Health Consultation

GILT EDGE MINE SITE

LAWRENCE COUNTY, SOUTH DAKOTA

EPA FACILITY ID: SDD987673985

MAY 16, 2005

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

Health Consultation: A Note of Explanation

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

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

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Prepared by:

Superfund and Program Assessment Branch
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Executive Summary

Under current conditions the Gilt Edge Mine Site poses no apparent public health hazard; site access is restricted, and on-site surface water is not used for drinking or for other domestic purposes.

Into the future, however, the Gilt Edge Mine Site is an indeterminate public health hazard. ATSDR cannot predict what human activities (e.g., residential, agricultural, recreational) could occur at the site, nor can we predict the final outcome of site remediation.

Currently, because of limited access to the property, trespassing onto the site by children is unlikely. Still, because of the site's physical hazards, we support the ongoing efforts to limit access.

For any reasonably expected recreational activities, exposure to off-site surface water and stream sediment pose no apparent public health hazard.

The data that we reviewed show that exposures to metals in Galena domestic water wells will likely pose no apparent public health hazard. Moreover, we believe that the metals found in these wells are not site-related.

ATSDR also supports continued efforts to treat the highly acidic mine water on the site and efforts to prevent a catastrophic release.

This health consultation report will be provided to the appropriate agencies and stakeholders, and ATSDR will review additional environmental data if and when they become available.

Purpose

The Agency for Toxic Substances and Disease Registry (ATSDR) in Atlanta, Georgia, is part of the U.S. Department of Health and Human Services. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, also known as Superfund, ATSDR conducts public health assessments at sites the US Environmental Protection Agency (USEPA) places on the National Priorities List (NPL). This health consultation for the Gilt Edge Mine site was prepared in accordance with this statutory requirement.

In response to a request from the Governor of South Dakota, the USEPA placed the Lead, South Dakota Gilt Edge Mine Site on the NPL in December 2000. The Governor requested that EPA Region 8 propose the site for the NPL, provide emergency response actions, and provide long-term remedial cleanup. USEPA has funded and overseen numerous investigations at the site [1–13] and completed a Record of Decision for the Ruby Gulch Waste Rock Dump [14]. The Brohm Mining Corporation [15] and the Bureau of Reclamation [16] prepared closure plans for the site. USEPA (17) developed an interim water treatment plan in 2001.

ATSDR reviewed available documents, conducted site visits in 2001 and 2004, and met with federal, state and local agencies to gather site-related information, issues, and concerns. This health consultation presents our findings and conclusions, identifies site-related public health issues — including child or community concerns — and recommends follow-up actions to mitigate exposures. It also describes the methods and data used to evaluate exposures for this site.

Site Description

The Gilt Edge Mine is a 260-acre open pit, cyanide heap-leach gold mine developed in sulfide (acid-generating) rock material. It is located about 5 miles east of Lead, South Dakota, in the northern Black Hills. The mine is situated at the headwaters of cold-water fisheries and local water supplies. The operator went out of business, leaving behind 150 million gallons of acidic, metal-laden water in three open pits. Also left were millions of cubic yards of acid-generating waste rock requiring cleanup and long-term treatment. Remediation efforts are focused on treating this water, on capping 12 million cubic yards of waste rock to minimize the production of more acid water, and on the long-term treatment of acid water. Figures 1–8 show various aspects of this mine site.

The Gilt Edge Mine is in mountainous terrain in the northern Black Hills. Elevations in the site area range from 5,700 feet above mean sea level (msl) to 4,780 msl — a difference about 920 feet. Some of the mined pits have vertical slopes of more than 300 feet [6].

The general site area is dissected by steep drainage valleys, known locally as gulches (e.g., Hoodo Gulch, Terrible Gulch, Ruby Gulch, and Boomer Gulch). The mine site is at the head of Ruby Gulch, Terrible Gulch, Hoodo Gulch, and Strawberry Creek. Strawberry Creek flows southeastward into Bear Butte Creek. Rainwater runoff from the mine site also flows from Ruby Gulch into Bear Butte Creek. Bear Butte Creek flows from southwest to northeast, through the community of Galena, to the city of Sturgis via Boulder Canyon.

Much of the land surrounding the mine site is the federally owned Black Hills National Forest, thus the area only includes a limited number of homes. The closest community (about 0.6 mile from the mine site) is Galena, which has about 20 to 25 residents with homes along Bear Butte Creek. Galena residents obtain their drinking water from private wells.

A few homes were noted west of the site along Forest Route 534, an unpaved road connecting State Highway 385 to the mining area. These homes are, however, upgradient of the mining area.

Background

Since 1876, this small mining district has seen mining operations for gold, copper and tungsten. About a century ago, a series of small mines began dumping metal-laden mill tailings into Strawberry Creek and into Bear Butte Creek. Thus by 1986, when the State of South Dakota permitted Brohm Mining Company (BMC) to conduct larger-scale open-pit mining, off-site receiving waters had been extensively contaminated.

Under a State mining permit, BMC developed three open pits, a large cyanide heap-leach pad, and a 12-million cubic yard valley-fill waste-rock dump, as well as other operations. BMC also conducted cleanup activities to address some previously accumulated tailings off site. Early permit applications did not mention acid-generating materials; in fact, however, sulfidic heavy-metal-laden rock materials were abundant.

During 1998–99, BMC had serious financial difficulty and told the state that it could not continue site controls. The South Dakota Department of Environment and Natural Resources (DENR) maintained necessary water-treatment operations at the site, using the state's Regulated Substance Response Fund until August 2000, when operations were turned over to EPA.

In February 2000, the Governor of South Dakota requested that EPA Region 8 propose the site for the Superfund National Priorities List (NPL) and provide emergency response, as well as long-term remedial cleanup. The site was proposed in May 2000. Final listing was announced in December 2000.

Remediation

The Superfund Remedial Program has designated the following Operable Units (OU) as distinct management units in overall plan for the site:

- OU1 - Gilt Edge Mine site (the overall 258-acre area)
- OU2 - Interim Water Treatment Operations
- OU3 - Ruby Gulch Waste Rock Dump Cap Project (62 acres)

EPA has characterized site conditions through a series of remedial investigations. Mining waste materials, surface waters, and groundwater have all been thoroughly investigated and reported.

