncertainties associated with this evaluation. Rather, the focus is to highlight the major assumptions and limitations that are specific to this evaluation and result in uncertainty.

- There is no land-use data to support the exposure frequency and/or exposure duration assumptions used in this assessment meaning that the assumptions used in this evaluation may over- or under-estimate health risks. This is a major source of uncertainty because these assumptions are vital components of the exposure dose calculations and the resulting public health implications of exposure to site-related contamination. However, based on the current knowledge, health protective/conservative assumptions were made to evaluate health risks.

- Site-specific chromium speciation has not been conducted at the Ute-Ulay Townsite. Therefore, the species of chromium was conservatively assumed to be Cr (VI) because of the availability of oral cancer slope factor for Cr (VI) (NJDEP 2009). This assumption is likely to overestimate cancer risk for chromium because it is unlikely that all chromium at the site is Cr (VI).

- The assumption of additivity to estimate cumulative cancer and non-cancer risks is likely to over- or under-estimate risk due to synergistic and antagonistic interactions.

- For lead risk evaluation, without site-specific data, there is uncertainty about how well the risk estimates predicted by modeling based on the default parameters reflect the true conditions at a site. For example, lead risks may be over- or underestimated based on the unavailable site-specific relative bioavailability of lead from soil. Overall, there is an underestimation of risk for lead based on the use of 5 µg /dL of blood lead level as a reference in light of the recent evidence that there is no safe level of lead.

- The overall cancer and non-cancer risks from ingestion pathway are likely overestimated because of the assumption of 100% metal bioavailability based on what is known of the reduced bioavailability of metals in soils.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical 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.

Child recreational users were included in this evaluation because they are most representative of the young children that are likely to be at the Ute-Ulay Townsite. Lead was the primary contaminant of concern for children using the site for recreational purposes. The IEUBK modeling that was conducted indicates that exposure to lead in EUs 1 and 3 could harm the health of young children (0-84 months) during recreational use of the site. In addition, recreational exposure to lead in EUs 1 and 3 could harm the fetus of pregnant women. Furthermore, exposure to lead in all EUs could harm the fetus of pregnant hostel workers. Exposure to all other surface soil contaminants of potential concern (other than lead) that were identified in this evaluation is not expected to harm the health of young children. Thus, it is recommended that exposure to Lead in EU1 and EU3 should be reduced to protect the fetuses of pregnant women using the site for recreational purposes, and in all EUs to protect the fetuses of pregnant hostel workers. In addition, exposure to lead should be reduced in all EUs to protect the health of young children (0-84 months) using the site for recreational purposes.

Conclusions

CCPEHA and ATSDR have reached four conclusions regarding current and future exposures to soil at the Ute-Ulay Townsite:

Exposure to lead in soil during recreational use of the Ute-Ulay Townsite could harm the health of children (age 0-7 years). This conclusion was reached because the results of the IEUBK model predicted blood lead levels in young children that are well above CDC's reference blood lead level in all exposure units. Exposure to lead in EU1 and EU3 presents the greatest concern for elevated blood lead levels in children who use the site for recreational purposes. In EU1, the predicted geometric mean blood lead level during recreational use by children is 9.0 µg/dL with an estimated 89.6% of all children having blood lead levels greater than 5 µg/dL. In EU3, the model estimated that 48.4% of children using the site for recreational purposes would have blood lead levels greater than CDC's reference level of 5 µg/dL with an estimated geometric mean blood lead level of 4.9 µg/dL. In EU2 and EU4, the IEUBK model results were lower than those predicted for EUs 1and 3, but still exceeded CDC's reference blood lead level.

Recreational exposure to lead in EU1 and EU3 could harm the health of the fetus of pregnant women. This conclusion was reached because the ALM predicted elevated blood lead levels in the fetus of pregnant recreational users following exposure to lead in EU1 and EU3. In EU1, the ALM predicted a geometric mean blood lead concentration in the fetus of 5.6 µg/dL and that 44.2% of all pregnant recreatinal users would have fetal blood lead concentrations equal to or greater than 5 µg/dL. In EU3, the ALM predicted a geometric mean blood lead concentration in the fetus of 2.8 µg/dL and that 14.0% of all pregnant female recreational users would have fetal blood lead concentrations equal to or greater than 5 µg/dL. Both of these outputs are above CDC's target for lead, which is fetal blood lead concentrations equal to or greater than 5 µg/dL. It should also be noted that exposure to lead in EU2 and EU4 did not indicate the probability of elevated fetal blood lead levels for ≥5% developing fetuses of the exposed recreational users in this evaluation.

Exposure to lead in all EUs at the Ute-Ulay Townsite could harm the health of the fetus of pregnant hostel workers. This conclusion was reached because the ALM predicted >5% probability of fetal blood lead levels for pregnant hostel workers that are well above CDC's reference blood lead level in all exposure units. Specifically, exposure to lead in EU1 and EU3 presents the greatest concern for elevated fetal blood lead levels. In EU1, the ALM predicted a geometric mean blood lead concentration in the fetus of 46.9 µg/dL and that 99.7% of all pregnant female hostel workers would have fetal blood lead concentrations equal to or greater than 5 µg/dL. In EU3, the ALM predicted a geometric mean blood lead concentration in the fetus of 14.6 µg/dL and that 87.6% of all pregnant female hostel workers would have fetal blood lead concentrations equal to or greater than 5 µg/dL. In EU2 and EU4 the estimated fetal blood lead levels of pregnant hostel workers is lower than those predicted for EUs 1 and 3, but are still in excess of CDC's reference blood lead level.

Exposure to metal contaminants other than lead at the Ute-Ulay site is not expected to harm the health of young children and adults during recreational activities or hostels workers. This conclusion was reached because the estimated non-cancer health hazards and estimated cancer risks for both receptor populations considered in this evaluation are associated with a low increased risk of developing cancer and non-cancer health effects.

