Public Health Assessment for

SOUTHEAST IDAHO PHOSPHATE MINING RESOURCE AREA
BANNOCK, BEAR LAKE, BINGHAM, AND CARIBOU COUNTIES, IDAHO
EPA FACILITY ID: IDN001002245
FEBRUARY 24, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

SOUTHEAST IDAHO PHOSPHATE MINING RESOURCE AREA

BANNOCK, BEAR LAKE, BINGHAM, AND CARIBOU COUNTIES, IDAHO

EPA FACILITY ID: IDN001002245

Prepared by:

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

Table of Contents

List of Appendices

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
AWAC	area-weight average concentrations
BCEH	Bureau of Community and Environmental Health
BLM	Bureau of Land Management
CDRI	Cancer Data Registry of Idaho
C-EMEG	chronic environmental media evaluation guide
COC	contaminants of concern
CREG	cancer risk evaluation guide
CV	comparison value
EMEG	environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
g/day	grams per day
HOD	health outcome data
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDL	Idaho Department of Lands
IMA	Idaho Mining Association
IMU	Interagency Memorandum of Understanding
kg	kilograms
lbs	pounds
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level
MW	Montgomery Watson
NOAEL	lowest no-observed-adverse-effect level
oz	ounce
ppm	parts per million
RfD	EPA’s chronic oral reference dose
RS-PRG	EPA Region 9’s residential soil preliminary remediation goals
SeAWAC	Selenium Area Wide Advisory Committee
SWG	Selenium Working Group
TtEMI	Tetra Tech EM Inc.
μg/L	micrograms per liter
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Summary

Phosphate has been mined from the Southeast Idaho Phosphate Mining Resource Area (Resource Area) since 1919. The major phosphate mines in this region are open pit or contour strip operations that were developed near surface exposures of the Phosphoria Formation. The area encompasses 2,500 square miles in southeastern Idaho that fall within Caribou, Bingham, Bannock, and Bear Lake counties (Appendix A, Figure A-1). In 1996, several horses pastured downstream from a historic mine in the Resource Area were diagnosed with chronic selenosis, which is characterized by erosions of long bones, emaciation, hoof lesions, and loss of mane and tail hair. In 1997, another group of horses pastured on a different piece of mine property in the Resource Area were also diagnosed with selenosis. These poisonings, along with problems reported in sheep, prompted public and agency concern about potential releases of selenium to the environment from mining activities and the impact on human health.

The Bureau of Community and Environmental Health (BCEH), Division of Health, Idaho Department of Health and Welfare (IDHW) has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct public health assessments and consultations for hazardous waste sites in Idaho. As part of this cooperative agreement, BCEH released two health consultations in 1999 to evaluate selenium contamination in the groundwater and selenium contamination in beef, elk, sheep, and fish in the Resource Area. In 2003, BCEH released another health consultation to evaluate selenium contamination in fish in streams of the upper Blackfoot River watershed.

Under the cooperative agreement, BCEH conducted this comprehensive public health assessment. In this public health assessment, BCEH revisited the conclusions and recommendations made in past health consultations for groundwater, beef, elk, sheep, and fish (BCEH 2001a, 2001b, 2003). BCEH also reviewed environmental data (soil, surface water, sediment), biological data (fish, elk, beef, plants), and community health concerns. Additionally, BCEH reviewed previous assessments conducted by Montgomery Watson (MW 1999a, 1999b, and 1999c) and Tetra Tech Inc. (TtEMI 2002). Personal communications with Idaho Department of Environmental Quality (IDEQ) staff were also used. Finally, BCEH conducted a cancer incidence analysis for the Resource Area in conjunction with the Cancer Data Registry of Idaho (CDRI).

On the basis of the data and information reviewed, BCEH has drawn the following conclusions and recommendations:

Conclusions

1. BCEH classifies the Southeast Idaho Phosphate Mining Resource Area as a no apparent public health hazard according to ATSDR’s interim public hazard categories (Appendix E).

2. The current, past, and future completed exposure pathways include soil, surface water, sediment, groundwater, and biota (fish, elk, beef, and plants). The most important exposure pathways are ingestion of fish, elk, and beef in the Resource Area.

3. The levels of contaminants in the soil, surface water, sediment, and groundwater in the Resource Area are not high enough to result in any cancer or adverse non-cancer health effects to hunters, anglers, collectors, and residents, including children, living near the Resource Area.

4. It is unlikely that the cadmium, chromium, and selenium in the fish from the Resource Area will result in any adverse health effects to the general public, as well as the Native American subsistence population who consume up to 70 grams of fish every day.

5. It is unlikely that the contaminants in elk muscle and elk liver will result in any adverse health effects to those who eat 8 ounces of elk meat daily, or eat up to 10 ounces of elk liver per month.

6. It is unlikely that the selenium in beef muscle and beef liver will result in any adverse health effects for people eating up to eight ounces every day.

7. It is unlikely that the contaminants in the plants at the Resource Area, which may be ingested or used by populations living in the Resource Area, will result in any adverse health effects.

8. The health outcome data analysis for the Resource Area showed that there were no statistically significant higher cancer incidence rates for any of the cancer types compared to the remainder of the State of Idaho. Instead, the cancer incidence rates for some cancer types are significantly lower than the remainder of the State of Idaho.

9. The conclusions in this report only apply to the current site conditions. If land uses change, these conclusions may no longer be applicable.

Recommendations

1. Even though fish from the East Mill Creek are very limited and subsistence consumption of fish from East Mill Creek is highly unlikely, to be cautious, it is recommended that children under the age of seven should not eat more than four 4-ounce meals per month of Yellowstone Cutthroat and Brook trout from East Mill Creek due to selenium contamination.

2. To be cautious, people should refer to Table 1 (page 18) to find out how much elk liver they can safely eat per month.

Public Health Action Plan

1. BCEH will continue to collaborate with IDEQ on their activities at the site and remain involved with the ongoing Selenium Area Wide Advisory Committee (SeAWAC) meetings.

2. BCEH will conduct community involvement and health education activities at the site, such as informing the hunters of the potential hazard scenario involving eating more than 10 ounces per month of elk liver.

3. IDEQ will continue to coordinate with the Interagency Selenium Area Wide Technical Group and lead the selenium area wide investigation.

4. BCEH will review new environmental sampling data and studies for the Resource Area relevant to public health as they become available.

5. BCEH will work with the Idaho Department of Fish and Game (IDFG) and the Idaho Department of Health and Welfare (IDHW) Bureau of Laboratories to analyze edible fish harvested from the Resource Area for selenium. BCEH will issue fish advisories if warranted.

1. Purpose and Health Issues

The Bureau of Community and Environmental Health (BCEH), Division of Health, Idaho Department of Health and Welfare (IDHW), has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct public health assessments and consultations for hazardous waste sites in Idaho. BCEH completed this public health assessment of the Southeast Idaho Phosphate Mining Resource Area (Resource Area) site under this cooperative agreement.

A public health assessment is a tool used to determine if contamination at a hazardous waste site poses a public health risk and if actions are needed to protect the health of community members residing or working at or near a hazardous waste site. For this public health assessment of the Southeast Idaho Phosphate Mining Resource Area (Resource Area), BCEH revisited the conclusions and recommendations made in past health consultations for groundwater, beef, elk, sheep, and fish (BCEH 2001a, 2001b, 2003). Secondly, BCEH reviewed available environmental data (soil, surface water, sediment), biological data (fish, elk, beef, plants), and community health concerns. Thirdly, BCEH reviewed previous assessments conducted by Montgomery Watson (MW 1999a, 1999b, and 1999c) and Tetra Tech Inc. (TtEMI 2002). Finally, BCEH conducted a cancer incidence analysis for the Resource Area in conjunction with the Cancer Data Registry of Idaho (CDRI). BCEH reviewed these documents and data to determine if contamination resulting from mining practices poses a health risk to the populations living near the Resource Area. This public health assessment uses data analysis to recommend actions to prevent, reduce, or further identify the possibility for site-related adverse health effects as appropriate.

2. Background

2.1 Site Description

Phosphate has been mined from the Resource Area since 1919. The major phosphate mines in this region are open pit or contour strip operations that were developed near surface exposures of the Phosphoria Formation. The Resource Area encompasses 2,500 square miles in southeastern Idaho that fall within Caribou, Bingham, Bannock, and Bear Lake counties (Appendix A, Figure A-1). This region contains 15 mines previously owned or operated by FMC Corporation, J.R. Simplot Company, Astaris, Nu-West Industries, Inc., and Nu-West Mining, Inc. (Nu-West), Rhodia, Inc., and P4 Production LLC. There are, as well, numerous “orphaned” mine sites that are primarily of underground design. Based on variations of relief, climate, and ore chemistry, the Resource Area has been delineated into three districts:

- Western district – Gay Mine on the Fort Hall Indian Reservation and phosphate ore lease area west of the Blackfoot Reservoir;
- Central district – Ballard, Champ, Conda, Dry Valley, Enoch Valley, Georgetown Canyon, Henry, Lanes Creek, Mountain Fuel, North Mabey, Rasmussen Ridge and Wooley Valley Mines, and the Dairy Syncline lease tract;

- Eastern district – Smoky Canyon Mine and associated leases, and the Diamond Creek phosphate lease.

The Resource Area, lying near the western base of the Aspen Range, is characterized by north- and northwest-trending mountain ranges and valleys. Elevations range from 4,528 feet to 9,957 feet above sea level. The two principal river systems that drain the Resource Area are the Bear River and the Snake River. The Upper Blackfoot River watershed is a tributary to the Snake River. The Snake River Plain region is semiarid. The southeastern part of the Resource Area is wetter and cooler than the other parts because of the increasing elevation (MW 1999c). Summers are dry with temperatures ranging from warm to hot. Winters are cool to cold.

2.2 Site History

Phosphate mining and ore processing are economically important to southeast Idaho. The phosphate ore is transported by truck, rail, and slurry pipeline to local processing facilities in Soda Springs and Pocatello, Idaho. Production from this region represents a significant source of phosphorous for industrial and agricultural applications. Some of the waste rock and overburden contains selenium levels that are much higher than typical background levels found in soil and rock.

In 1996, several horses pastured downstream from a historic mine in the Resource Area were diagnosed with chronic selenosis, which is characterized by erosions of long bones, emaciation, hoof lesions and loss of mane and tail hair. In 1997, another group of horses pastured on a different piece of mine property in the Resource Area were also diagnosed with selenosis. These poisonings, along with problems reported in sheep, prompted public and agency concern about potential releases of selenium to the environment from mining activities and the impact on human health (MW 1999a).