EPA has also conducted several feasibility studies and pilot tests and has published three Records of Decision (RODs). An Early-Action Interim Water-Treatment ROD enabled the Remedial Program to carry out site management, environmental controls, and water treatment. Another Interim Water-Treatment ROD calls for conversion of the existing water-treatment plant to improve the process and further reduce metals.

The Ruby Gulch Waste-Rock Repository and Cap ROD calls for a composite geomembrane cap and drainage/soil cover using surplus materials from a nearby highway project. Surface-water controls will also be put in place.

These actions will greatly reduce the risk associated with acid rock drainage. Most recently, EPA evaluated methods for improving the efficiency of the current system. This resulted in a ROD that

changes the water-treatment system to a new one, using lime in a high-density sludge process. These actions will reduce the long-term water-treatment costs for the state.

Several Web sites provide information on the remediation efforts and status of this site:

http://www.epa.gov/region8/sf/giltedge/

http://technology.infomine.com/enviromine/case_hist/richmondhill/ch1.html

http://www.state.sd.us/denr/denr.html

http://www.state.sd.us/denr/DES/ground/Superfund/Superfundpage.htm

http://www.state.sd.us/denr/DES/ground/groundprg.htm

2004 Site Visit

ATSDR staff visited the Gilt Edge Mine site and the surrounding areas during the week of 14 September 2004. The EPA Remedial Project Manager, an EPA contractor from the Bureau of Reclamation, and the South Dakota Department of Health Regional Manager accompanied ASTDR staff during the on-site tour. At the time of the site visit, the perimeter fence was intact and the security gate was locked. No evidence of trespass was noted.

ATSDR staff viewed the rural area southwest of the site by vehicle. This area is characterized by mountainous terrain and the Strawberry and Galena Creek drainages. We evaluated the potential for off-site exposure to contaminants from the Superfund site. ATSDR staff noted the location of residential homes, rural businesses, mine adits, monitoring wells and drinking water wells. Staff met with Regional Forest Service Managers to obtain maps and additional information about this site and the surrounding area, and met with the Lawrence County Planning and Zoning Office to evaluate possible development planned for the area around the former mine site.

Two residential areas were noted during the site visit: the community of Galena (20 to 25 residences) southwest of the site, and a group of about 5 to 7 homes west of the site along Forest Route 534 — an unpaved road connecting State Highway 385 to the mining area. The fire hydrants along the road indicate municipal water is available to these residences.

Abandoned mine adits (entrances to old mines) were observed within the stream valley and adjacent to a few residences in the Galena community. Rusted mining equipment resting along the stream valley is evidence of historical mining within the community area.

Stakeholders

Federal, state and local regulatory and natural resource management agencies have roles and responsibilities pertinent to this site, including long-term operation and maintenance. Non-governmental organizations and other parties also have interests in various aspects of site evaluation and remediation. Stakeholders identified by EPA to date include:

- Property owners
- Lawrence County Commission, Planning and Zoning Administration
  - South Dakota Department of Environment and Natural Resources
- Minerals and Mining Program, Ground Water and Surface Water Quality Programs
  - SD Department of Game, Fish and Park, Biological Assessment Program

  - U.S. Fish and Wildlife Service
  - USDA Forest Service
  - Cheyenne River Sioux Tribe
- Non-Governmental Organizations
  - Action for the Environment, Spearfish Canyon Preservation Trust, EarthLaw
  - Black Hills Flyfishers, Sierra Club, Prairie Hills Audubon Society
  - Spearfish Canyon Foundation

Evaluation of Exposure Pathways and Environmental Contaminants

An exposure pathway is a route by which a person can come in contact with chemicals originating from a contamination source. An exposure pathway consists of the following five elements:

1. a source of contamination,
2. a media such as air or soil through which the contaminant is transported,
3. a point of exposure where people can contact the contaminant,
4. a route of exposure by which the contaminant enters or contacts the body, and
5. a receptor population.

A pathway is considered complete if all five elements are present and connected. If one of these elements is missing, the pathway is considered incomplete, and human exposure is not possible.

ATSDR evaluated the potential for human exposure to metals from Gilt Edge Mine in a 4-step process. First, we examined the pathways by which people could come in contact with metals from Gilt Edge Mine. Second, we screened the contaminants found in each exposure pathway to determine if levels were sufficient to warrant further health evaluation. Third, for metals present at levels above screening values, we estimated the amount (dose) that people could ingest. In the final step, we determined whether a reasonable combination of dose and duration (amount of time a person might be exposed) was sufficient to cause illness or other adverse health problems.

To screen for contaminants of concern in each exposure pathway, we used environmental media evaluation guides (EMEGs). These are very conservative levels derived for chemicals on the basis of toxicity, frequency of occurrence at National Priorities List (NPL) sites, and potential for human exposure. They are intended to protect the most sensitive populations and are not clean-up levels. They do not consider carcinogenic effects, chemical interactions, or multiple routes of exposure. EMEGs are derived from ATSDR minimal risk levels (MRLs).

The only known site contaminants are metals. Appendix A includes summary tables for the metals data which we reviewed to evaluate public health concerns. Most metals were found below levels of concern, were present in only a few samples, or were in locations where the public is not likely to come into contact with them. ATSDR will review future site-related data when it is available. The following exposure pathway sections discuss our evaluation of chemicals found at this site.

On-site Soil

On-site soil data included in the Site Inspection Report (14) are summarized in Appendix A (Table A1). Arsenic, cadmium, copper and manganese exceeded environmental comparison values (Table

A1). People currently exposed to on-site soils are workers involved with remediation efforts at the site and occasional official visitors. The public is not currently exposed to on-site soils.

Off-site Surface Water

We reviewed off-site surface water data included in the Site Inspection Report (14). Our summary is shown in Table A2. Cadmium exceeded its environmental comparison value. Surface water is not currently used for drinking water in the vicinity of the site. Current recreational activities in local streams appear to be minimal.