Recommendations

The following recommendations have been made to the Hazardous Material and Waste Management Division of CDPHE in order to protect the health of recreational users and hostel workers at the Ute-Ulay Townsite:

- Exposure to Lead in all EUs should be reduced to protect the health of the young children (0-7 years or 0-84 months) using the site for recreational purposes;

- Exposure to Lead in EU1 and EU3 should be reduced to protect the health of the fetuses of pregnant women using the site for recreational purposes, and in all EUs to protect the fetuses of pregnant hostel workers;

- To achieve CDPHE's long-term cancer risk target level, exposure to arsenic in EU1 and EU3 should be reduced in accordance with CDPHE risk management guidance for arsenic in soil;

- Ensure that the future drinking water supply that will be necessary for the site following redevelopment has not been impacted by the mine site in a way that would threaten public health; and

- Ensure that hostel workers are non-residential (i.e., not using the hostel as their primary residence); especially, ensure that children are not staying onsite with their worker parents. Upon reclamation and remediation of the exposure units in the near future, surface metals concentrations can/will be re-evaluated to potentially include year –round hostel workers or commercial workers and be reevaluated from a public health perspective.

The following recommendations have been made for recreational users and hostel workers at the Ute-Ulay Townsite to reduce their risk of elevated blood lead levels:

- While onsite, refrain from hand-to-mouth activities such as eating, smoking, drinking, etc. Particularly, keep young children from eating soil onsite.

- Wash hands, and remove and wash potentially contaminated clothing (boots, pants, etc.).

- Examine other potential sources of lead in the home, particularly those homes built prior to 1978.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by CCPEHA and other governmental agencies at the site. The purpose of the public health action plan is to ensure that this public health consultation both identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, drinking, eating, or touching hazardous substances in the environment. Included is a commitment on the part of CCPEHA to follow up on this plan to be sure that it is implemented.

Public health actions that will be implemented include:

- Provide copy of health consultation to stakeholders;

- Provide additional health education by distributing health education material such as fact sheets and responding to any questions via phone, meetings, or emails, etc. as requested or necessary; and

- Review any additional soil data collected and update the health consultation report on the Ute-Ulay site as requested. The action item is particularly relevant for recreational use and hostel worker exposures to lead.

Report Preparation

This Health Consultation for the Ute-Ulay Townsite was prepared by the Colorado Department of Public Health and Environment under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry. It is in accordance with approved agency methodology and the procedures existing at the time the health consultation was initiated. Editorial review was completed by the cooperative agreement partner. The Agency for Toxic Substances and Disease Registry has reviewed this health consultation and concurs with its findings based on the information presented in this report. ATSDR's approval of this document has been captured in an electronic database, and the approving reviewers are listed below.

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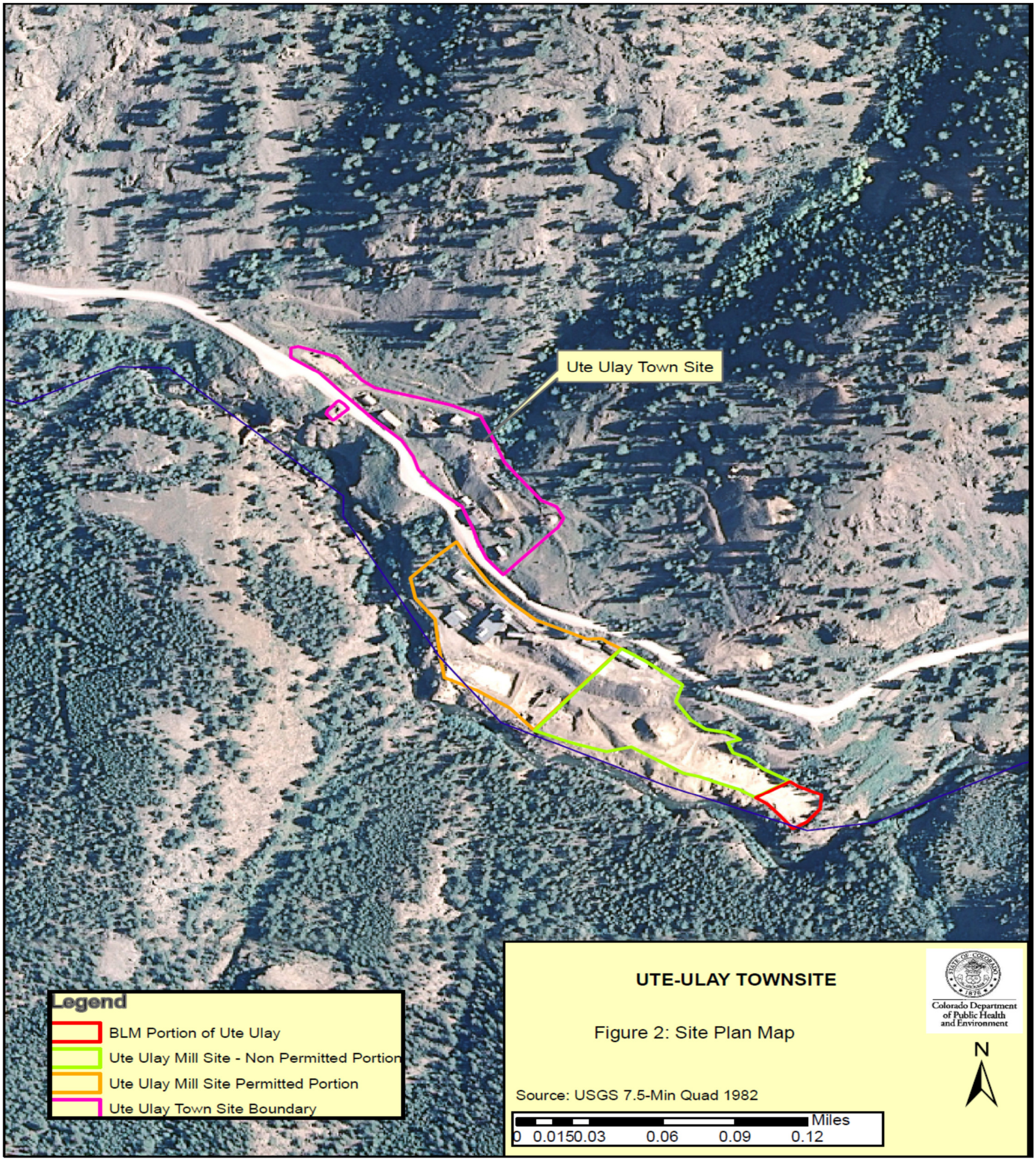
APPENDIX A. Figures and Additional Tables