In 1997, a voluntary ad hoc committee of the Idaho Mining Association (IMA) was formed and named the IMA Selenium Subcommittee. This subcommittee was organized to characterize and identify mitigation methods for selenium in mining waste (MW 1999b). In 1997, the Subcommittee established the Interagency/Phosphate Industry Selenium Working Group (SWG). The SWG was made up of representatives from member companies of the Selenium IMA Subcommittee as well as Native Americans, federal, state, and local agencies and stakeholders. Montgomery Watson (MW), an engineering firm, was the lead contractor doing most of the assessment for the mining companies. The SWG also retained local technical experts in the areas of agricultural science and veterinary medicine to assist in the preparation of public education materials and in the organization of public education events (MW 1999c).

In July 2000, an Interagency Memorandum of Understanding (IMU) was signed designating the Idaho Department of Environmental Quality (IDEQ) as the lead agency for the Selenium Area Wide Investigation. A scope of work was developed and formalized through the IMU requiring IDEQ to review the previous data, conduct a data gap analysis, collect any remaining critical data to support an independent risk assessment effort by the IDEQ, and to develop regional risk management guidance for the performance of future mine-specific evaluations. The IDEQ retained Tetra Tech EM Inc. (TtEMI) in October 2000 as their contractor for technical assistance and support in the implementation of the Area Wide Investigation scope of work.

The SWG was redesignated the IDEQ Selenium Area Wide Advisory Committee (SeAWAC). The SeAWAC is currently composed of representatives from the mining companies, the Shoshone-Bannock Tribes, BCEH, IDEQ, Idaho Department of Lands (IDL), Bureau of Land Management (BLM), Bureau of Indian Affairs, University of Idaho, U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), Idaho Department of Fish and Game (IDFG), Idaho Congressional Delegation staff, U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), and other stakeholders and interested parties.

IDEQ has been designated as the lead for the area wide assessments. Regular, public meetings are convened to review issues at the site and to present the remedial investigation work and the human and ecological risk assessments conducted by IDEQ, other agencies and their contractors.

In June 1999, BCEH became involved in the activities at the site by attending a two-day Resource Area field workshop. During that year, BCEH released two health consultations to evaluate selenium contamination in the groundwater (BCEH 2001a) and selenium contamination in beef, elk, sheep, and fish in the Resource Area (BCEH 2001b). In December 2002, Tetra Tech EM Inc. released the *Final Area Wide Human Health and Ecological Risk Assessment* (TtEMI 2002). In 2003, BCEH released another health consultation to evaluate the selenium contamination in fish in streams of the upper Blackfoot River watershed (BCEH 2003).

BCEH conducted this public health assessment based on the former health consultations (BCEH 2001a, 2001b, 2003), environmental data which were not evaluated in the former health consultations, health outcome data, and environmental data and information used in the area wide human health and ecological risk assessment (TtEMI 2002). Because of the broad similarities in mining operations and the similar characteristics of the mined material, this public health assessment was approached from an area-wide perspective.

2.3 Land Use

The Resource Area consists of about 2,500 square miles in Caribou, Bingham, Bannock, and Bear Lake Counties in southeastern Idaho. Significant portions of the Resource Area are within the Caribou National Forest, the Fort Hall Indian Reservation, or are administered by the BLM (MW 1999c). Farming and ranching are the dominant land uses in the Resource Area (MW 1999c). Recreation is also an important regional land use, with the most popular activities being hunting, fishing, and camping. Mining for phosphate materials in the Resource Area has been done by FMC Corporation, Rhodia (formerly Rhone Poulenc), Astaris (a joint venture of FMC and Solutia), Nu-West (formerly Agrium), J.R. Simplot Company, and P4 Production (a joint venture of

Monsanto and Solutia). Nu-West, J.R. Simplot Company, and P4 Production currently have mining operations in the area.

2.4 Demographics

The Resource Area is sparsely populated. The largest nearby population centers are Pocatello, Fort Hall, Montpelier, and Soda Springs, Idaho and Afton, Wyoming (Appendix A, Figure A-1). According to the U.S. Census Bureau, the 2004 estimated populations of Pocatello, Montpelier, Soda Springs, and Afton were 50,723, 2,600, 3,299 and 1,797 respectively (US Census Bureau). Fort Hall had a population of 3,193 in the 2000 US Census.

2.5 Site Visit

In June 1999, BCEH participated in a two-day field workshop on the Resource Area. Representatives from state, local and federal agencies, as well as the mining industry were in attendance. The workshop included presentations from various agencies and companies that were conducting investigations about the biological impacts of selenium leaching from waste rock in reclaimed areas of the phosphate mining sites.

Additionally, the workshop included field trips to the Dry Valley and Wooley Valley mining sites. The mining sites were remote from large population centers; however, ranches were present nearby. Statements from various individuals indicated fish, previously seen in creeks and ponds, were no longer present. Evidence of wildlife use of the surface water was abundant. Elk, deer, moose, raccoon, fox, and various bird prints and droppings were seen. The BCEH program manager was told that people hunt deer, elk, and other game in the Resource Area.

BCEH staff also spoke with the local health district and local IDFG staff about their impression of the site and concerns expressed by the citizens in the area. The Southeastern District Health Department staff stated that their informal conversations with community members indicated that some of the public was concerned about selenium contamination in the food and private well water supplies. The district staff also thought that due to the heavy concentration of mines in the area and the potential for ecological and human health impacts, the site should be closely monitored. When questioned about community concerns, IDFG staff said that hunters from the area had contacted them with concerns about animals harvested from the area. One hunter brought an elk into the office because he was concerned that papillomas found on the elk were caused by exposure to selenium. IDFG staff told the hunter that papillomas were a common ailment on elk regardless of location. Other hunters reported seeing dead cattle and sheep near mines, and indicated that they would not hunt in the Resource Area any longer because they were concerned about contaminated game (BCEH 2001b).

3. Discussion

3.1 Data and Information Used

The data used in this document to assess possible health impacts from contaminants in the Southeast Idaho Phosphate Resource Area are from the following sources: Montgomery Waton reports prepared for the Idaho Mining Association's Selenium Subcommittee (MW 1999a, 1999b, 1999c, 2000, 2001), Tetra Tech EM Inc. reports prepared for IDEQ (TtEMI 2001, 2002), elk muscle and liver data collected in 2000 (Personal communication: R.L. Clegg, selenium project officer, IDEQ, email, July 2003), former BCEH health consultations (BCEH 2001a, 2001b, 2003), IDEQ's Public Water System record (1983-2001) (Personal communication: J. Henry, drinking water regulatory analyst, IDEQ, email, September 2001), and Cancer Data Registry of Idaho data.

The conclusions reached in this document are based on currently available data, previous health consultations, information obtained from site visits, community concerns, and public and agency input. If additional data or information becomes available, the conclusions may be modified at a later time.

3.2 Evaluation Process

The general process by which BCEH evaluates the possible health effects of environmental contaminants is summarized here and described in more detail in Appendix B. BCEH follows a two-step methodology to evaluate public health issues related to the contamination. First, BCEH obtains environmental contamination data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, BCEH uses health-based comparison values (CVs) (Appendix C, Table C-1 and C-2) to screen out those contaminants that do not have a realistic possibility of causing adverse health effects. For the remaining contaminants, BCEH reviews recent scientific studies to determine whether the levels of environmental contamination and exposure indicate a public health hazard.

Using CVs provides a way to screen and prioritize the contaminants at a site for further evaluation. CVs are derived for each of the various media (soil, air, water) and reflect an estimated contaminant concentration that is *not expected* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed) and body weight.

CVs are set at levels many times lower than levels where studies show there are no health effects in either animals or, if data is available, humans. CVs are deemed conservative or cautious because they include safety or protective factors that account for more sensitive populations, such as young children. If a contaminant concentration is above its CV, BCEH further analyzes exposure variables (for example, duration and frequency of exposure), the toxicology of the contaminant, other epidemiology studies, and the weight of evidence for health effects.

3.3 Exposure Pathways and Public Health Implications

To determine if human populations are exposed to contaminants, BCEH evaluates the environmental contamination and human activities that could lead to exposure. Only when there is a completed exposure pathway, is it possible that there may be health effects to the public. A completed exposure pathway exists when all of the following five elements are present: (1) a source of contamination; (2) transport through an environmental medium (air, soil, or water); (3) a point of exposure; (4) a route of human exposure; and (5) a receptor population. Appendix D summarizes the completed exposure pathways in this public health assessment, including soil, surface water, sediment, groundwater, and biota (fish, elk, beef, and plants). The following sections describe the various exposure pathways people could come into contact with contaminants in the Resource Area and any public health implications.

For the exposure pathways (groundwater, fish, elk, and beef) which BCEH evaluated in the past health consultations, BCEH reviewed the documents, summarized the major findings and, when available, reviewed and discussed new information or environmental data which were not previously addressed. This health assessment discusses any changes in previously identified exposure pathways and public health implications if review of the new information and environmental data warranted such changes.

3.3.1 Soil Exposure Pathway

Soils along stream banks in the Resource Area were sampled by the Idaho Mining Association in the summer of 2001 (TtEMI 2001). Soil samples were collected from locations both upstream and downstream of mining facilities. Areas upstream of mining facilities are referred to as unimpacted (or background) reaches and areas downstream of mining facilities are referred to as impacted reaches. Since the soil along the banks of streams that drain mines may accumulate sediments containing elevated levels of contaminants, and water carrying dissolved contaminants may also enter the soil systems during flooding or under seepage conditions, the levels of contaminants in these soils are assumed to be higher than the soils in other areas. Table C-3 (Appendix C) lists the detected contaminants, their concentrations, and frequency of detection.

The surface soil CVs in Table C-1 (Appendix C) are concentrations of contaminants in the soil below which no adverse human health effects should occur based on residential living conditions, and intermediate (15 to 365 days) or long time exposure (more than 365 days). Among the detected contaminants in the soil, only the concentrations of arsenic, cadmium, chromium and vanadium (Appendix C, Table C-3) are above their residential surface soil CVs, and are considered the contaminants of concern in the soil for this public health assessment.

It is possible for recreational users (hunters, collectors, and anglers) of the Resource Area to have contact with and/or ingest the contaminated soil. Therefore, for recreational users, a completed exposure pathway for surface soil currently exists, existed in the past, and will exist in the future. However, the areas of high impacts are very limited and occur primarily on public lands where a residential scenario cannot occur. Also, it should be noted that no gardens, residential or otherwise, have been observed on any areas along streams in the Resource Area (TtEMI 2002).