Off-site Stream Sediment

We reviewed off-site stream sediment data included in the Site Inspection Report (14). Our summary is shown in Table A3. Arsenic, cadmium and copper exceeded environmental comparison values. Current recreational activities in local streams appear to be minimal.

Domestic Well Water

After reviewing EPA groundwater investigations and latest monitoring results, it is very unlikely that the acidic and metal laden on-site groundwater reaches the current domestic wells in the Galena community. Metals detected in the domestic wells are more likely to be derived from the historical mining operations within the Galena community as evidenced by presence of abandoned mine adits and rusting mining equipment within the stream valley.

Although we do not believe a groundwater pathway connects the site with domestic wells in the Galena community, as part of our public health evaluation we reviewed domestic well water data included in the Site Activities Report (13). Eleven domestic groundwater wells were sampled two times in 2000 and analyzed for metals (Table A4). Maximum arsenic, copper and thallium levels exceeded environmental comparison values. Arsenic was found in 7 of 42 samples, copper in 19 and thallium in 5 samples. While exposure to these metals in domestic well water is considered sporadic, they were evaluated further to determine potential health concerns.

Further Evaluation of Selected Contaminants

The few metals exceeding Environmental Media Evaluation Guides (EMEGs) were evaluated further to assess the potential health risks. We used either ATSDR MRLs or EPA reference doses (RfDs) for non-cancer health effects. MRLs are ATSDR estimates of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), non-cancer effects. MRLs are calculated for specific routes of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful health effects. A reference dose is an EPA estimate — with uncertainty or safety factors built in — of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

The cancer risk evaluation guide (CREG) values are based on EPA chemical-specific cancer slope factors. CREG values are based on an estimated risk of one additional cancer in one million people exposed over a 70-year lifetime. Many assumptions used to calculate health guideline values are conservative with respect to protecting public health. Consequently, exceeding a health guideline value does not necessarily indicate that adverse health effects will occur.

MRLs and RfDs are based on the assumption of a chemical exposure threshold below which adverse health effects are not likely. Thus, MRLs and RfDs are conservative estimates of the daily exposure to contaminants that are unlikely to cause adverse health effects — even if exposure occurs for a lifetime.

On-site surface soil samples

The maximum arsenic level exceeded the EMEG and the CREG in on-site surface soil samples (Table A1). To estimate exposure potential, ATSDR used a conservative exposure scenario of 5 days/week, 50 weeks/year, for 30 years to the maximum arsenic level. The resulting exposure estimate is just at the MRL, and the theoretical excess cancer risk is in the moderate category (Table A5). Site access is restricted, and the public would not be consistently exposed to maximum arsenic levels. Thus, exposure levels, cancer risks, and frequencies of exposure would be much lower than indicated by our conservative estimate.

Cadmium, copper and manganese also exceeded respective comparison values in on-site surface soil samples. We used a conservative exposure scenario of 5 days/week for 50 weeks/year to the maximum levels (Table A1) to estimate exposure potential. The resulting exposure estimates are well below health guideline levels as represented by MRLs and RfDs (Table A5). Site access is restricted, thus the public is not expected to be exposed consistently to maximum metal levels present. Accordingly, any reasonably expected exposures would be lower than our estimates.

Off-site surface water

Cadmium exceeded the comparison value in surface water samples (Table A2). A very conservative exposure scenario using 2 liters/day for drinking water indicated exposures below the MRL (Table A5). Occasional recreational exposures to surface water in the area would result in much lower exposures.

Off-site stream sediment

The maximum arsenic level in sediment exceeded the EMEG and CREG (Table A3). To assess child exposure we used an exposure scenario of occasional recreational activity 2 days/week, 12 weeks/ year for 9 years. We also used incidental sediment ingestion of 200 mg/day. Our arsenic exposure estimate is well below the MRL, and our theoretical excess cancer risk estimate is considered low (Table A5).

Cadmium and copper exceeded their respective comparison values in sediment (Table A3). Again, to assess child exposure we used a scenario of occasional recreational activity 2 days/week for 12 weeks/ year. We also used incidental sediment ingestion of 200 mg/day. Resulting estimates of cadmium and copper exposures were below the respective MRLs (Table A5).

Domestic Wells

Arsenic exceeded the EMEG and the CREG in domestic well samples (Table A4). Lifetime estimates (70 years) using the maximum arsenic level indicated exposures in the same range as the MRL for non-cancer health effects. The lifetime estimate for excess cancer risks was in the moderate range (Table A5). Actual exposures would be lower because people are not exposed to the maximum arsenic level all the time.

The maximum copper level reported for domestic well samples exceeded the screening value (Table A4). Our lifetime exposure estimate for copper was below the intermediate MRL (Table A5). Copper was found in less than half of the domestic well samples, and actual exposures are expected to be well below our estimate.

The maximum thallium level found in domestic well samples exceeded the USEPA lifetime health advisory (0.5ug/l) screening value (Table A4). Our lifetime exposure estimate was about two times greater than the lifetime health advisory level published by USEPA. Thallium was found in only five domestic well samples, and actual exposures are expected to be well below our estimate.

Public Health Implications

On-site Soil and Surface Water

Site access is currently restricted, with no residences on site property. Thus, current exposure to on-site soil and surface water poses no apparent public health hazard. If residential housing is considered as a future use for this site (upon completion of remediation), this exposure pathway should be re-evaluated.

Off-site Surface Water

Surface water in the vicinity of the site is not used for drinking water. Recreational activities in local streams appear to be minimal. Actual exposure to metals in surface water through ingestion or dermal exposure is considered unlikely and infrequent. Thus, exposure to surface water in the vicinity of the Gilt Edge Mine Site is considered to pose no apparent public health hazard.

Stream Sediment

Exposure to metals in sediments of local streams is considered unlikely or infrequent. Exposure to stream sediment would not likely result in adverse health effects. Therefore, exposure to metals in stream sediment currently poses no apparent public health hazard.