Figure A1. Ute-Ulay Mine and Mill Complex



Source: CDPHE 2011
Figure A2. Ute-Ulay Surface Soil Sampling Locations

SOURCE: CDPHE 2011

Table A1. Ute-Ulay Townsite Surface Soil Data Results (August 2011)

Exposure Units (EU)	EU1	EU2	EU3		EU4										
Surface Soil Samples	**Sample# 1**	**Sample #2**	**Sample #7**	**Sample# 11**	**Sample #3**	**Sample #4**	**Sample #5**	**Sample #6**	**Sample #8**	**Sample #9**	**Sample# 10**	**Sample# 12**	**Sample# 13**	**Sample# 14**	**Sample# 15**
Aluminum	2,390	9,240	2,130	3,860	11,700	11,800	5,980	5,370	9,580	6,690	6,390	12,400	8,060	11,300	10,200
Arsenic	271	6.3	163.0	67.0	6.8	5.8	16.1	34.4	14.7	18.9	21.3	9.7	20.6	11.2	7.4
Cadmium	130.0	2.2	6.1	14.2	1.8	1.6	0.76	4.9	3.0	6.3	12.8	3.8	6.4	2.4	1.4
Chromium	0.62	8.80	0.38 U	1.60	8.30	7.70	2.00	6.60	9.20	6.30	5.00	7.80	6.40	7.50	6.80
Copper	1,000.0	59.2	167.0	210.0	44.0	38.1	20.3	64.8	66.5	180.0	93.5	66.5	110.0	46.1	37.6
Iron	19,000	12,100	14,900	14,600	11,500	11,400	9,770	10,300	11,700	11,500	10,700	11,100	11,200	11,700	10,200
Lead	44,200	1,730	12,600	8,860	657	715	51.9	1,330	1,710	2,790	2,190	1,470	4,030	855	446
Manganese	72.1	653	398	1,150	604	513	587	1,660	669	871	1,740	714	735	725	625
Magnesium	160	2,850	215	704	2,930	3,090	3,330	3,500	2,510	2,930	3,470	2,620	2,800	3,030	2,760
Mercury	0.18	1.10	0.31	0.18	0.23	0.26	0.12	0.16	1.00	0.41	0.17	0.16	0.67	0.24	0.20
Nickel	0.47 U	5.2	0.38 U	1.1	5.5	4.9	3.2	3.3	5.9	6.2	3.6	4.9	4.9	5.0	4.3
Selenium	1.5	1.5 U	1.1 U	1.4 U	1.1 U	1.2 U	1.1 U	2.1 U	1.1 U	1.1 U	2.6 U	1.5 U	1.3 U	1.5 U	1.6 U
Silver	231	2.3	15.7	11.8	2.0	1.5	0.5 U	2.8	3.1	4.4	3.7	2.6	5.8	1.7	1.1
Zinc	19,300	305	927	3,080	280	230	84.5	663	391	1,820	2,640	547	1,090	416	183

NOTE: All sample results in milligram per kilogram soil, U = analyte not detected above the reporting limit, Sample #1 corresponds to sampling location UTS-SO1 in figure A2.
SOURCE: CDPHE 2011

Table A2. Selection of Contaminants of Potential Concern (COPC)

Contaminant	Maximum Detected Concentration				Comparison Values (CV)		Selected as COPC
	Exposure Unit 1 (in mg/kg)	*Exposure Unit 2 (in mg/kg)*	*Exposure Unit 3 (in mg/kg)*	*Exposure Unit 4 (in mg/kg)*	*ATSDR Soil CV (in mg/kg)*	*EPA Regional Screening Level (in mg/kg)*	
Aluminum	2,390	9,240	3,860	12,400	**50,000 (Child cEMEG)**	77,000 (non-cancer)	
Arsenic	271	6.3	163	34.4	0.5 (CREG)	**0.39 (cancer)**	X
Cadmium	130.0	2.2	14.2	12.8	**5 (Child cEMEG)**	70 (non-cancer)	X
Chromium	0.62	8.80	1.6	9.2	50 (Child cEMEG)	**0.29 (VI-cancer)**	X
Copper	1,000.0	59.2	210	180	**500 (Child iEMEG)**	3,100 (non-cancer)	X
Iron	19,000	12,100	14,900	11,700	N/a	**55,000 (non-cancer)**	
Lead	44,200	1,730	12,600	4,030	400 (OSWER)	**400 (OSWER)**	X
Manganese	72.1	653	1,150	1,740	3,000 (Child RMEG)	**1,800 (non-diet, non-cancer)**	
Magnesium	160	2,850	704	3,500	N/a	N/a	
Mercury	0.18	1.10	0	1.0	N/a	**23 (non-cancer)**	
Nickel	0.47 U	5.2	1	6.2	**1,000 (Child RMEG)**	1,500 (soluble salts, non-cancer)	
Selenium	1.5	1.5 U	1.4U	2.6U	**300 (Child cEMEG)**	390 (non-cancer)	
Silver	231	2.3	16	5.8	**300 (Child RMEG)**	390 (non-cancer)	
Zinc	19,300	305	3,080	2,640	**20,000 (Child cEMEG)**	23,000 (non-cancer)	