Public health implications

Among the above discussed contaminants of concern in the soil, arsenic is the contaminant of concern with the highest cancer risk. The average concentration of arsenic in the soil of the impacted area is about 19 times higher than its cancer risk evaluation guide (CREG) (Appendix C, Table C-1). The CREG is the estimated concentration that would be expected to cause no more than one additional excess cancer in one million people exposed over a lifetime (365 days/year × 70 years). As discussed before, no residences have been observed along any streams in the Resource Area. Even for people living in the Resource Area 190 days per year for 70 years, the estimated highest cancer risk is still below one estimated cancer for 100,000 persons exposed. Therefore, the contaminants in the soil are highly unlikely to result in any appreciable increase in cancer risk to hunters, anglers, or collectors in the Resource Area and residents around the Resource Area.

For non-cancer health effects, the maximum concentrations of arsenic, cadmium, chromium and vanadium are higher than the corresponding CVs for children (Appendix C, Table C-1). However, the average concentrations are all below the CVs for children. Even the maximum concentrations of the above contaminants are still several times lower than the CVs for adults (Appendix C, Table C-1). Since there is little possibility of children consuming the maximum levels of arsenic, cadmium, chromium, or vanadium in the soil on a daily basis, the contaminants in the soil are unlikely to result in any adverse non-cancer health effects to residents, including children, hunters, collectors, and anglers.

Both children and adults are more likely to be exposed to contaminants by ingesting soil than by inhaling soil (Hawley 1985). However, for chemicals that have specific toxic effects on the respiratory tract (such as chromium and beryllium), special consideration must be given. EPA Region 9's residential soil preliminary remediation goals (RS-PRGs) take into account the ingestion, inhalation, and dermal absorption of contaminants in soil. While the maximum concentration of chromium is higher than its RS-PRG (210 miligrams per kilogram, mg/kg, 1:6 ratio Cr VI: Cr III), the average concentration is below the RS-PRG. As discussed above, there is little possibility of children consuming the maximum levels of chromium in the soil on a daily basis due to no one residing in the mining areas. Also, even the maximum concentration of beryllium in the soil is below its RS-PRG (150 mg/kg). Therefore, beryllium and chromium in surface soil are unlikely to result in any adverse health effects through ingestion, inhalation, and dermal contact.

In conclusion, ingestion of the contaminants, inhalation of the contaminants, and dermal contact with the contaminants in the soil in the Resource Area are unlikely to result in cancer or adverse non-cancer health effects for hunters, anglers, collectors, and residents, including children, who live near or recreate in the Resource Area.

3.3.2 Surface Water Exposure Pathway

Tetra Tech EMI Inc. and IDEQ personnel collected surface water samples in May, June, July, and September of 2001 (TtEMI 2001). In total, surface water samples were collected from 39 locations associated with different streams at locations upstream (background) and downstream (impacted) of various mining sites. Table C-4 (Appendix C) lists the detected contaminants, their concentrations, and how often they were detected.

The drinking water CVs in Table C-2 (Appendix C) are concentrations of contaminants in the drinking water below which no adverse human health effects should occur even if used as the sole water source for intermediate (15 to 365 days) or long time (more than 365 days) exposures (2 L per day for adults or 1 L per day for children). Among the detected contaminants in the surface water, only the concentrations of arsenic, boron, and selenium are above their drinking water CVs (Appendix C, Table C-4), and are considered the contaminants of concern for surface water.

It is possible for recreational users (hunters, collectors, and anglers) of the Resource Area to have contact with and/or drink the contaminated water. Therefore, for recreational users, a completed exposure pathway for surface water currently exists, existed in the past, and will exist in the future. However, because surface water is not used as a source of drinking or household water in the Resource Area, ingestion of chemicals in surface water is expected to occur only infrequently, such as while hiking or hunting in the area or through inadvertent ingestion while swimming in surface water bodies. As with ingestion, direct contact with surface water is expected to be infrequent. Anglers fishing in area surface water bodies are expected to wear waders most, if not all, of the time because of the cold water temperatures in the Resource Area (TtEMI 2002).

Public health implications

Among the contaminants of concerns in the surface water (arsenic, boron, and selenium), arsenic is the only contaminant of concern with a possible cancer risk. Its average concentration in surface water of impacted areas is about 20 times higher than its CREG (Appendix C, Table C-2). Even if people were to use the surface water in the Resource Area as their sole drinking water source 180 days per year for 70 years, the estimated highest cancer risk is still below one estimated cancer for 100,000 persons exposed. Since surface water is not used as a source of drinking or household water in the Resource Area, ingestion of chemicals in surface water is expected to occur only infrequently through activities, such as hiking or hunting in the area or through inadvertent ingestion while swimming. Therefore, the arsenic in the surface water is highly unlikely to result in any appreciable increase in cancer risk to hunters, collectors, and anglers in the Resource Area or residents living near the Resource Area.

For non-cancer health effects, the maximum concentrations of arsenic and boron are only two times higher than their CVs for children, while their average concentrations are all below their CVs for children (Appendix C, Table C-2). Therefore, arsenic and boron are unlikely to result in any adverse non-cancer health risks to children living near the

Resource Area. For selenium, its maximum concentration is about 23 times higher than the chronic environmental media evaluation guide (C-EMEG) for children and 6 times higher the C-EMEG for adults, while its average concentration is still below the C-EMEGs (Appendix C, Table C-2). This means selenium will not result in any adverse health effects to children or adults who use the surface water with the maximum selenium concentration as their sole drinking water source for 16 and 64 days a year, respectively. Once again, since surface water is not used as a source of drinking or household water in the Resource Area, ingestion of chemicals in surface water is expected to occur only infrequently while hiking or hunting in the area or through inadvertent ingestion while swimming. Therefore, the contaminants in the surface water are unlikely to result in any adverse non-cancer health effects.

In conclusion, the contaminants in the surface water in the Resource Area are unlikely to result in any cancer or adverse non-cancer health effects to hunters, anglers, collectors, and residents, including children, living near the Resource Area.

3.3.3 Sediment Exposure Pathway

Sediments from different streams were sampled at locations upstream (background) and downstream (impacted) of various mining sites (TtEMI 2001, MW 1999c). Table C-5 (Appendix C) lists the detected contaminants, their concentrations, and frequency of detection. Among the detected contaminants in sediment, only the concentrations of arsenic and cadmium are above their residential soil CVs (Appendix C, Table C-1), and are considered the contaminants of concern for sediment.

It is possible for recreational users (hunters, collectors, and anglers) of the Resource Area to contact and accidentally ingest the contaminated sediment. Therefore, for recreational users, a completed exposure pathway for sediment currently exists, existed in the past, and will exist in the future. However, exposure to contaminants through incidental ingestion of sediment is expected to be minimal primarily because most sediment is expected to be washed off either deliberately or inadvertently with surface water by recreational users of the Resource Area.

Public health implications

Among the contaminants of concern in the sediment (arsenic and cadmium), arsenic is the contaminant of concern with the cancer risk. Its average concentration in sediment of the impacted area is about 11 times higher than its residential soil CREG (Appendix C, Table C-1). Even for people that accidentally ingest 100 milligram (mg) sediment per day, 33 days a year for 70 years, the estimated highest cancer risk is still below one estimated cancer for 1,000,000 persons exposed. As discussed before, exposure to chemicals through incidental ingestion of sediment is expected to be minimal in the Resource Area. Therefore, arsenic in the sediment is highly unlikely to result in any appreciable increase in cancer risk to recreational users (such as hunters, anglers, and collectors) of the Resource Area.

For non-cancer health effects, the maximum concentration of cadmium in sediment is only 1.4 times the C-EMEG for children, while the average concentration is less than half of the C-EMEG for children (Appendix C, Table C-1). Children who accidentally ingest the maximum contaminated sediments for 260 days every year will not suffer any adverse health effects. Since no children live in the Resource Area, it is highly unlikely that cadmium in the sediment will result in any adverse non-cancer health risks to children living near the Resource Area.

In conclusion, the contaminants in the sediment in the Resource Area are unlikely to result in any adverse cancer or non-cancer health effects to hunters, anglers, collectors, and residents, including children, living near the Resource Area.

3.3.4 Groundwater Exposure Pathway

BCEH and the Southeastern District Health Department tested seven private wells within the Resource Area (BCEH 2001a, and Appendix F). All the well water samples were collected and tested for possible selenium contamination. Selenium levels were undetectable in six of the seven tested private wells. Only one out of the seven private wells had a detected selenium level of 5 micrograms per liter (µg/L), which is below selenium's C-EMEG of drinking water for children (50 µg/L) and adults (200 µg/L) (Appendix C, Table C-2). According to IDEQ's Public Water System records from 1983-2001, the selenium levels (3 – 26 µg/L) in the Resource Area public water system are well below the EPA's drinking water regulatory standard (50 µg/L) (IDEQ 2001), and ATSDR's selenium C-EMEG of drinking water for children (50 µg/L) and adults (200 µg/L) (Appendix C, Table C-2). BCEH (2001a) concluded that there is no apparent public health hazard from drinking and/or using ground water from the Resource Area.

Since the health consultation on selenium in groundwater (BCEH 2001a), no additional private well water sampling has occurred. The previous health consultation's conclusion of no apparent public health hazard for the groundwater in the Resource Area is still applicable. That is, adverse health effects are unlikely to occur in adults or children from drinking and/or using ground water from the Resource Area.

3.3.5 Biota - Fish, Elk, Beef, and Plants - Exposure Pathway

A completed exposure pathway for biota (such as fish, elk, beef and plants) in the Resource Area currently exists, existed in the past, and will exist in the future for the recreational users (such as hunters, collectors, and anglers) and their families who consume and use animals and/or plants from the Resource Area.

3.3.5.1 Fish Tissue Exposure Pathway

In 1998, 1999, and 2000, fish from the Blackfoot watershed were collected and analyzed for selenium. The resulting health consultation (BCEH 2003, and Appendix G) concluded that there is no fish consumption restriction for the general public and pregnant women at any location in the Blackfoot watershed. For children under the age of seven there is no consumption restriction, except for East Mill Creek where children under the age of seven should not eat more than four 4-ounce meals per month of Yellowstone Cutthroat and Brook trout. This recommendation is just for caution, since fish from the East Mill Creek are very limited and subsistence consumption of fish from East Mill Creek is highly unlikely. Therefore, the selenium contamination in fish from Blackfoot watershed is unlikely to result in any adverse health effects to adults and children, including subsistence populations.

To conduct the Area Wide Human Health and Ecological Risk Assessment, TtEMI and IDEQ personnel collected more fish tissue samples (TtEMI 2001) in July 2001. In total, samples of fish tissue were collected from six areas located in both impacted and unimpacted reaches of the streams (TtEMI 2002). Based on the data in TtEMI (2002), the area-weight average concentrations (AWAC) of the contaminants in fish tissue are summarized in Table C-6 (Appendix C).