Domestic Well Water

Lifetime exposure estimates for arsenic, copper and thallium in domestic well water indicated that adverse health effects are unlikely. People are likely to be exposed to levels much lower than the maximum values used for our estimates. Also arsenic and thallium were found in only a few samples, and copper was found in about half. Domestic well water in the vicinity of this site is considered to pose no apparent public health hazard.

Future Public Health Hazards

Our finding of no apparent public health hazard is based on current site conditions. This includes efforts made to prevent catastrophic release of highly acidic water from the site and limiting site access to trained remedial workers. A catastrophic release of highly acidic water into Strawberry Creek could lead to chemical burns for people using Strawberry Creek for recreation or for Galena residents living adjacent to Bear Butte Creek.

Land use changes that would allow the general public access to the site before final remediation is complete could lead to greater chances for chemical burns from exposure to water in the mining pits and in the processing impoundments. It also increases the chances for serious physical injury or death from falls on steep terrain or into the impoundments.

Children's Health Considerations

ATSDR evaluated the likelihood for children living in the vicinity of the Gilt Edge Mine Site to be exposed to site contaminants at levels of health concern. Trespassing onto the site by children is unlikely because of limited access to the property. Should trespassing occur, however, exposure to contaminated sediment and surface water would likely be infrequent and not at sufficient concentrations to cause a health concern. Because of the physical hazards at this site, ATSDR supports EPA efforts to restrict access.

Conclusions

Under current conditions, the Gilt Edge Mine Site is considered to pose no apparent public health hazard for the following reasons:

1. Current exposure to on-site soil and surface water are considered incomplete pathways because site access is restricted, and because on-site surface water is not used for drinking water. These pathways currently pose no apparent public health hazard.
2. Current exposure to off-site surface water and stream sediment are considered complete exposure pathways, but for any reasonably expected recreational activities, they represent no apparent public health hazard.
3. Current and past exposures to metals in domestic well water are not considered site-related pathways. Given the data we reviewed, these exposures are considered to pose no apparent public health hazard.
4. Past on-site exposures are considered complete pathways. No information is available with which to assess these exposures, and they are considered an indeterminate public health hazard.
5. For the future, the Gilt Edge Mine Site is an indeterminate public health hazard; we cannot predict what human activities (e.g., residential, agricultural, recreational) might occur at the site in the future, nor can we predict the final outcome of the site remediation.
6. Current exposure to on-site soil and surface water are considered incomplete pathways because site access is restricted, and because on-site surface water is not used for drinking water. These pathways currently pose no public health hazard.
7. Current exposure to off-site surface water and stream sediment are considered complete exposure pathways, but they represent no apparent public health hazard for any reasonably expected recreational activities.
8. Past on-site exposures are considered complete pathways. But no information is available with which to assess these exposures, and they are considered an indeterminate public health hazard.

Concerns about future on-site exposures are contingent on remediation and future use of the site. Future recreational exposure to surface water and sediment are considered to pose no apparent public health hazard.

Recommendations

- Continue to restrict public access to the site and maintain fencing to prevent unauthorized access.
- Continue to remediate contaminated on-site soils to mitigate future exposure risks
- Maintain water treatment process to prevent catastrophic release of highly acidic mine water.
- Private owners of domestic water wells should consider routine testing for metals and arsenic.

Public Health Action Plan

- This health consultation report will be provided to the appropriate agencies and stakeholders.
- ATSDR will review additional environmental data when they become available.

Authors, Technical Advisors, and Organizations

Authors

W. Allen Robison, Ph.D.

Toxicologist
ATSDR
Division of Health Assessment and Consultation

John Mann, PG

Geologist
ATSDR
Division of Health Assessment and Consultation

Dan Strausbaugh, MPH

ATSDR
Division of Regional Operations

Reviewers

Roberta Erlwein, Team Leader

Division for Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Rick Gillig, Branch Chief

Superfund and Program Assessment Branch
Agency for Toxic Substances and Disease Registry

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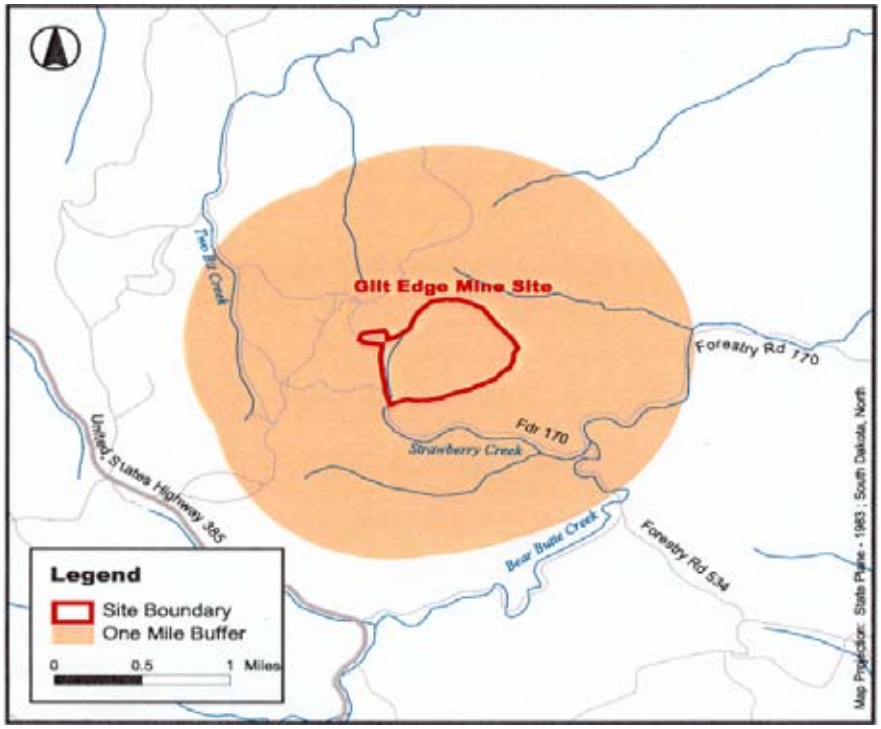
Figures

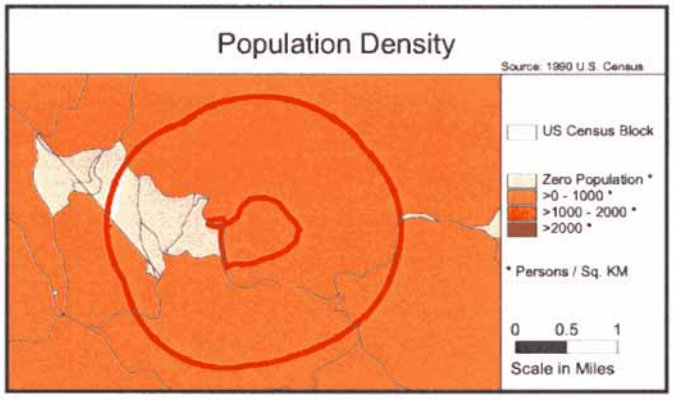
Figure 1a. Site location.