TABLE A2 NOTES: mg/kg = milligram analyte per kilogram soil, **bolded** comparison values were used for COPC selection, N/a = Comparison Value Not available, cEMEG = chronic Environmental Media Evaluation Guide, iEMEG = Intermediate Environmental Evaluation Guide , CREG = Cancer Risk Evaluation Guide , OSWER = 0ffice of Solid Waste and Emergency Response, RMEG = Reference Dose Media Evaluation Guide

Table A3. Estimated Non-cancer Hazard Quotients for Recreational Users

COPC	Exposure Unit 1		Exposure Unit 2		Exposure Unit 3		Exposure Unit 4	
	Child	*Adult*	*Child*	*Adult*	*Child*	*Adult*	*Child*	*Adult*
Arsenic	4.0E-01	4.2E-02	9.2E-03	9.9E-04	2.4E-01	2.6E-02	2.9E-02	3.1E-03
Cadmium	5.7E-01	6.1E-02	9.6E-03	1.0E-03	6.2E-02	6.7E-03	2.9E-02	3.1E-03
Chromium	2.7E-04	2.9E-05	3.9E-03	4.1E-04	7.0E-04	7.5E-05	3.4E-03	3.6E-04
Copper	1.1E-02	1.2E-03	6.5E-04	7.0E-05	2.3E-03	2.5E-04	2.0E-03	2.1E-04
Hazard Index	9.8E-01	1.0E-01	2.3E-02	2.5E-03	3.0E-01	3.3E-02	6.3E-02	6.8E-03

NOTE: COPC: Contaminant of Potential Concern, 4.0E-01 is equivalent to 4 x 10^{-1} or 0.4, Hazard Quotient is equal to the estimated dose divided by the health-based guideline, Hazard Index is the sum of the hazard quotients from each COPC

Table A4. Estimated Cancer Risks associated with Recreational Use of the Ute-Ulay Site

COPC	Exposure Unit 1			Exposure Unit 2			Exposure Unit 3			Exposure Unit 4		
	Child	*Adult*	*Combined*	*Child*	*Adult*	*Combined*	*Child*	*Adult*	*Combined*	*Child*	*Adult*	*Combined*
Arsenic	1.5E-05	6.5E-06	2.2E-05	3.6E-07	1.5E-07	5.1E-07	9.2E-06	3.9E-06	1.3E-05	1.1E-06	4.8E-07	1.6E-06
Chromium	1.2E-08	5.0E-09	1.7E-08	1.7E-07	7.1E-08	2.4E-07	3.0E-08	1.3E-08	4.3E-08	1.4E-07	6.2E-08	2.1E-07
Total Cancer Risk	1.5E-05	6.6E-06	2.2E-05	5.2E-07	2.2E-07	7.4E-07	9.2E-06	4.0E-06	1.3E-05	1.3E-06	5.4E-07	1.8E-06

NOTE: COPC: Contaminant of Potential Concern, 1.5E-05 is equivalent to 1.5 * 10^{-5} or 15 excess cancer cases per million exposed individuals

Table A5. Estimated Non-cancer Hazard Quotients for Hostel Workers

COPC	Exposure Unit 1	Exposure Unit 2	Exposure Unit 3	Exposure Unit 4
Arsenic	4.9E-01	1.2E-02	3.0E-01	3.6E-02
Cadmium	7.1E-01	1.2E-02	7.8E-02	3.6E-02
Chromium	3.4E-04	4.8E-03	8.8E-04	4.2E-03
Copper	1.4E-02	8.1E-04	2.9E-03	2.5E-03
Hazard Index	1.2E+00	2.9E-02	3.8E-01	7.9E-02

Table A6. EstimatedCancer Risks for Hostel Workers at the Ute-Ulay site

COPC	Exposure Unit 1	Exposure Unit 2	Exposure Unit 3	Exposure Unit 4
Arsenic	8.0E-05	1.8E-06	4.8E-05	5.8E-06
Chromium	6.1E-08	8.6E-07	1.6E-07	7.5E-07
Total Cancer Risk	8.0E-05	2.7E-06	4.8E-05	6.6E-06

Table A9: Adult Lead Model Results for Hostel Workers

Exposure Unit (EU)	Geometric Mean Fetal Blood Lead Concentration (µg/dL)	Probability of fetal Blood Lead Exceeding 10 µg/dL
EU1	46.9	96.4%
EU2	3.4	4.2%
EU3	14.6	58.8%
EU4	3.2	3.4%

NOTE: µg/dL = micrograms lead per deciliter of blood, EU = Exposure Unit

Appendix B. Additional Exposure Assessment Information

This section provides additional information on the exposure assumptions and exposure doses that were used to evaluate the public health implications of surface soil exposures at the Ute-Ulay Townsite.

The two primary exposure pathways that are likely to occur in the future and were evaluated in this health consultation:

- Short term Recreational Users, and
- Hostel Workers

The recreational use exposure scenario evaluated in this health consultation is evaluated for future timeframes of exposure. The Hostel Worker exposure scenario is likely to occur in the future after the restoration and redevelopment of the Ute-Ulay Townsite. The primary exposure parameters that were used to evaluate each scenario are shown in detail below.

Exposure Parameters

The following exposure parameters were used to describe recreational users and hostel workers.