BCEH found that the concentration of selenium in the Blackfoot watershed was higher than the concentrations in the Salt and Georgetown watersheds (Appendix C, Table C-6). Therefore, it is unlikely the selenium in fish tissue from the Salt and Georgetown watersheds will result in any adverse health effects to adults and children, including subsistence populations.

In the 2003 health consultation (BCEH 2003), only the selenium contamination was evaluated. To evaluate the cadmium and chromium contamination in the fish, BCEH calculated estimated daily exposure doses for all the contaminants. According to EPA's exposure factors handbook (EPA 1997), the estimated mean and 95th percentile fish consumption rates for recreational freshwater anglers are 8 grams per day (g/day) and 25 g/day respectively, while the recommended mean fish consumption rate for Native American subsistence population is 70 g/day. It should be emphasized that 70 g/day refers only to the Native American subsistence fishing population, not the Native American general population. Several studies (West et al., 1989; Ebert et al., 1993) show that the consumption rate of recreationally caught fish among Native Americans with state fishing licenses are somewhat higher than consumption rates among other anglers, but far lower than the rate (70 g/day) for the Native American subsistence population.

To be conservative and more protective of the population, BCEH used the Native American mean fish consumption rate of 70 g/day and the adult body weight of 75 kilograms (kg) (165 lbs) (BVRHS 2001) to calculate the estimated daily exposure. The estimated daily exposure doses (Appendix C, Table C-6) for cadmium and chromium are at least 10 times lower than ATSDR's chronic oral minimal risk level (MRL) and EPA's chronic oral reference dose (RfD) (Appendix C, Table C-7). The estimated exposure dose for selenium (Appendix C, Table C-6) is also lower than both the MRL and RfD for selenium (Appendix C, Table C-7). RfDs and the chronic MRLs are estimates of daily human exposure to a contaminant that is unlikely to result in adverse non-cancer health effects over a lifetime. Since these exposures are below both the MRL and RfD, the exposure to cadmium, chromium, and selenium from eating fish from the Resource Area is unlikely to result in any non-cancer adverse health effects to the general public, as well as the Native American subsistence population who consume up to 70 grams of fish every day.

Even though fish from the East Mill Creek are very limited and subsistence consumption of fish from East Mill Creek is highly unlikely, to be cautious, it is recommended that children under the age of seven should not eat more than four 4-ounce meals per month of Yellowstone Cutthroat and Brook trout from East Mill Creek.

While chromium (VI) and cadmium can be carcinogenic (cancer causing) when inhaled, there is not sufficient information to determine whether ingesting them orally will cause cancer (ATSDR 2000, 1999a). Thus, cancer evaluations for chromium and cadmium in fish were not conducted as part of this health assessment.

3.3.5.2 Elk Exposure Pathway

In June 2001, a health consultation (BCEH 2001b, and Appendix H) that evaluated the selenium contamination in elk from the Resource Area was released. This health consultation did not address cadmium contamination and only evaluated the selenium data collected in 1999. It concluded that, using the maximum concentration of selenium detected in elk muscle for the calculations, estimated exposures for adults (typical, non-subsistence hunters) and children are not considered a public health hazard because levels are below what would be expected to cause adverse health effects. The health consultation did find that given the level of selenium in elk liver, it is possible that an adult consuming large amount of contaminated elk liver could experience adverse health effects like nausea, vomiting and diarrhea. However, since the amount of elk liver hunters consume is not well understood, it is not known if acute health effects are occurring or have occurred.

Elk skeletal muscle and liver harvested in the Resource Area in September 1999 were analyzed for both selenium and cadmium levels (MW 2000), but the former health consultation (BCEH 2001b) only evaluated the selenium contamination. For this health assessment, the cadmium concentrations in the elk tissue sampled in 1999 are summarized in Appendix C, Table C-8. In September 2000, more elk muscle and liver samples were collected and analyzed for selenium, cadmium, copper, lead, manganese, molybdenum and zinc (Clegg 2003). The analytical data of selenium in elk samples collected both in 1999 and 2000 are combined together and summarized in Appendix C, Table C-8. The concentrations of other contaminants found in the 2000 elk samples are also summarized in Appendix C, Table C-8. Among 50 elk muscle samples, only one sample was detectable for lead with a very high concentration of 50 mg/kg, which is about 66 times higher than the highest measured lead concentration in elk liver (0.76 mg/kg). Since lead levels are generally higher in liver than in muscle, BCEH does not think this value is reliable and highly suspects this sample was somehow contaminated. Therefore, BCEH assumes all the elk muscle are non-detectable for lead.

Because there are no comparison values available for contaminants in animals or plants, BCEH used three exposure scenarios defined in Table C-9 (Appendix C) based on the information gained from hunters (Personal communication: J.L. Jones, U.S. Forest Service, Caribou National Forest, Soda Springs Ranger Station, email, April 2000) to evaluate the exposure to contaminants from the elk meat. Exposure scenario #1 estimates the amount of exposure for a hunter who frequently eats elk meat. The estimated consumption rate is 8 ounces (227 grams) of elk meat every day for a lifetime. Exposure scenario #2 estimates the amount of exposure for a hunter who consumes elk liver meals once or twice a year for a lifetime (rarely eats elk liver). The largest meal size is 10 ounces (284 grams) based on the information provided by hunters in the study. Exposure scenario #3 estimates the exposure to a person eating elk liver once a month (occasionally eats elk liver). This includes those who freeze portions of an entire liver and eat elk liver meals approximately monthly, throughout the year. The largest meal size is 10 ounces (284 grams).

Exposure dose estimates for different exposure scenarios were calculated using the exposure descriptions in Table C-9 (Appendix C) and the following parameters:

One meal of elk meat = 8 ounce (oz) (227g);
One meal of elk liver = 10 oz (284g);
Maximum detected concentrations for all the contaminants (except of lead in elk muscle) shown in Appendix C, Table C-8;
Absorption rate of contaminants in elk tissues = 100%;
Body weight of adult = 75 kg (165 lb)

The estimated exposure doses for each of the three exposure scenarios derived from hunters in the Resource Area are listed in Table C-10 (Appendix C). To evaluate whether the exposure doses (as shown in Appendix C, Table C-9) are at levels that might result in adverse health effects, the exposure doses are compared to health-based guidelines (Appendix C, Table C-7).

Selenium, Manganese, Molybdenum

For the three exposure scenarios (frequently eats elk meat, rarely eats elk liver, and occasionally eats elk liver), the estimated exposure doses of selenium, manganese and molybdenum are all below their chronic MRL and/or chronic oral RfDs (Appendix C, Table C-7). Therefore, it is unlikely that selenium, manganese, and molybdenum in elk muscle and elk liver will result in any adverse health effects to those who eat 8 ounces of elk meat daily, or eat up to 10 ounces of elk liver per month.

Cadmium

For the three exposure scenarios (frequently eats elk meat, rarely eats elk liver, and occasionally eats elk liver), the estimated highest exposure dose of cadmium is 0.0008 mg/kg/day for exposure scenarios #1 (frequently eats elk meat: one 8-ounce meal of elk muscle per day, 365 days per year). The exposure scenarios used the maximum cadmium concentrations in the muscle and liver and 100% absorption of cadmium for persons eating elk meat and liver. The estimated highest exposure dose (0.0008 mg/kg/day) is about four times higher than the chronic oral MRL for cadmium (0.0002 mg/kg/day) (Appendix C, Table C-7), but lower than the EPA's oral RfD of 0.001 mg/kg/day for cadmium in food (Appendix C, Table C-7).

The RfD and the chronic MRL for cadmium are estimates of the amount of cadmium that people can be exposed to on a daily basis without suffering adverse non-cancer health effects over a lifetime. The actual exposure doses of the three exposure scenarios are expected to be much less because: people are unlikely to always consume the elk muscle and liver with the highest cadmium concentrations; people are unlikely to eat 8 ounces of elk muscle every day; and only about one-twentieth of the total ingested cadmium (in food or water) is absorbed in adult humans (Ellis et al. 1979; Flanasen et al. 1978; McLellan et al. 1978; Morgan and Sherlock 1984; Newton et al. 1984; Rahola et al. 1973). Therefore, estimated exposures to cadmium in elk muscle (up to 8 ounces of elk muscle a day, 365 days a year) and in elk liver (up to one 10-ounce meal of elk liver per month) are unlikely to result in any non-cancer adverse health effects.

While cadmium can be carcinogenic when inhaled, the carcinogenicity by the oral route of exposure cannot be determined (ATSDR 1999a). Thus, cancer evaluations for cadmium in elk muscle and liver were not conducted as part of this health assessment.

Lead

There is no MRL or RfD for lead. Nevertheless, the estimated highest exposure dose for lead is 0.00009 mg/kg/day for the exposure scenario #3 (occasionally eats elk liver: 10 ounces of elk liver a month), which is about 17 times lower than the lowest no-observed-adverse-effect level (NOAEL) among all the related studies (ATSDR 1999b). BCEH uses the maximum concentration in the elk liver to estimate the exposure dose. However, it must be noted that only three of the 50 elk liver samples had detectable levels of lead. Therefore, these exposure doses are overly protective; the actual exposure doses will be lower than the estimated doses. Also, BCEH assumed that the lead in elk muscle is non-detectable as discussed before. Thus, it is unlikely that lead in elk meat and liver will result in any adverse health effects to those who eat 8 ounces of elk meat daily, or eat up to 10 ounces of elk liver per month.

Zinc

The estimated exposure doses for exposure scenario #2 (rarely eats elk liver: 20 ounces of elk liver a year) and #3 (occasionally eats elk liver: 10 ounces of elk liver per month) are all below the MRL and RfD for zinc. The estimated exposure dose for exposure scenario #1 (frequently eats elk meat: 8 ounce elk meat daily) is 0.33 mg/kg/day, which is only slightly above the MRL and RfD for zinc (0.3 mg/kg/day). Because BCEH uses the maximum concentrations in the elk muscle and elk liver to estimate the exposure doses and that it is unlikely that each meal will contain the maximum concentrations, the actual exposure doses will most likely be lower than the estimated doses. Therefore, it is unlikely that zinc in elk muscle and elk liver will result in any adverse health effects to those who eat 8 ounces of elk meat daily, or eat up to 10 ounces of elk liver per month.