Ba.a **Map** Source 1995 TIGERIUna Alas

Figure 1b. Demographic information.

Demographic Statistics Within One Mile of Site*	
Total Population	30
White	29
Black	0
American Indian, Eskimo, Aleut	1
Asian or Pacific Islander	0
Other Race	0
Hispanic Origin	0
Children Aged 6 and Younger	2
Adults Aged 65 and Older	2
Females Aged 15 - 44	7
Total Housing Units	18



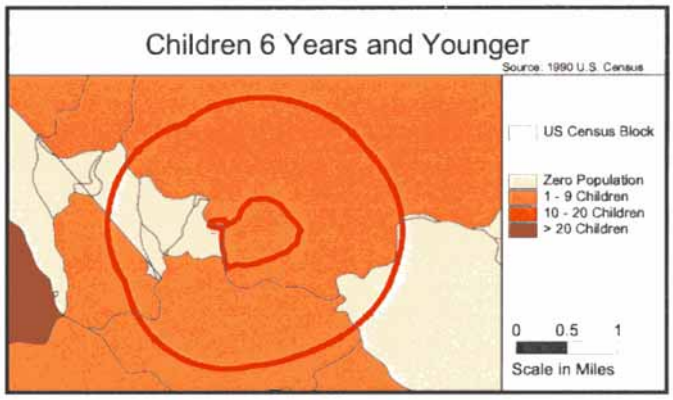
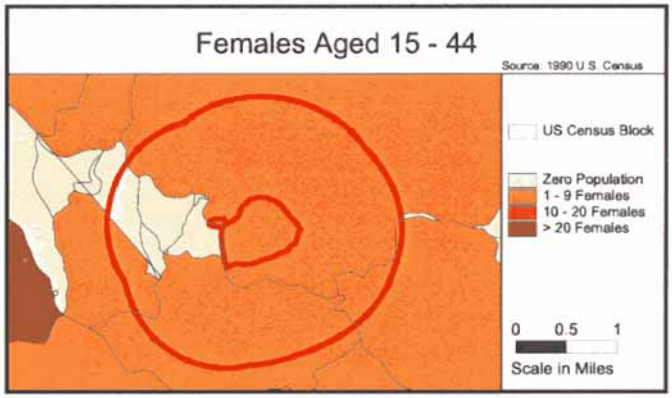


Figure 1b, continued. Demographic information.