Table B1. Exposure Factors

Receptor	Recreational User	Source of Exposure Factor	Hostel Worker	Source of Exposure Factor
Exposure Frequency (days/year)	12 days	Site-specific Professional Judgment	140 days	Site-specific Professional Judgment
Exposure Duration (years)	Child: 6 yrs. Adult: 24 yrs.	RME Default Value (EPA 1997)	25 yr.	Site-specific Professional Judgment
Soil Ingestion Rate (mg/day)	Child: 200 mg/day Adult: 100 mg/day	Default Value (EPA 2002)	100 mg/day	Default Value (EPA 2002)
Body Weight (kg)	Child: 15 kg. Adult: 70 kg.	Default Value (PHAGM 2005)	70 kg.	Default Value (PHAGM 2005)
Non-Cancer Averaging Time (days)	Child: 2,190 days Adult: 10,950 days	Default Value (PHAGM 2005)	9125 days	Default Value (PHAGM 2005)
Cancer Averaging Time (days)	25,550 days	Default Value (EPA 1997)	25,550 days	Default Value (EPA 1997)

kg. = kilogram, mg. = milligram, RME: Reasonable Maximum Exposure
EPA (1997) = Environmental Protection Agency, Exposure Factors Handbook

EPA (2002) = Environmental Protection Agency, Supplemental Guidance for Developing Soil Screening Levels at Superfund Sites
EPA (2004) = Environmental Protection Agency, Risk Assessment Guidance for Superfund, Part E. Supplemental Guidance for Dermal Exposure, PHAGM (2005) = Agency for Toxic Substances and Disease Registry, Public Health Assessment Guidance Manual

Exposure Point Concentrations

The exposure concentrations used in this evaluation for each exposure unit are presented below in Table B2.

Table B2. Soil Exposure Point Concentrations

Contaminant of Potential Concern	Exposure Unit 1 EPC* (in mg/kg)	Exposure Unit 2 EPC* (in mg/kg)	Exposure Unit 3 EPC* (in mg/kg)	Exposure Unit 4 EPC** (in mg/kg)	ProUCL Recommended Statistical Method
Arsenic	271	6.3	163	19.8	95% Student's-t UCL
Cadmium	130	NS	14.2	6.6	95% Approximate Gamma UCL
Chromium	0.62	8.8	1.6	7.7	95% Student's-t UCL
Copper	1,000	NS	NS	NS	95% Approximate Gamma UCL
Lead	44,200	1,730	12,600	1,477***	N/a

* Only 1 composite soil sample is available for Exposure Units 1 and 2, and two composite soil samples are available for Exposure Unit 3. Therefore, the Exposure Point Concentration in EU 1, 2 and 3 is the maximum detected concentration.
** Eleven composite soil samples are available for Exposure Unit 4. Therefore, ProUCL Version 4.1.00 was used to estimate the Exposure Point Concentration for Exposure Unit 4 (EPA 2011).
*** As per EPA IEUBK and ALM Guidance, the mean value of lead was used as the model inputs (EPA 2007)
EPC: Exposure Point Concentration, **NS:** Not Selected as a Contaminant of Potential Concern in this Exposure Unit, **N/a:** Not applicable

Exposure Dose Equations and Results

Ingestion Pathway

Using Equation 1, the non-cancer exposure doses for soil ingestion were calculated for all non-lead surface soil contaminants of concern. Equation 1 applies to soil ingestion for recreational users and hostel workers. The estimated exposure doses for incidental ingestion of surface soil during recreational use are shown below in Table B3 and the estimated exposure doses for incidental ingestion of surface soil while working at the hostel are shown in Table B5.

Equation 1. Non-Cancer Soil Ingestion Dose

Non-Cancer Dose = (C_s * IRS * CF * EF * ED) / (BW * AT_{NC})

Where:
C_s = Chemical Concentration in Soil (in mg/kg or milligrams contaminant per kilogram of soil) Soil exposure point concentrations are found in Table A6
IRS = Ingestion Rate of Soil (in milligrams of soil per day)
FI = Fraction of soil ingested from contaminated source
CF = Conversion Factor (in kilograms per milligram)
EF = Exposure Frequency (in days per year)
ED = Exposure Duration (in years)
BW = Body Weight (in kilograms)
AT_{NC} = Non-Cancer Averaging Time (in days)

Example: Non-cancer Adult Recreational User ingestion dose of Arsenic, Exposure Unit 1 (Table B3) => (271 mg/kg * 100 mg/day * 10^{-6} kg/mg * 12 days per year * 24 years) / (70 kg. * 8,760 days) = **1.3 * 10^{-5} (1.3E-05) mg/kg-day**

Table B3. Estimated Non-cancer Exposure Dose Results from Recreational Use of the Ute-Ulay Site
(in milligrams of contaminant per kilogram body weight a day)

COPC	**Exposure Unit 1**		**Exposure Unit 2**		**Exposure Unit 3**		**Exposure Unit 4**	
	Child	***Adult***	***Child***	***Adult***	***Child***	***Adult***	***Child***	***Adult***
Arsenic	1.2E-04	1.3E-05	2.8E-06	3.0E-07	7.1E-05	7.7E-06	8.7E-06	9.3E-07
Cadmium	5.7E-05	6.1E-06	9.6E-07	1.0E-07	6.2E-06	6.7E-07	2.9E-06	3.1E-07
Chromium	2.7E-07	2.9E-08	3.9E-06	4.1E-07	7.0E-07	7.5E-08	3.4E-06	3.6E-07
Copper	4.4E-04	4.7E-05	2.6E-05	2.8E-06	9.2E-05	9.9E-06	7.9E-05	8.5E-06

NOTE: COPC: Contaminant of Potential Concern, 1.2E-04 is equivalent to 1.2 * 10^{-4} or 0.00012 mg/kg-day

Table B4. Estimated Non-cancer Exposure Dose Results for Hostel Workers at the Ute-Ulay Site
(in milligrams of contaminant per kilogram body weight a day)

COPC	**Exposure Unit 1**	**Exposure Unit 2**	**Exposure Unit 3**	**Exposure Unit 4**
Arsenic	1.5E-04	3.5E-06	8.9E-05	1.1E-05
Cadmium	7.1E-05	1.2E-06	7.8E-06	3.6E-06
Chromium	3.4E-07	4.8E-06	8.8E-07	4.2E-06
Copper	5.5E-04	3.2E-05	1.2E-04	9.9E-05

NOTE: COPC: Contaminant of Potential Concern, 1.5E-04 is equivalent to 1.5 * 10^{-4} or 0.00015 mg/kg-day

The equation used to calculate the exposure dose for cancer risks is similar to the non-cancer exposure dose equation shown above. The primary difference between the two is that non-cancer exposure doses are averaged over the time period of exposure and cancer exposures are averaged over a lifetime (70 years). As mentioned previously, it was assumed that the chromium detected in surface soil is hexavalent chromium because site-specific speciation of the chromium valency has not been performed. Therefore, the conservative assumption that chromium in site soils is hexavalent was made to be prudent of public health. In reality, it is more likely that the majority of chromium found onsite is trivalent chromium, which is not classified as a human carcinogen. Equation 2 was used to calculate surface soil ingestion doses for all receptors in this evaluation.