Copper

The estimated exposure doses for exposure scenario #1(frequently eats elk meat: 8 ounce elk meat daily), #2 (rarely eats elk liver: 20 ounces of elk liver a year), and #3 (occasionally eats elk liver: 10 ounces of elk liver per month) are all below the intermediate MRL for copper (0.01 mg/kg/day). Because BCEH uses the maximum concentrations in the elk muscle and elk liver to estimate the exposure doses and assumes that the copper is 100% absorbed, the actual exposure doses will be lower than the estimated doses. Therefore, it is unlikely that copper in elk liver will result in any adverse health effects to those who eat 8 ounces of elk meat daily, or eat up to 10 ounces of elk liver per month.

However, based on information verbalized by Native Americans and hunters, an "unusual" exposure scenario exists for a limited number of individuals who may consume several meals of elk liver within a week's time while in a hunting camp. Using the highest concentration observed for copper in elk liver, a body weight of 75 kg (165 lbs); a consumption rate of two 10-ounce (284 grams) meals in one month, the exposure dose is estimated at 0.015 mg/kg/day. This exposure dose exceeds the intermediate MRL for copper (0.01 mg/kg/day). While such an exposure dose may not necessarily result in adverse health effects, prudent public health practice would recommend avoiding such acute exposures. Therefore, BCEH recommends that a person with a body weight of 75 kg (165 lbs) should not eat more than 10 ounces per month of elk liver from the Resource Area.

Following these recommendations is important because while copper is essential for good health, exposure to higher doses can be harmful. If you drink water that contains higher than normal levels of copper, you may experience nausea, vomiting, stomach cramps, or diarrhea (ATSDR 2004). High intakes of copper can cause liver and kidney damage and even death. Currently, it is not known if copper can cause cancer in humans.
To assist hunters and their families, Table 1 shows how much elk liver can be safely consumed per month according to body weight.

Table 1. Amount (oz) of Elk Liver That Can Be Safely Consumed per Month according to Body Weight

Body Weight	**Kg**	15	25	35	45	55	65	75	85	95	105	115
	Lb	33	55	77	99	121	143	165	187	209	231	254
Amount of Elk Liver	**oz**	2	3.3	4.6	6	7.3	8.6	10	11.3	12.6	14	15.3

kg = kilogram; lb = pounds; oz = ounce

It should be noted that the copper level in elk liver (maximum: 64 mg/kg or ppm) is not unique to the Resource Area. According to ATSDR (2004), the food item with the highest average copper level is beef/calf liver (61 ppm).

3.3.5.3 Beef Exposure Pathway

For nine weeks in July and August 1999, 15 steers were confined to a pasture located on a reclaimed overburden pile at the Henry Mine. These animals were included as part of a study in the fall of 1999 (MW 2000). After grazing in the reclaimed land, the steers were sent to a feed lot for four/five months before they were slaughtered. This process of pasturing and then sending animals to feed lots is said to be typical of how cattle are managed in the Resource Area. Skeletal muscle and liver (as well as kidney and heart) samples were collected postmortem. Analytical results associated with these samples were used to represent levels of contaminants in beef tissue potentially ingested by humans.

In June of 2001, a health consultation was released for the selenium contamination in beef muscle from the Resource Area (BCEH 2001b, and Appendix H). It concluded that the maximum concentration of selenium detected in the muscle of the steers shipped to feedlots after pasturing on selenium contaminated land is not considered a public health hazard for adults or children because levels are below what would be expected to cause adverse health effects.

However, in the former health consultation (BCEH 2001b), the selenium contamination in the beef liver was not evaluated. To assure that the selenium contamination in beef liver does not pose a health risk, BCEH evaluated the potential risk of consuming beef liver from the Resource Area. Table C-11 (Appendix C) summarizes the selenium concentrations in beef muscle and liver.

The maximum selenium concentration in beef liver was found to be 0.91 mg/kg. This level is almost the same as the maximum selenium concentration in elk muscle (0.92 mg/kg). Using the maximum level of contamination in beef liver (0.91 mg/kg), a person weighing 75 kg (165 lbs) who eats 8 ounces (227grams) of beef liver per day would have an estimated exposure dose of 0.0028 mg/kg/day of selenium. This exposure dose is less than both the chronic oral MRL for selenium (0.005 mg/kg/day) and EPA's oral RfD (0.005 mg/kg/day) for selenium (Appendix C, Table C-7). Therefore, the selenium in beef liver is unlikely to result in any adverse health effects if a person eats up to eight ounces of beef liver every day.

The maximum selenium concentration in beef muscle (1.3 mg/kg) is higher than that in elk muscle (0.92 mg/kg). Using the maximum level of contamination in beef muscle (1.3 mg/kg), a person weighing 75 kg (165 lbs) who eats 8 ounces (227g) of beef muscle per day would have an estimated exposure dose of 0.0039 mg/kg/day of selenium. This estimated exposure dose is lower than both the oral chronic MRL and RfD (Appendix C, Table C-7). Therefore, the selenium in beef muscle is unlikely to result in any adverse health effects.

In conclusion, the selenium in beef muscle and liver is unlikely to result in any adverse health effects for people eating up to eight ounces of muscle or liver every day.

It should be noted that the analyses provided in this health assessment are, by design, very protective or “cautious”. It is highly improbable that a person will eat either eight ounces of beef liver or beef muscle every day for a long period of time. Also it is highly unlikely for a person to eat beef muscle with the maximum selenium concentration everyday for long periods of time. This means that most persons eating beef muscle and liver will be exposed to lower doses of selenium than were used in the analyses presented in this health assessment.

3.3.5.4 Plant Exposure Pathway

TtEMI and IDEQ personnel collected samples of both aquatic and terrestrial plants in May and July 2001 (TtEMI 2001). Specifically, tissue samples were collected from two aquatic species – watercress (*Nasturtium officinale*) and water buttercup (*Cara photomycetin*), and from four terrestrial species – wild onion (*Allium canadense*), bitterroot (*Camus spp.*), golden sage (*Artemesia spp.*), and red willow (*Salix spp.*). Samples of plant tissue were collected in streams or along stream banks downstream of specific mines (impacted reaches) and from unimpacted (background zones).

As shown in Table 6-6 of TtEMI (2002), the maximum concentration of contaminants in aquatic plants are at least several times higher than the maximum contaminant concentrations found in terrestrial vegetation. In the following discussion, BCEH uses the maximum contaminant concentrations to represent the contaminant concentrations in all the different plants which may be ingested or used by populations living in the Resource Area. The maximum concentrations of contaminants in aquatic plants are listed in Table C-12 (Appendix C).

Public health implications:
To evaluate the contaminants in the plants, BCEH calculated estimated daily exposure doses for all the contaminants. There is no information available regarding subpopulation-specific ingestion rates for different plants. According to “Exposure Factors Handbook” (EPA1997), the recommended average and 95th percentile intake rate for vegetables for the general public are 4.3 and 10 g/kg/day respectively. To calculate the estimated daily exposure doses of the contaminants in the plants, BCEH assumes that populations consume the plants from the Resource Area at a rate equal to 10% of the total vegetable intake rate. Additionally, to calculate risk, BCEH uses a body weight of 75 kg (165 lbs), a vegetable consumption rate of 10 g/kg/day (95th percentile), and the maximum concentrations of contaminants (dry weight) in all the different plants. BCEH assumed the water content in the aquatic plants is 90% for estimating exposure doses. The estimated exposure doses are listed in Appendix C, Table C-12.

The estimated exposure doses (Appendix C, Table C-12) are approximately 100 times lower than the MRLs and/or RfDs (Appendix C, Table C-7). Therefore, the contaminants in the plants at the Resource Area which may be ingested or used by populations living in the Resource Area are unlikely to result in any non-cancer adverse health effects.

Arsenic can also cause cancer. However, based on the exposure dose of arsenic, the estimated highest cancer risk will be four estimated excess cancers for 1,000,000 persons exposed. Therefore, arsenic in the plants is unlikely to result in any appreciable increase in cancer risk to people who may ingest or use the plants from the Resource Area.

No gardens, residential or otherwise, have been observed in areas along streams in the Resource Area (TtEMI 2002). Therefore, this estimated exposure represents the worst-case exposure scenario to the contaminants in the plants. This means that most persons who ingest or use plants from the Resource Area will be exposed to lower doses than were used in the analyses presented in this health assessment.

3.4 ATSDR Child Health Considerations

Children are not small adults. They differ from adults in their exposures and may differ in their susceptibility to hazardous chemicals. Children breathe more than adults relative to their body weight. Children absorb, metabolize and excrete contaminants differently than adults. Children’s organs may be more susceptible to toxins than adult organs. Therefore, it is always important to address chemical exposures of these sensitive populations. Infants and children may be more vulnerable to the toxic effects of chemicals for the following reasons:

1) children are more likely to play outdoors than adults and bring food into contaminated areas;
2) children are closer to the ground (shorter), resulting in a greater likelihood that they breathe dust, soil, and heavy vapors laying near the ground;
3) children weigh less, resulting in higher doses of chemical exposure per body weight; and
4) children’s developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages.

As delineated in the discussions of different exposure pathways, surface soil contamination, surface water contamination, sediment contamination, and groundwater contamination are highly unlikely to result in any adverse health effects to hunters, anglers, as well as the residents, including children living around the Resource Area.

For the different biota (fish, elk, beef and plants), the major contaminants of concern are cadmium, chromium, copper and selenium. Studies show that the health effects seen in children from exposure to toxic levels of cadmium are expected to be similar to the effects seen in adults (kidney, lung, and intestinal damage depending on the route of exposure) (ATSDR 1999a). Harmful effects on child development or behavior have not generally been seen in populations exposed to cadmium (ATSDR 1999a). It is not known if children differ from adults in their susceptibility to the negative health effects of chromium (ATSDR 2000). Also, children will probably show the same sort of health effects from selenium exposure as adults show, although some studies suggest that they may be less susceptible to the health effects of selenium than adults (ATSDR 2003).

According to ATSDR (2004), exposure to high levels of copper will result in the same types of effects in children and adults. We do not know if these effects would occur at the same dose level in children and adults. Studies in animals suggest that children may have more severe effects than adults; we do not know if this would also be true in humans. Studies in animals suggest that ingestion of high levels of copper may cause a decrease in fetal growth. We do not know if copper can cause birth defects or other developmental effects in humans.

Since the exposure dose of chemicals (such as copper) depends on body weight, and children weigh less than adults, exposure doses may be high for the children. Therefore, BCEH listed the amount of elk liver which can be safely consumed per month for different body weights (Section 3.3.5.2, Table 1).

3.5 Health Outcome Data Evaluation

According to ATSDR guidelines, health outcome data (HOD) should be considered in a public health assessment. Health outcome data may include mortality information (e.g., the number of people dying from a certain disease) or morbidity information (e.g., the number of people in an area getting a certain disease or illness). In order to thoroughly evaluate health outcome data as it relates to a hazardous waste site, the following elements are necessary: (1) the presence of a completed human exposure pathway; (2) sufficiently high contaminant levels to result in measurable health effects; (3) sufficient number of people in the completed pathway for the health effect to be measured; and (4) a health outcome database in which disease rates for populations of concern can be identified.