Demographics Statistics Source 1990 US Census

'Calculated using an aroa-proporlion spatial analysis tedVliqua

Figure 2. Map of Gilt Edge Mine Site

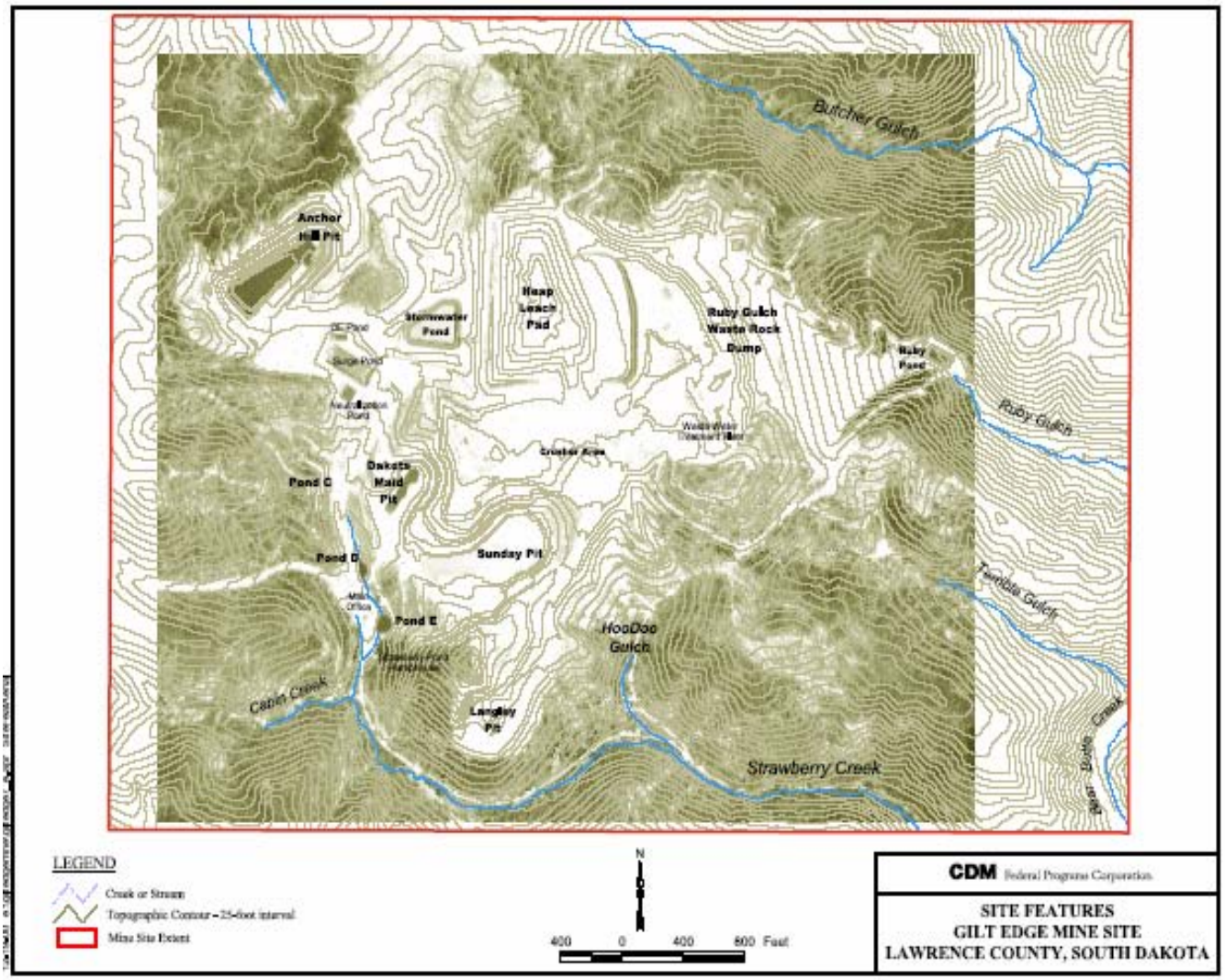


Figure 3. Aerial photograph of Gilt Edge Mine Site.

Figure 4. Sediment retention pond for heap leach pad and portion of Ruby Gulch Waste Rock Cap.

Figure 5. On-site treatment of acid mine drainage.

Figure 6. Ruby Gulch Waste Rock Dump Cap Project

Figure 7. Anchor Hill Pit at Gilt Edge Mine Site

Figure 8. On-site Treatment of Acid Mine Drainage

Appendix A. Tables

Table A1. Summary of On-site (Source) Soils Data from Site Inspection Report (14).

Metals	*Frequency Detected*	*Maximum (mg/kg)*	*ATSDR Screening Values (mg/kg) Used*		*Further Evaluation Done?*
			NC*	C*	
Aluminum	9/9	29,200	100,000(i)	NA*	No
Antimony	0/9	6.1	20 ®	NA	No
Arsenic	9/9	640	20	0.5	Yes[a]
Barium	9/9	810	4,000 ®	NA	No
Beryllium	6/9	6.9	100	NA	No
Cadmium	7/9	16.3	10	NA	Yes [a]
Calcium	8/9	22,400	NA	NA	No
Chromium	9/9	27.3	200 ®	NA	No
Cobalt	9/9	23.8	500 (i)	NA	No
Copper	9/9	753	500 (i)	NA	Yes [a]
Iron	9/9	83,600	NA	NA	No
Lead	9/9	775	NA	NA	No
Magnesium	9/9	5,550	NA	NA	No
Manganese	9/9	7,590	3,000 ®	NA	Yes [a]
Mercury	1/9	0.020	20	NA	No
Nickel	6/9	60.3	1,000 ®	NA	No
Potassium	9/9	5,430	NA	NA	No
Selenium	4/9	11.9	300	NA	No
Silver	9/9	11.0	300 ®	NA	No
Sodium	9/9	903	NA	NA	No
Thallium	0/9	2.3	NA	NA	No
Vanadium	9/9	51.6	200(i)	NA	No
Zinc	9/9	1,390	20,000	NA	No
Cyanide	4/9	0.27	1,000 ®	NA	No

*NA= not available. NC=non-cancer; C=cancer. Where zero frequency detected is shown, the maximum value given is the reported sample quantitation limit.

Notes: ATSDR chronic child environmental media evaluation guides (EMEGS) were used as screening values for **non-cancer** health effects, unless otherwise noted. Intermediate child EMEGs denoted by (i); child reference doses EMEGs denoted by ®; lifetime health advisory values denoted by (L). For **cancer**, ATSDR cancer risk evaluation guides (CREGs) for $1x10^{-6}$ excess cancer risk (one in a million) are shown.

[a] Chemicals exceeding environmental comparison values were evaluated further. Our conservative exposure estimates were below health comparison values. Our conservative theoretical excess cancer risk estimates were in the moderate category.

Table A2. Summary of Off-site Surface Water Data from Site Inspection Report (14).

Metals	*Frequency Detected*	*Maximum (ug/L)*	*ATSDR Screening Values (ug/L) Used*		*Further Evaluation Done?*
			NC*	C*	
Aluminum	8/11	527	20,000(i)	NA*	No
Antimony	0/11	3.5	4 ®	NA	No
Arsenic	0/11	3.7	3	0.02	No
Barium	11/11	54	700 ®	NA	No
Beryllium	0/11	0.30	20	NA	No
Cadmium	4/11	4.1	2	NA	Yes [a]
Calcium	11/11	82,100	NA	NA	No
Chromium	2/11	1.5	30 ®	NA	No
Cobalt	4/11	4.8	100 (i)	NA	No
Copper	11/11	105	100 (i)	NA	No
Iron	11/11	721	NA	NA	No
Lead	1/11	22.5	NA	NA	No
Magnesium	11/11	19,300	NA	NA	No
Manganese	4/11	363	500 ®	NA	No
Mercury	0/11	0.10	3	NA	No
Nickel	3/11	11.6	100 (L)	NA	No
Potassium	11/11	3,030	NA	NA	No
Selenium	0/11	3.1	50	NA	No
Silver	0/11	0.70	50 ®	NA	No
Sodium	11/11	40,700	NA	NA	No
Thallium	0/11	4.09	0.5 (L)	NA	No
Vanadium	0/11	1.4	30 (i)	NA	No
Zinc	6/11	145	3,000	NA	No
Cyanide	0/11	0.60	200 ®	NA	No

*NA= not available. NC=non-cancer; C=cancer. Where zero frequency detected is shown, the maximum value given is the reported sample quantitation limit.

Notes: ATSDR chronic child environmental media evaluation guides (EMEGS) were used as screening values for **non-cancer** health effects, unless otherwise noted. Intermediate child EMEGs denoted by (i); child reference doses EMEGs denoted by ®; lifetime health advisory values denoted by (L). For **cancer**, ATSDR cancer risk evaluation guides (CREGs) for $1x10^{-6}$ excess cancer risk (one in a million) are shown.