Equation 2. Cancer Soil Ingestion Dose

Cancer Dose = (C_s * CF * IRS * FI * EF * ED) / (BW * AT_C)

Where:
C_s = Chemical Concentration in Soil (in mg/kg or milligrams contaminant per kilogram of soil)
CF = Conversion Factor (in kilograms per milligram)
IRS = Soil Ingestion Rate (in milligrams of soil-year per kilogram body weight)
EF = Exposure Frequency (in days per year)
FI = Fraction ingested from contaminated source
ED = Exposure Duration (in years)
AT_C = Cancer Averaging Time (in days)

Example: Theoretical Cancer Dose of Chromium for the Child Recreational User, Exposure Unit 1 (Table B3) =>
(271 mg/kg * 10^{-6} kg/mg * 200 mg/day * 12 days/year * 6 years) / (33kg. * 25,550 days)
= 4.3 * 10^{-7} mg/kg/day

The resulting carcinogenic exposure doses from incidental ingestion of soil are shown below in Tables B5 and B6.

Table B5. Estimated Cancer Exposure Dose Results from Recreational Use of the Ute-Ulay Site
(in milligrams of contaminant per kilogram body weight a day)

COPC	Exposure Unit 1			Exposure Unit 2			Exposure Unit 3			Exposure Unit 4		
	Child	***Adult***	***Combined***	***Child***	***Adult***	***Combined***	***Child***	***Adult***	***Combined***	***Child***	***Adult***	***Combined***
Arsenic	1.0E-05	4.4E-06	1.5E-05	2.4E-07	1.0E-07	3.4E-07	6.1E-06	2.6E-06	8.7E-06	7.4E-07	3.2E-07	1.1E-06
Chromium	2.3E-08	1.0E-08	3.3E-08	3.3E-07	1.4E-07	4.7E-07	6.0E-08	2.6E-08	8.6E-08	2.9E-07	1.2E-07	4.1E-07

NOTE: COPC: Contaminant of Potential Concern

Table B6. Estimated Cancer Exposure Dose Results for Hostel Workers at the Ute-Ulay Site
(in milligrams of contaminant per kilogram body weight a day)

COPC	Exposure Unit 1	Exposure Unit 2	Exposure Unit 3	Exposure Unit 4
Arsenic	5.3E-05	1.2E-06	3.2E-05	3.9E-06
Chromium	1.2E-07	1.7E-06	3.1E-07	1.5E-06

NOTE: COPC: Contaminant of Potential Concern

Appendix C. Evaluation of Non-cancer Health Hazards Associated with Lead Exposure

Lead is naturally occurring element found at low levels in soils. At mining sites, lead is typically released either directly by targeting and removing lead from the mine, or indirectly through acid mine drainage, which has a low pH capable of releasing metals from their naturally bound state. Thus, lead is a common contaminant found at mining sites throughout the state. Lead is naturally occurring element found at low levels in soils. At mining sites, lead is typically released either directly by targeting and removing lead from the mine, or indirectly through acid mine drainage, which has a low pH capable of releasing metals from their naturally bound state. Thus, lead is a common contaminant found at mining sites throughout the state.

Exposure Assessment

Lead exposure can occur via multiple pathways (air inhalation and ingestion of water, food, soil, and dust). 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 7 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

Health effects of lead are well known from studies of children. 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. 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, i.e. most poisoned children have no symptoms. Extremely high levels of lead in children (BLL of 380 µg/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 which do not cause distinct symptoms, are associated with decreased intelligence and impaired neurobehavioral development (CDC, 1991). 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.

Recently, EPA developed candidate lead dust hazard standards (i.e. the amount of lead dust present on floors and window sills) aimed at providing various levels of protection for sensitive populations using blood lead concentration as a marker of adverse health effects (EPA 2011b). Blood lead concentrations of 1.0, 2.5, and 5.0 micrograms per deciliter were selected to protect children against IQ deficits in both residences and public and commercial buildings. It is however, important to note that in order to protect children against IQ deficits in both residences and public and commercial buildings, EPA's Science Advisory Board (SAB) Lead Review Panel recently recommended target blood lead concentrations of 1.0 and 2.5 micrograms per deciliter for dust lead hazard standard rulemaking (EPA, 2011b). The SAB does not support the high target blood lead concentration of 5 micrograms per deciliter due to recent studies indicating significant adverse health effects in children with blood lead concentrations well below 10 micrograms per deciliter (EPA 2011b).

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 non-cancer effects discussed above provide a more sensitive endpoint than cancer effects to assess health risks from exposure to lead.