This health assessment finds that the contaminant levels in the Resource Area are not high enough to result in any measurable health effects in the possible exposed population, and no contaminant exposures in the Resource Area could possibly result in any increased cancer rate. However, to be prudent, BCEH compared the cancer incidence rate between the Resource area and the remainder of the state of Idaho. These comparisons are discussed in the following sections.

3.5.1 Data Review

The health outcome data evaluation for the Resource Area is based on an analysis of available cancer data from the Cancer Data Registry of Idaho (CDRI). CDRI is an Idaho Hospital Association program that contracts with IDHW to provide a statewide cancer surveillance system. CDRI is a population-based cancer registry that collects incidence and survival data on all cancer patients who reside in the State of Idaho or are treated for cancer in the State of Idaho. Through collaborative efforts with Idaho’s neighboring states, CDRI is able to obtain data on cancer cases of Idaho residents diagnosed or treated for cancer in adjacent states. CDRI, in operation since 1969, became population-based in 1971. Each Idaho hospital, outpatient surgery center, and pathology laboratory is responsible for reporting cancer diagnoses and treatments within 6 months after services are provided. CDRI has a 99.6% case completeness rate and a 98.6% accuracy rate.

Cancer incidence (cases), instead of cancer mortality, was reviewed for this public health assessment because cancer death rates are affected by how advanced the cancer is at the time of diagnosis, access to health care, and other factors not related to exposure.

3.5.2 Data Analysis

Cancer incidence for the Resource Area was calculated by comparing the observed number of cases to the expected number of cases (also known as standardized incidence ratio) (Appendix I, Tables I-1, I-2, and I-3). The expected number was calculated by multiplying rates for the remainder of Idaho by the population of the Resource Area. Rates for the remainder of Idaho were calculated by dividing observed cases by the person-years for the remainder of Idaho. Person-years describe the length of time a group of people have been exposed, observed, or at risk.

To help interpret the difference between cancer incidence in the study area population and the remainder of Idaho, the "statistical significance" of the difference is calculated. "Statistical significance" for this public health assessment means that the chance that the observed difference is due to random chance alone is less than 5% ($p<0.05$). In other words, if the difference was found to be statistically significant, then the difference between the expected and observed cases is probably due to some set of factors that influences the rate of that disease. The factors could be environmental, lifestyle, or family histories. In the public health assessment, only statistically significant differences are discussed.

It should be noted that cancer is not a single disease, but a group of more than 200 different diseases. Because cancer is, unfortunately, a common disease (one in two men, or one in three women will develop cancer in the lifetime), every community will experience a certain number of cancer cases.

3.5.3 Results of Cancer Incidence Analysis

In order to fully understand the cancer incidence rates in the Resource Area, BCEH, with the help of CDRI (Personal communication: C.J. Johnson, epidemiologist, CDRI, email, August 2005), made three comparisons. First, BCEH compared the cancer incidence rates between Caribou County which is located entirely within the Resource Area with the remainder of the State of Idaho. Second, BCEH compared the combined cancer incidence rates from the four counties (Bannock, Bear Lakes, Bingham, and Caribou Counties) which are partially or fully located in the Resource Area with the remainder of the State of Idaho. Finally, to further refine the cancer incidence data to areas closer to the Resource area, BCEH compared cancer incidence rates from the zip codes 83203, 83217, 83234, 83241, 83246, 83250, 83254, 83276, and 83285, with the remainder of the State of Idaho. The results were summarized in Appendix I, Tables I-1, I-2, and I-3.

Because the number of cancers was very small when analyzed by zip code, the cancer incidence analysis used two more years' of data (1997-2003) for the zip code level than for the county level (1999-2003).

Compared to the remainder of the State of Idaho, all the results (Appendix I, Tables I-1, I-2, and I-3) showed that there were no statistically significant higher cancer incidence rates for any of the cancer types. Instead, the cancer incidence rates for some cancer types, such as the total lung cancers and male lung cancers, are significantly lower than the remainder of the State of Idaho.

4. Conclusions

On the basis of the data and information reviewed, using conservative approaches to evaluate adverse health impact from exposure to the contaminants in the Resource Area, BCEH has drawn the following conclusions:

1. BCEH classifies the Southeast Idaho Phosphate Mining Resource Area as a no apparent public health hazard according to ATSDR's interim public hazard categories (Appendix E).

2. The current, past, and future completed exposure pathways include soil, surface water, sediment, groundwater, and biota (fish, elk, beef, and plants). The most important exposure pathways are ingestion of fish, elk, and beef in the Resource Area.

3. The levels of contaminants in the soil, surface water, sediment, and groundwater in the Resource Area are not high enough to result in any cancer or adverse non-cancer health effects to hunters, anglers, collectors, and residents, including children, living near the Resource Area.

4. It is unlikely that the cadmium, chromium, and selenium in the fish from the Resource Area will result in any adverse health effects to the general public, as well as the Native American subsistence population who consume up to 70 grams of fish every day.

5. It is unlikely that the contaminants in elk muscle and elk liver will result in any adverse health effects to those who eat 8 ounces of elk meat daily, or eat up to 10 ounces of elk liver per month.

6. It is unlikely that the selenium in beef muscle and beef liver will result in any adverse health effects for people eating up to eight ounces every day.

7. It is unlikely that the contaminants in the plants at the Resource Area, which may be ingested or used by populations living in the Resource Area, will result in any adverse health effects.

8. The health outcome data analysis for the Resource Area showed that there were no statistically significant higher cancer incidence rates for any of the cancer types compared to the remainder of the State of Idaho. Instead, the cancer

incidence rates for some cancer types are significantly lower than the remainder of the State of Idaho.

9. The conclusions in this report only apply to the current site conditions. If land uses change, these conclusions may no longer be applicable.

5. Recommendations

On the basis of the data and information reviewed, BCEH has made the following recommendations:

1. Even though fish from the East Mill Creek are very limited and subsistence consumption of fish from East Mill Creek is highly unlikely, to be cautious, it is recommended that children under the age of seven should not eat more than four 4-ounce meals per month of Yellowstone Cutthroat and Brook trout from East Mill Creek due to selenium contamination.

2. To be cautious, people should refer to Table 1 (page 18) to find out how much elk liver they can safely eat per month.

6. Public Health Action Plan

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

1. BCEH will continue to collaborate with IDEQ on their activities at the site and remain involved with the ongoing Selenium Area Wide Advisory Committee (SeAWAC) meetings.

2. BCEH will conduct community involvement and health education activities at the site, such as informing the hunters of the potential hazard scenario involving eating more than 10 ounces per month of elk liver.

3. IDEQ will continue to coordinate with the Interagency Selenium Area Wide Technical Group and lead the selenium area wide investigation.

4. BCEH will review new environmental sampling data and studies for the Resource Area relevant to public health as they become available.

5. BCEH will work with the Idaho Department of Fish and Game (IDFG) and the Idaho Department of Health and Welfare (IDHW) Bureau of Laboratories to analyze edible fish harvested from the Resource Area for selenium. BCEH will issue fish advisories if warranted

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8. Certifications

This Public Health Assessment was prepared by the Idaho Bureau of Community and Environmental Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health assessment and concurs with its findings.

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Appendix A

Map of Southeast Idaho Phosphate Mining Resource Area

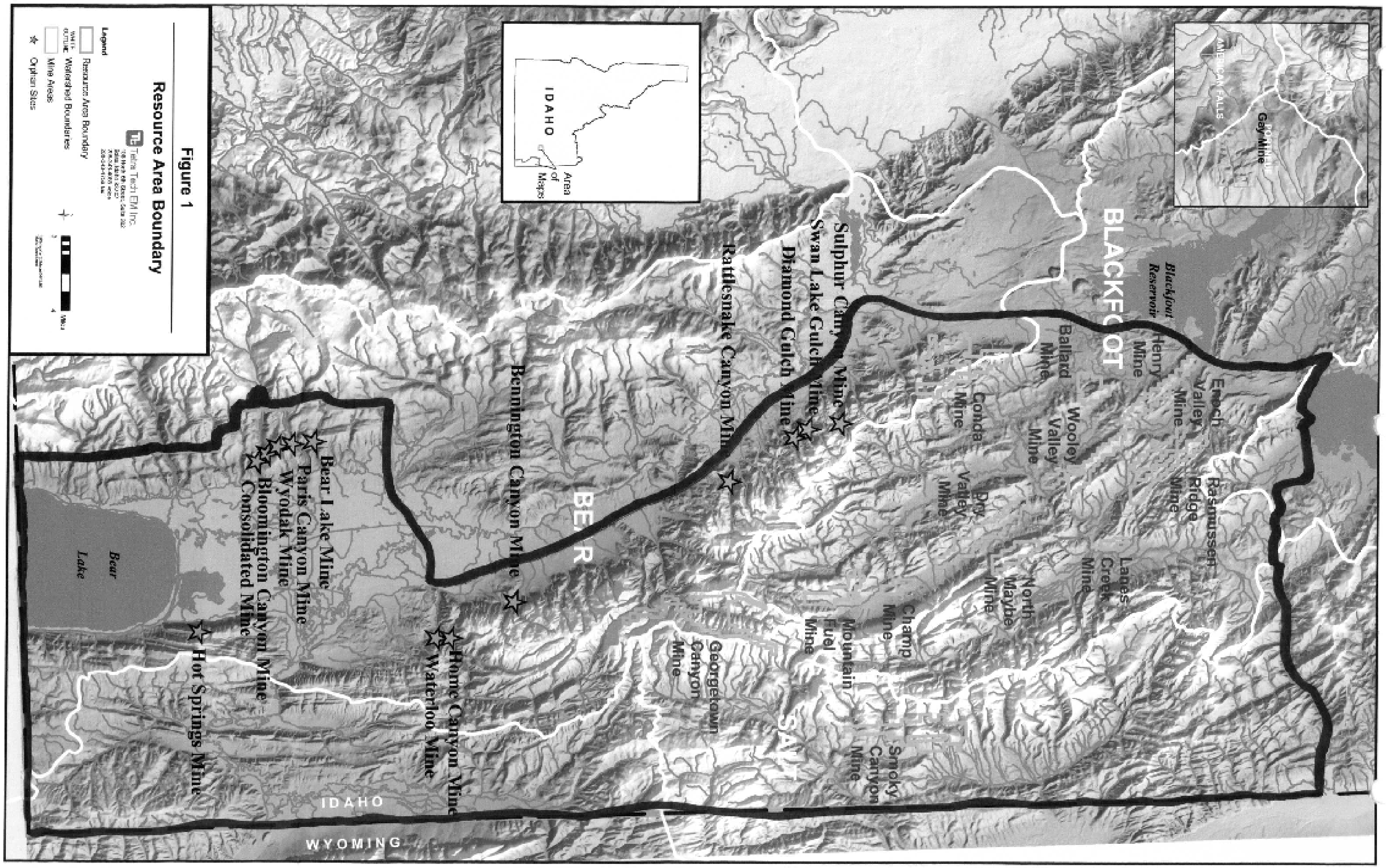
Figure 1
Resource Area Boundary
Tetra Tech EM Inc.
Legend
Resource Area Boundary
Watershed Boundaries
Mine Areas
Orphan Sites
Miles
IDAHO
Area of Maps
BLACKFOOT
Blackfoot Reservoir
BEAR
SALT
Gay Mine
Enoch Valley Mine
Rasmussen Ridge Mine
Henry Mine
Lanes Creek Mine
Ballard Mine
Wooley Valley Mine
North Maybe Mine
Conda Mine
Dry Valley Mine
Champ Mine
Smoky Canyon Mine
Mountain Fuel Mine
Sulphur Canyon Mine
Swan Lake Gulch Mine
Diamond Gulch Mine
Rattlesnake Canyon Mine
Georgetown Canyon Mine
Bennington Canyon Mine
Home Canyon Mine
Waterloo Mine
Bear Lake Mine
Paris Canyon Mine
Wyodak Mine
Bloomington Canyon Mine
Consolidated Mine
Hot Springs Mine
Bear Lake
IDAHO
WYOMING