[a] Chemicals exceeding environmental comparison values were evaluated further. Our conservative exposure estimates were below health comparison value. Our conservative theoretical excess cancer risk estimates were in the moderate category.

Table A3. Summary of Off-site Stream Sediment Data from Site Inspection Report (14).

Metals	*Frequency Detected*	*Maximum (mg/kg)*	*ATSDR Screening Values (mg/kg) Used*		*Further Evaluation Done?*
			NC*	C*	
Aluminum	9/9	20,500	100,000(i)	NA*	No
Antimony	0/9	2.0	20 ®	NA	No
Arsenic	9/9	298	20	0.5	Yes[a]
Barium	9/9	172	4,000 ®	NA	No
Beryllium	9/9	2.2	100	NA	No
Cadmium	7/9	12.2	10	NA	Yes [a]
Calcium	9/9	12,700	NA	NA	No
Chromium	9/9	31.4	200 ®	NA	No
Cobalt	9/9	32.2	500(i)	NA	No
Copper	9/9	1,200	500(i)	NA	Yes [a]
Iron	9/9	48,400	NA	NA	No
Lead	9/9	256	NA	NA	No
Magnesium	9/9	6,030	NA	NA	No
Manganese	9/9	1,580	3,000 ®	NA	No
Mercury	2/9	0.73	20	NA	No
Nickel	9/9	39.7	1,000 ®	NA	No
Potassium	9/9	4,220	NA	NA	No
Selenium	1/9	5.1	300	NA	No
Silver	9/9	3.1	300 ®	NA	No
Sodium	9/9	310	NA	NA	No
Thallium	0/9	2.8	NA	NA	No
Vanadium	9/9	38.7	200(i)	NA	No
Zinc	9/9	658	20,000	NA	No
Cyanide	3/9	0.69	1,000 ®	NA	No

*NA= not available. NC=non-cancer; C=cancer. Where zero frequency detected is shown, the maximum value given is the reported sample quantitation limit.

Notes: ATSDR chronic child environmental media evaluation guides (EMEGS) were used as screening values for **non-cancer** health effects, unless otherwise noted. Intermediate child EMEGs denoted by (i); child reference doses EMEGs denoted by ®; lifetime health advisory values denoted by (L). For **cancer**, ATSDR cancer risk evaluation guides (CREGs) for $1x10^{-6}$ excess cancer risk (one in a million) are shown.

[a] Chemicals exceeding environmental comparison values were evaluated further. Our conservative exposure estimates were below health comparison values. Our conservative theoretical excess cancer risk estimates were in the moderate category.

Table A4. Summary of Domestic Water Well Data from Site Activities Report (13).

Metals	*Frequency Detected*	*Maximum (ug/L)*	*ATSDR Screening Values (ug/L) Used*		*Further Evaluation Done?*
			NC*	C*	
Aluminum	14/42	804	20,000(i)	NA*	No
Antimony	4/42	3.8	4 ®	NA	No
Arsenic	7/42	10.2	3	0.02	Yes [a]
Barium	36/42	82.9	700 ®	NA	No
Beryllium	0/42	0.6	20	NA	No
Cadmium	1/42	3	2	NA	No
Calcium	41/42	63,300	NA	NA	No
Chromium	2/42	0.4	30 ®	NA	No
Cobalt	8/42	0.8	100 (i)	NA	No
Copper	19/42	192	100 (i)	NA	Yes [a]
Iron	25/42	5030	NA	NA	No
Lead	10/42	12.5	NA	NA	No
Magnesium	39/42	45,600	NA	NA	No
Manganese	31/42	358	500 ®	NA	No
Mercury	0/42	0.2	3	NA	No
Nickel	4/42	1.3	100 (L)	NA	No
Potassium	40/42	5,920	NA	NA	No
Selenium	18/42	4.4	50	NA	No
Silver	0/42	0.3	50 ®	NA	No
Sodium	41/42	97,600	NA	NA	No
Thallium	5/42	6.3	0.5 (L)	NA	Yes [a]
Vanadium	9/42	0.7	30 (i)	NA	No
Zinc	35/42	403	3,000	NA	No

*NA= not available. NC=non-cancer; C=cancer. Where zero frequency detected is shown, the maximum value given is the reported sample quantitation limit.

Notes: ATSDR chronic child environmental media evaluation guides (EMEGS) were used as screening values for **non-cancer** health effects, unless otherwise noted. Intermediate child EMEGs denoted by (i); child reference doses EMEGs denoted by ®; lifetime health advisory values denoted by (L). For **cancer**, ATSDR cancer risk evaluation guides (CREGs) for $1x10^{-6}$ excess cancer risk (one in a million) are shown.

[a] Chemicals exceeding environmental comparison values were evaluated further. Our conservative exposure estimates were below health comparison value. Our conservative theoretical excess cancer risk estimates were in the moderate category.

Table A5. Summary of Toxicological Evaluation for Chemicals Exceeding Environmental Comparison Values

Chemical	*Estimated Exposure Dose (mg/kg/day)*	*Oral MRL*	*Chronic Oral RfD*	*Cancer Slope Factor*	*Cancer Class*	*Theoretical Excess Cancer Risk*
On-site Surface Soil						
Arsenic	0.00031	0.0003	0.0003	1.5	A	2.0×10^{-4} (moderate)
Cadmium	0.000008	0.0002	0.0005	NA	NA	NA
Copper	0.00037	0.01 (i)	---	NA	NA	NA
Manganese	0.0037	---	0.14	NA	NA	NA
Off-site Surface Water						
Cadmium	0.000008	0.0002	---	NA	NA	NA
Stream Sediment						
Arsenic	0.00011	0.0003	0.0003	1.5	A	2.2×10^{-5} (low)
Cadmium	0.000005	0.0002	0.0005	NA	NA	NA
Copper	0.00045	0.01 (i)	---	NA	NA	NA
Domestic Wells						
Arsenic	0.00029	0.0003	0.0003	1.5	A	4.4×10^{-4} (moderate)
Copper	0.0055	0.01 (i)	---	NA	NA	NA
Thallium	0.00018		0.00008	NA	NA	NA

MRLs are chronic unless noted otherwise; i-denotes intermediate MRL. Units for MRLs and RfDs are mg/kg/day. A-human carcinogen; B2-Probable human carcinogen; C-possible human carcinogen; D-not classified. NA-Not Applicable.