CDC New 2012 Reference Value for Lead

Until recently, the U.S. Centers for Disease Control and Prevention (CDC) had established a level of concern for case management of 10 micrograms lead per deciliter of lead blood (µg/dL) (CDC 2005). Recent scientific research, however, has clearly shown that blood lead levels below 10 µg/dL can cause serious harmful effects in children. Blood lead levels below 10 µg/dL have been shown to cause neurological, behavioral, immunological, and developmental effects in young children. Specifically, lead causes or is associated with decreases in intelligent quotient (IQ); attention deficit hyperactivity disorder (ADHD); deficits in reaction time; problems with visual-motor integration and fine motor skills; withdrawn behavior; lack of concentration; issues with sociability; decreased height; and delays in puberty, such as breast and pubic hair development, and delays in menarche (CDC 2011; CDC 2012a; CDC 2012b). On January 4, 2012, CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended that CDC adopt the 97.5 percentile for children 1 to 5 years old as the reference value for designating elevated blood lead levels in children. The 97.5% currently is 5 µg/dL (CDC 2012a). On June 7, 2012, the CDC released a statement indicating concurrence with the recommendations of the ACCLPP (CDC 2012b).

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 or 0- 84 months (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 0-7 years or 0-84 months) as recreational users 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. The model calculates the expected distribution of blood lead and estimates the probability that any random child might have a blood lead value over 10 µg/dL. For example, using a combination of default parameters for the IEUBK model and using EPA's soil lead screening concentration of 400 mg/kg, the model estimates children have a 4.5% risk of exceeding 10 µg/dL. Stated another way, if 100 children lived on properties with an average of 400 mg/kg lead in soil, the IEUBK model predicts that four or fewer children out of 100 will exceed old CDC's 10 µg/dL, a blood lead level that corresponds to the EPA current residential lead screening level in soil. In this evaluation, the blood lead level of 10 µg/dL has been modified to 5 µg/dL in the IEUBK model to be consistent with the new 2012 CDC reference value noted above.

As shown in Table C1, Blood lead levels were estimated for children exposed for 12 days/year to the weighted soil lead concentrations and the background levels of lead at home (default assumption of 200 ppm).

The ALM Model for Outdoor Adults

In accordance with ATSDR guidelines, the EPA's Adult Lead Model (ALM) is used to estimate the blood lead level in fetuses from the predicted blood lead level of the pregnant mother. The evaluation of susceptible subpopulations to lead exposure, such as the fetus, is also considered protective of the general population. Therefore, if the blood lead concentration predicted in the fetus is not a concern at the site, exposures to lead by other recreational users is also not of concern.

It is important to note that the ALM relies on many input parameters to estimate blood lead levels. The 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 used the default values. These default values could result in an over- or under estimation of the actual blood lead levels in any fetus. When possible, the exposure parameters such as frequency, duration, and incidental ingestion of soil are the same values used in the non-lead evaluation. The Technical Review Workgroup (TRW) for lead recommends that 12 days (weekly exposure over a period of three months) should be the minimum exposure frequency used in the ALM (EPA OSWER #9285.7-76). All exposure parameters used for this model and risk evaluation are shown below in Tables C1 to C3. Please note that the blood lead level of 10 µg/dL has been modified to 5 µg/dL in the ALM model in this evaluation to be consistent with the new CDC reference value noted above.

Uncertainty in Risks Predicted by the IEUBK and ALM Lead Model

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 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 µg/dL (EPA, 2003a). This suggests that the target blood lead level of 5 µg/dL in fetuses and young children for the IEUBK model and ALM model may result in underestimation of lead hazards.

Table C1. IEUBK Time Weighted Soil Concentrations by Exposure Unit

Exposure Unit (EU)	Lead Exposure Point Concentration (in mg/kg)	Exposure Frequency (in days)	Averaging Time (in days)	Time Weighted Average Lead Concentration (in mg/kg)
EU 1	44,200	12	365	1,652
EU 2	1,730	12	365	250.5
EU 3	12,600	12	365	609.2
EU 4	1,477	12	365	242.1

NOTE:
Time Weighted Concentration Calculation:
Frequency of time spent at the site (F_{site}) = 12 days/365 days = 0.0033
Frequency of time spent at home (F_{home}) = 1-0.0033 = 0.967
Lead site = 0.0033 x 44,200 (EU 1 lead EPC) = 1,458.6 ppm
Lead home = 0.967 x 200 ppm (default) = 193.4 ppm
Lead site weighted (PbS_w) = 1,458.6 + 193.4 = 1,652 ppm

Table C2. Child IEUBK Input Parameters for Recreational Use

Exposure variable	EPA Default Value
Groundwater concentration (C_{gw})	4.0 µg/L
Soil to Dust Ingestion Weighting Factor (percent soil)	45% (0.45)
Geometric standard deviation (GSD) or interindividual variability	1.6
Soil Concentration (ppm)	Site-specific Time-Weighted (Table C1)
Concentration of Lead in Outdoor Air	0.1 µg/m^3
FDA dietary parameters	1.95 – 2.26 µg/day

NOTE: µg/L = micrograms lead per liter of water, µg/m^3 = micrograms lead per cubic meter of air, µg/day = micrograms of lead from dietary ingestion per day

Table C3. Adult Lead Model Inputs for Recreational Use and Hostel Workers

Description of Exposure Variable	Input Value	Units
Soil lead concentration	Exposure Unit 1: 44,200 Exposure Unit 2: 1,730 Exposure Unit 3: 12,600 Exposure Unit 4: 1,477	mg/kg
Fetal/maternal Blood Lead ratio	0.9	Unitless
Biokinetic Slope Factor	0.4	µg/dL per µg/day
Geometric standard deviation Blood Lead	2.1	--
Baseline Blood Lead	1.5	µg/dL
Soil ingestion rate (including soil-derived indoor dust)	0.050	g/day
Absorption fraction (same for soil and dust)	0.12	Unitless
Exposure frequency (same for soil and dust)	Recreational Adult: 12 Innkeeper: 140	days/yr
Averaging time (same for soil and dust)	365 (default)	days/yr

NOTE: mg/kg = milligram per kilogram, µg/dL = micrograms per deciliter, µg/day = micrograms per day, g/day = grams per day, yr = year

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), the duration of exposure (acute, subchronic, chronic or lifetime), the health condition of the person, the nutritional status of the person, and the life style and family traits of the person.