Appendix B

Explanation of Evaluation Process

Explanation of Evaluation Process

Screening Process

In evaluating available data, the Bureau of Community and Environmental Health (BCEH) uses comparison values (CVs) to determine which chemicals to examine more closely. CVs are contaminant concentrations found in a specific media (air, soil, or water) and are used to select contaminants for further evaluation. CVs are designed to be conservative and non-site specific, and therefore protective for all probable exposures. Their intended use is only to screen out contaminants which do not need further evaluation. CVs are not intended as cleanup levels or as indicators of public health effects. CVs, derived from toxicological information, incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that a person may inhale or ingest each day. Generally, the assumptions are very conservative (i.e., worst case).

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds or less) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one in a million excess cancer risk for an adult eating contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and non-cancer numbers exist, the lower level is used to be protective. Exceeding a CV does not mean that adverse health effects will occur, just that more evaluation is needed.

If a chemical contaminant is selected for further evaluation, the next step is to identify which chemicals and exposure situations could be a health hazard. Child and adult exposure doses are calculated for contaminants of concern (COCs) in site media (e.g., soil, groundwater, surface water, sediment, and biota). Exposure doses are the estimated amounts of a contaminant that people come in contact with under specified exposure situations. These exposure doses are compared to appropriate health guidelines for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known health effect levels identified in ATSDR’s toxicological profiles and other scientific references. If the chemical of concern is a carcinogen, the cancer risk is also estimated. These comparisons are the basis for stating whether the exposure is a health hazard.

CVs used in this document and previous health consultations are listed below:

Environmental media evaluation guides (EMEGs) are estimated contaminant concentrations in a media where non-carcinogenic health effects are unlikely. The EMEG is derived from the Agency for Toxic Substances and Disease Registry’s (ATSDR) minimal risk level.

Cancer risk evaluation guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million people exposed over a lifetime. CREGs are calculated from the U.S. Environmental Protection Agency's (EPA) cancer slope factors.

Lifetime health advisories (LTHAs) are derived by EPA from a drinking water equivalent level below which no adverse noncancer health effects are expected to occur over a 70-year lifetime.

Lowest-observed-adverse-effect level (LOAEL) is defined as the lowest dose of chemical in a study, or group of studies, that produces statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

National Ambient Air Quality Standards (NAAQS) are developed by EPA to protect people and the environment from unhealthy and undesirable levels of air pollution. NAAQS have been developed specifically to protect the health and welfare of humans. To be conservative, these standards were designed to be protective of exposed persons, including the most "sensitive" populations (e.g., persons with asthma).

No-observed-adverse-effect level (NOAEL) is defined as the lowest dose of chemical at which no statistically or biologically significant increases occurred in the frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Minimal risk levels (MRLs) are defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (non-carcinogenic) over a specified duration of exposure. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specified duration within a given route of exposure. MRLs are based only on non-cancerous health effects, and do not consider carcinogenic effects. MRLs can be derived for acute, intermediate, and chronic durations of exposure.

Maximum contaminant levels (MCLs) are enforceable drinking water regulations, established by EPA under the Safe Drinking Water Act, that are protective of human health to the extent feasible both technologically and economically. The MCL assumes exposure over a 70-year lifetime and ingestion of 2 liters of water per day.

Risk-Based concentrations (RBCs) are the estimated contaminant concentrations in which no chance exists for carcinogenic or non-carcinogenic health effects.

Secondary maximum contaminant levels (SMCLs) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply.

For radiological contaminants, BCEH uses information on radiation exposure and its effects related to environmental levels prepared by federal agencies, including EPA, the U.S. Department of Energy (DOE), and the Nuclear Regulatory Commission. BCEH and ATSDR also use other publicly available data sources and recommendations on radiation dose limits. The National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), the United Nations Scientific Committee on the Effects of Atomic Radiation, and others develop these sources.

Determination of Exposure Pathways

BCEH identifies human exposure pathways by examining environmental and human components that might lead to contact with contaminants of concern. A pathway analysis considers five principal elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. Completed exposure pathways are those for which the five elements are evident, and indicate that exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. Potential exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. It should be noted that the identification of an exposure pathway does not imply that health effects will occur. Exposures may, or may not be, substantive. Therefore, even if exposure has occurred, is occurring currently, or is likely to occur in the future, human health effects may not result.

BCEH reviews site history, information on site activities, and the available sampling data. On the basis of this review, BCEH identifies exposure pathways that warrant consideration. Additional information regarding the exposure pathways identified for the EMF site is provided in Appendix E of this public health assessment. If people are unlikely to be exposed to contaminants in a given pathway, then that pathway will not be evaluated further for human health risks.

Evaluation of Public Health Implications

The next step is to take those contaminants that are above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of who goes on the site and how often they contact the site contaminants. The exposure dose is the amount of a contaminant that gets into a person’s body.

Appendix C

Contaminants of Concern Selection and Estimated Exposure Doses

Table C-1 Health Comparison Values of Surface Soil (mg/kg)

Contaminant	Non-cancer			Cancer and Other	
	Child	Adult	Source	Standards	Source
Aluminum	100,000	1,000,000	I-EMEG		
Antimony	20	300	RMEG		
Arsenic	20	200	C-EMEG	0.5	CREG
Barium	4,000	50,000	RMEG		
Beryllium	100	1,000	C-EMEG	Inhalation	
Boron	500	7,000	I-EMEG		
Cadmium	10	100	C-EMEG		
Chromium (III)	80,000	1,000,000	RMEG		
Chromium (VI)	200	2,000	RMEG	Inhalation	
Cobalt	500	7,000	I-EMEG		
Copper	500	7,000	I-EMEG		
Mercuric Chloride	100	1,000	I-EMEG		
Molybdenum	300	4,000	RMEG		
Nickel	1,000	10,000	RMEG		
Selenium	300	4,000	C-EMEG		
Silver	300	4,000	RMEG		
Uranium, Highly Soluble Salts	100	1,000	I-EMEG		
Vanadium	200	2,000	I-EMEG		
Zinc	20,000	200,000	C-EMEG		

C-EMEG = Chronic Environmental Media Evaluation Guide
CREG = Cancer Risk Evaluation Guide for 10^{-6} excess cancer risk
I-EMEG = Intermediate Environmental Media Evaluation Guide
Inhalation: chemicals can be carcinogenic when inhaled
mg/kg = milligram per kilogram
RMEG = Reference Dose Media Evaluation Guide

Table C-2   Health Comparison Values of Drinking Water (µg/L)

Contaminant	Non-cancer			Cancer and Other	
	Child	Adult	Source	Standards	Source
Aluminum	20,000	70,000	I-EMEG		
Antimony	4	10	RMEG		
Arsenic	3	10	C-EMEG	0.02	CREG
Beryllium	20	70	C-EMEG	Inhalation	
Boron	100	400	I-EMEG		
Cadmium	2	7	C-EMEG		
Chromium	100		LTHA		
Cobalt	100	400	I-EMEG		
Copper	100	400	I-EMEG		
Mercuric Chloride	20	70	I-EMEG		
Molybdenum	50	200	RMEG		
Nickel	200	700	RMEG		
Selenium	50	200	C-EMEG		
Silver	50	200	RMEG		
Uranium	30		MCL		
Vanadium	30	100	I-EMEG		
Zinc	3,000	10,000	C-EMEG		

C-EMEG = Chronic Environmental Media Evaluation Guide
CREG = Cancer Risk Evaluation Guide for 10^{-6} excess cancer risk
I-EMEG = Intermidiate Environmental Media Evaluation Guide
Inhalation: chemicals can be carcinogenic when inhaled
LTHA = Lifetime Health Advisory for drinking water (EPA)
MCL = Maximum Contaminant Level for drinking water (EPA)
RMEG = Reference Dose Media Evaluation Guide
µg/L = microgram per Liter

Table C-3 Contaminants of Concern in Soil

Contaminant	Impacted Sample Concentrations (mg/kg)				Background Sample Concentrations (mg/kg)				Above CVs (Y/N)
	Minimum	Maximum	Mean	FOD	Minimum	Maximum	Mean	FOD	
Aluminum	7,870	33,400	24,200	4/4	18,000	29,600	23,400	4/4	N
Antimony	0.2	17	2.8	7/11	0.2	5.6	1.3	4/8	N
Arsenic	3	29	9.6	11/11	5.2	7.8	6.6	8/8	Y
Beryllium	0.5	1.7	1.4	11/11	0.8	1.8	1.2	8/8	N
Boron	1	43	15.9	9/11	2.7	24	5.7	4/8	N
Cadmium	0.1	63	7.7	10/11	0.1	2.7	1.1	7/8	Y
Chromium	21	970	144	11/11	35	110	57.7	8/8	Y
Cobalt	3.2	19	7.08	24/25	NA	NA	NA	NA	N
Copper	7.5	120	27.7	11/11	11	26	17.4	8/8	N
Mercury	0.0001	0.62	0.0914	11/11	0.14	0.07	0.0292	8/8	N
Molybdenum	31	31	6.1	1/7	< 3.8	< 3.8	1.9	0/4	N
Nickel	13.7	280	56	11/11	19	37	24.7	8/8	N
Selenium	0.9	150	16.4	11/11	0.4	1.4	0.9	8/8	N
Silver	0.1	5.2	0.6	5/11	0.1	0.1	0.1	4/8	N
Uranium	1	11	6.4	6/7	4.1	9.3	6.6	4/4	N
Vanadium	17.7	500	104	8/8	42.3	83	54.9	8/8	Y
Zinc	40.7	1,400	246	11/11	67	190	106	8/8	N

CVs = Comparison Values
FOD = Frequency of Detection
mg/kg = milligram per kilogram
NA = Not Applicable
Note: The mean values were calculated using ½ the equipment detection limit for below detection limit analytical results; Highlighted concentrations indicate contaminant concentration is above the health-based comparison values.