MRLs were obtained from http://www.atsdr.cdc.gov/mrls.html and RfDs were obtained from http://www.epa.gov/iris/ (last accessed 16 Dec 2004). Chemical specific information obtained from ATSDR Toxicological Profiles available at http://www.atsdr.cdc.gov/toxpro2.html.

Appendix B - Estimating Exposure Doses

This appendix briefly provides the basic equations and assumptions used to further evaluate chemicals that exceeded environmental comparison values. It also contains example calculations. It is adapted from the ATSDR Public Health Assessment Guidance Manual [18, 19]. The following equation was used to estimate exposure to chemicals for non-cancer health concerns:

$$\text{Estimated Exposure Dose (EED)} = \frac{\text{Contaminant Concentration (CC)} \times \text{Ingestion Rate (IR)} \times \text{Exposure Factor (AEF)}}{\text{Body Weight (BW)}}$$

EED = Estimated exposure dose (mg/kg-day) to specific chemical or contaminant

CC = contaminant concentration (mg/L for water; mg/kg for soil or sediment)

IR = Ingestion rate (L/day for water; mg/day for soil or sediment)

Water (2 L/day for adults; 1 L/day for children)

Soil or Sediment (50 mg/day for adults; 200 mg/day for children)

BW = Body weight (70 kg for adults; 35 kg for children)

EF = Exposure Factor (see below)

$$EF = \frac{\text{Exposure Frequency} \times \text{Annual Exposure Duration} \times \text{No. of Years of Exposure}}{\text{Averaging Time (usually 365 days} \times \text{Years of Exposure)}}$$

The estimated exposure dose (EED) is calculated from available site specific information. The amount of water, soil, or sediment ingested by people is described by an ingestion rate (IR). The frequency and duration of exposure on a yearly basis is expressed as an annual exposure factor (AEF) to ease calculations. Estimated body weight (BW) for adults or children is the denominator of the equation.

For cancer, lifetime excess cancer risks are calculated for a 70 year exposure period as follows:

$$\text{Estimated Exposure Dose (mg/kg/day)} \times \text{Cancer Slope Factor (mg/kg/day}^{-1}\text{)}$$

Excess cancer risks for exposures less than an entire lifetime are calculated as follows:

$$(\text{Estimated Exposure Dose} \times \text{Cancer Slope Factor}) \times \frac{\text{No. of Years Exposed}}{\text{70 year lifetime}}$$

A typical less-than-lifetime exposure period is the residence time in the community where the exposure occurred. Two such residence times often used are 30 years for the maximum time at one residence and 9 years for the median time at one residence (USEPA 1997). In this consultation, we took a conservative approach by considering only lifetime exposures.

Example Calculations

Exposure estimate for adults to arsenic in on-site soil

Exposure assumptions: 5 days per week, 50 weeks per year, for 30 years

$$EF = \frac{\text{Exposure Frequency} \times \text{Annual Exposure Duration} \times \text{No. of Years of Exposure}}{\text{Averaging Time (usually 365 days} \times \text{Years of Exposure)}}$$

$$\text{Adult EF} = \frac{5 \text{ days/week} \times 50 \text{ weeks/year} \times 30 \text{ years}}{365 \text{ days/year} \times 30 \text{ years}} = \frac{7{,}500 \text{ days}}{10{,}950 \text{ days}} = 0.68$$

$$\text{Adult EED} = \frac{640 \text{ mg/kg} \times 50 \text{ mg/day} \times 0.68 \times 10^{-6} \text{ kg/mg}}{70 \text{ kg}} = \frac{0.02176}{70} = 0.00031 \text{ mg/kg/day}$$

Conclusion

This conservative estimated adult exposure dose is at the current MRL of 0.0003 mg/kg/day. We think this indicates that the public (visitors/trespassers) are unlikely to have exposures to arsenic that could cause non-cancer adverse health effects. We are unable to evaluate actual past worker exposure because relevant information is not available.

Theoretical Excess Cancer Risks

(Estimated Exposure Dose × Cancer Slope Factor) × *No. of Years Exposed*

70 year lifetime

$(0.00031 \text{ mg/kg/day} \times 1.5) \times 30/70 = 0.0002 = 2.0 \times 10^{-4}$ = 2 per 10,000 (moderate)

Theoretical excess cancer risk calculated from the conservative exposure estimate indicates that if 10,000 people were exposed for 30 years, 2 additional cancer cases could occur. The baseline cancer rate in the U.S. is 1 in 4 (25%). Thus, these two additional cancer cases would be in addition to 2,500 cases that would be expected to occur in a population of 10,000. We do not think there is a substantial cancer risk from exposure of the public to arsenic at this site.

Exposure estimate for children to arsenic in stream sediment

Exposure assumptions: 2 days per week, 12 weeks per year, for 9 years

$$\text{Child EF} = \frac{2 \text{ days/week} \times 12 \text{ weeks/year} \times 9 \text{ yrs}}{9 \text{ yrs} \times 365 \text{ days/yr}} = \frac{216 \text{ days}}{3{,}285 \text{ days}} = 0.066$$

$$\text{Child EED} = \frac{298 \text{ mg/kg} \times 200 \text{ mg/day} \times 0.066 \times 10^{-6} \text{ kg/mg}}{35 \text{ kg}} = \frac{0.0039}{35} = 0.00011 \text{ mg/kg/day}$$

Conclusion

This estimated exposure dose is 3 times below the current MRL of 0.0003 mg/kg/day. We think this indicates that children playing in local streams are unlikely to have exposures to arsenic in stream sediment that could cause adverse health effects. Theoretical excess cancer risks for this exposure scenario are 2.0×10^{-5} or 2/100,000 (low).