The U.S. Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease (ATSDR) have established oral reference doses (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 364 days, and 1-year to lifetime, respectively. The health-based guidelines for the contaminants of potential concern for this evaluation are listed below.

The toxicity assessment process is usually divided into two parts: the first characterizes and quantifies the cancer effects of the chemical, while the second addresses the non-cancer effects of the chemical. This two-part approach is employed because there are typically major differences in the risk assessment methods used to assess cancer and non-cancer effects. For example, cancer risks are expressed as a probability of suffering an adverse effect (cancer) during a lifetime and non-cancer hazards are expressed, semi-quantitatively, in terms of the hazard quotient (HQ), defined as the ratio between an individual's estimated exposure and the health guideline (MRL or RfD). HQs are not an estimate of the likelihood that an effect will occur, but rather an indication of whether there is potential cause for concern for adverse health effects.

Please note inhalation health guideline for arsenic was derived California EPA from studies of arsenic in drinking water and decreases in intellectual function in 10 year old children. Performance results from neurobehavioral testing and exposure to arsenic in drinking water were extrapolated to inhalation exposures. Performance results from neurobehavioral testing and exposure to arsenic in drinking water were extrapolated to inhalation exposures.

Methodology for in-depth evaluation of potential for noncancer health Effects

The estimated non-cancer exposure doses are compared with observed effect levels reported in the **critical toxicological and/or epidemiologic study** used to derive the health guideline in ATSDR Tox Profile and/or EPA IRIS database. In addition, the larger toxicological/epidemiological database is also evaluated, especially for critical chemicals with high concentrations in all media in order to gain a better understanding of the range of effect levels rather than focusing on a single dose level, which is used to derive the health guideline.

- When the estimated dose approaches or exceeds a Lowest-Observed -Adverse-Effect-Level (LOAEL), it is considered that it could *harm people's health* for longer term exposures, but evaluated for "urgent public health hazard for acute exposures based on other factors listed below.

The relevance of the critical study is carefully evaluated in relation to site-specific exposure conditions by taking into consideration the following factors:

- Animal or human study (adults or children)
- Relevance of effects observed in animals to humans
- High bolus dose or low /medium dose levels, dose regimens, and method of dosing
- Bioavailability of metals (arsenic, lead, copper) in the study matrix versus the environmental media evaluated (e.g., soil and water)
- Level of confidence in the critical study and uncertainties/limitations in supporting studies

For cancer effects, the toxicity assessment process has two components. The first is a qualitative evaluation of the weight of evidence that the chemical does or does not cause cancer in humans. Typically, this evaluation is performed by the EPA, using the system summarized in the table below:

Table D1. Cancer Classifications

Category	Meaning	Description
A	Known human carcinogen	Sufficient evidence of cancer in humans.
B1	Probable human carcinogen	Suggestive evidence of cancer incidence in humans.
B2	Probable human carcinogen	Sufficient evidence of cancer in animals, but lack of data or insufficient data from humans.
C	Possible human carcinogen	Suggestive evidence of carcinogenicity in animals.
D	Cannot be evaluated	No evidence or inadequate evidence of cancer in animals or humans.

For chemicals which are classified in Group A, B1, B2, or C, the second part of the toxicity assessment is to describe the carcinogenic potency of the chemical. This is done by quantifying how the number of cancers observed in exposed animals or humans increases as the dose increases. Typically, it is assumed that the dose response curve for cancer has no threshold, arising from the origin and increasing linearly until high doses are reached. Thus, the most convenient descriptor of cancer potency is the slope of the dose-response curve at low dose (where the slope is still linear). This is referred to as the Slope Factor (SF), which has dimensions of risk of cancer per unit dose. Conversely, the inhalation unit risk (IUR) is defined as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air.

Estimating the cancer SF and/or IUR is often complicated by the fact that observable increases in cancer incidence usually occur only at relatively high doses, frequently in the part of the dose-response curve that is no longer linear. Thus, it is necessary to use mathematical models to extrapolate from the observed high dose data to the desired (but unmeasurable) 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 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. This approach ensures that there is a margin of safety in cancer risk estimates.

Table D2. Non-cancer Toxicity Value Table

Analyte	**ATSDR Oral MRL (in mg/kg-day)**	**Source**	**EPA Oral Reference Dose (in mg/kg-day)**	**Source**
Aluminum	1.0	Chronic	1.0	PPRTV
Arsenic	0.0003	Chronic	0.0003	IRIS
Cadmium	0.0001	Chronic	0.001	IRIS (diet)
Chromium (hexavalent)	0.001	Chronic	0.003	IRIS (VI)
Copper	0.01	Acute & Int.	0.04	HEAST
Iron	NA		0.7	PPRTV
Lead	NA		NA	
Magnesium	NA		NA	
Manganese	NA		0.024	IRIS (modified)
Mercury	NA		0.0003	IRIS (HgCl2)
Nickel	NA		0.02	IRIS (soluble salts)
Selenium	0.005	Chronic	0.005	IRIS
Silver	NA		0.005	IRIS
Zinc	0.3	Chronic	0.3	IRIS

NOTE: Highlighted values were selected for use in this assessment, ATSDR = Agency for Toxic Substances and Disease Registry, MRL = Minimal Risk Level, IRIS = EPA Integrated Risk Information

System, PPRTV = EPA Provisional Peer Reviewed Toxicity Value, Cal EPA OEHHA = California Office of Environmental Health Hazard Assessment, HEAST = Health Effects Assessment Summary Tables

Table D3. Cancer Toxicity Guideline Values

Analyte	EPA Oral Slope Factor (in mg/kg-day^{-1})	Source
Arsenic	1.5	IRIS
Chromium (hexavalent)	0.5	New Jersey

NOTE: IRIS = EPA Integrated Risk Information System, PPRTV = EPA Provisional Peer Reviewed Toxicity Value, OEHHA = California Office of Environmental Health Hazard Assessment, New Jersey Department of Health and Senior Services