Table C-4 Contaminants of Concern in Surface Water

Contaminant	Impacted Sample Concentrations (µg/L)				Background Sample Concentrations (µg/L)				Above CVs (Y/N)
	Minimum	Maximum	Mean	FOD	Minimum	Maximum	Mean	FOD	
Aluminum	4.5	1600	194	66/66	9.3	8100	475	30/30	N
Antimony	< 0.2	< 2.5	1.2	0/66	< 0.2	< 2.5	1.1	0/30	N
Arsenic	< 0.5	5	0.4	3/66	< 0.5	1.5	0.3	2/30	Y
Beryllium	< 0.1	5	2.4	3/66	< 0.1	< 5	2.3	0/30	N
Boron	10	180	71.9	66/66	10	120	61.1	30/30	Y
Cadmium	< 0.1	1.8	0.1	12/66	< 0.1	0.65	0.1	8/30	N
Chromium	< 0.1	4.6	0.4	18/66	< 0.1	5.8	0.6	5/30	N
Cobalt	< 2.5	30.7	5.07	2/177	NA	NA	NA	NA	N
Copper	< 0.13	5.8	0.6	34/66	< 0.13	3.4	0.5	11/30	N
Mercury	< 0.002	0.009	0.1	24/45	< 0.0002	0.005	0.1	11/21	N
Molybdenum	< 0.1	10.1	1.4	5/66	< 0.1	< 2.5	1.1	3/30	N
Nickel	< 0.13	43	1.6	41/66	0.13	4	1	21/30	N
Selenium	< 1	1140	23.4	41/66	< 1	1.6	0.6	4/30	Y
Silver	< 0.05	1.1	0.2	8/66	< 0.05	3.5	0.1	2/30	N
Uranium	0.21	5.4	1	66/66	0.3	1.9	0.6	30/30	N
Vanadium	< 0.05	6.2	1.1	46/66	< 0.05	8.1	1.1	16/30	N
Zinc	10	110	22.9	45/66	< 10	71	16.4	17/30	N

CVs = Comparison Values
FOD = Frequency of Detection
NA = Not Applicable
µg/L = microgram per Liter
Note: The mean values were calculated using ½ the minimum detection limit for below detection limit analytical results; Highlighted concentrations indicate contaminant concentration is above the health-based comparison values.

Table C-5 Contaminants of Concern in Sediment

Contaminant	Impacted Sample Concentrations (mg/kg)				Background Sample Concentrations (mg/kg)				Above CVs (Y/N)
	Minimum	Maximum	Mean	FOD	Minimum	Maximum	Mean	FOD	
Aluminum	11,400	41,000	24,400	7/7	9,500	19,000	14,900	3/3	N
Antimony	0.02	3.5	0.75	2/19	0.02	2.3	0.73	1/12	N
Arsenic	0.25	16	5.62	18/19	1.1	12	5.53	12/12	Y
Beryllium	0.5	1.4	0.9	19/19	0.39	1.6	0.9	12/12	N
Boron	1	29	9.21	11/19	1	25	12.6	10/12	N
Cadmium	0.65	14	4.42	19/19	0.1	5.1	1.05	8/12	Y
Chromium	16	191	65.6	19/19	11	100	39.5	12/12	N
Cobalt	1.7	2.7	2.27	3/3	NA	NA	NA	NA	N
Copper	4.2	44	14.9	19/19	3.2	25	11.3	12/12	N
Mercury	0.01	0.227	0.0426	19/19	0.0084	0.034	0.0199	12/12	N
Molybdenum	0.5	5	1.96	4/17	0.5	4	1.77	2/12	N
Nickel	11	164	42.2	19/19	6.4	44	19.1	12/12	N
Selenium	1.1	188	18.4	19/19	0.52	2.6	1.22	12/12	N
Silver	0.1	2.04	0.24	7/19	0.04	0.1	0.09	3/12	N
Uranium	1.64	20	8.67	17/17	0.59	12	4.38	12/12	N
Vanadium	14	133	54.3	19/19	14	72	35.3	12/12	N
Zinc	35	866	201	19/19	38	210	84.2	12/12	N

CVs = Comparison Values
FOD = Frequency of Detection
mg/kg = milligram per kilogram
NA = Not Applicable
Note: The mean values were calculated using ½ the equipment detection limit for below detection limit analytical results; Highlighted concentrations indicate contaminant concentration is above the health-based comparison values.

Table C-6 Area-Weighted Average Concentrations (AWAC) (wet weight) of Contaminants in Fish Tissue and Estimated Exposure Dose

Watershed	Blackfoot Watershed		Salt Watershed		Georgetown Watershed	
	AWAC (mg/kg)	Exposure Dose (mg/kg/day)	AWAC (mg/kg)	Exposure Dose (mg/kg/day)	AWAC (mg/kg)	Exposure Dose (mg/kg/day)
Cadmium	0.0541	0.00005	0.0306	0.00003	0.0376	0.00004
Chromium	0.45	0.0004	0.38	0.0004	0.4	0.0004
Selenium	2.88	0.0027	1.95	0.0018	2.24	0.0021

AWAC = Area-Weighted Average Concentration
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
Note: The concentrations of contaminants are wet weight; the exposure doses were based on the recommended mean fish consumption rate (70 gram per day) for the Native American subsistence population (EPA 1997), and the adult body weight of 75 kilogram (165 lbs) (BVRHS 2001).

Table C-7 Health Guideline Values

Contaminant	ATSDR's Chronic Oral MRL mg/kg/day	ATSDR's Intermediate Oral MRL mg/kg/day	ATSDR's Acute Oral MRL mg/kg/day	EPA's Chronic Oral RfD mg/kg/day	EPA's Oral Slope Factor $(mg/kg/day)^{-1}$
Aluminum		2			
Antimony				0.0004	
Arsenic	0.0003		0.005	0.0003	1.5
Beryllium	0.002			0.002	
Boron		0.01		0.2	
Cadmium	0.0002			0.0005 (Water) 0.001 (Food)	
Chromium (III)				1.5	
Chromium (VI)				0.003	
Cobalt		0.01			
Copper		0.01	0.01		
Cyanide				0.02	
Lead					
Manganese (environmental)				0.05	
Manganese (food)				0.14	
Mercuric Chloride		0.002	0.007	0.0003	
Methyl Mercury	0.0003			0.0001	
Molybdenum				0.005	
Nickel				0.02	
Selenium	0.005			0.005	
Silver				0.005	
Uranium, Soluble salts				0.003	
Vanadium		0.003			
Zinc	0.3	0.3		0.3	

mg/kg/day = milligram per kilogram per day
MRL = Minimal Risk Level
RfD = Reference Dose

Table C-8 Contaminant Levels Found in Elk Tissues

Contaminant	Sample Year	Concentration in Elk Liver (mg/kg, wet weight)				Concentration in Elk Muscle (mg/kg, wet weight)			
		Minimum	Maximum	Mean	95th Percentile	Minimum	Maximum	Mean	95th Percentile
Selenium	**1999 & 2000**	0.17	13.06	1.63	5.85	0.06	0.92	0.24	0.54
Cadmium	**1999**	0.11	1.7	0.44	NA	0	0.27	0.11	NA
	2000	0.06	0.66	0.27	0.49	0	0.15	0.01	0.04
Copper	**2000**	8.1	64	28.6	58.5	0.62	2.6	1.5	2.3
Lead	**2000**	LEAD							
Manganese	**2000**	1.4	9.5	3.0	4.04	0.068	6.7	0.65	3.52
Molybdenum	**2000**	0.62	2.0	1.2	1.68	MOLYBDENUM			
Zinc	**2000**	16	40	25.8	36.8	18	110	54.4	90.2

mg/kg = milligram per kilogram

NA = Not Applicable

LEAD: among 50 elk liver samples, only three were detectable for lead with concentrations of 0.54, 0.65, and 0.76 mg/kg respectively; among 50 elk muscle samples, only one was detectable for lead with concentration of 50 mg/kg.

MOLYBDENUM: among 50 elk muscle samples, only two were detectable for molybdenum with the concentration of 0.14 and 1.2 mg/kg respectively.

Note: The concentrations of contaminants are wet weight; the selenium concentration data were combined for the elk samples collected in 1999 and 2000.

Table C-9 Description of Exposure Scenarios to Elk Tissues

Exposure Scenario	Elk Tissue	Consumption Description	Consumption Rate	Estimated Meal Size
1	**Muscle**	Frequently eats elk meat	One meal per day	8 ounces
2	**Liver**	Rarely eats elk liver	Two meals per year	10 ounces
3	**Liver**	Occasionally eats elk liver	One meal per month	10 ounces

Table C-10 Estimated Exposure Doses of the Contaminants in Elk Tissues for Different Exposure Scenarios

Exposure Scenario	Elk Tissue	Exposure Dose (mg/kg/day)						
		Selenium	Cadmium	Copper	Lead	Manganese	Molybdenum	Zinc
1	**Muscle**	0.0028	0.0008	0.008	NA	0.02	0.004	0.33
2	**Liver**	0.00027	0.000035	0.0013	0.000016	0.0002	0.00004	0.0008
3	**Liver**	0.0016	0.00021	0.0079	0.00009	0.001	0.0002	0.005

mg/kg/day = milligram per kilogram per day

NA = As shown in Appendix C, Table C-8, among 50 elk muscle samples, only one sample was detectable for lead with a very high concentration of 50 mg/kg. BCEH does not think this value is reliable and highly suspects this sample was somehow contaminated. Therefore, BCEH assumes all the elk muscle are non-detectable for lead.

Note: The exposure doses were based on the maximum concentrations of the contaminants, and the adult body weight of 75 kilogram (165 lbs) (BVRHS 2001).

Table C-11 Selenium Concentrations in Beef Tissues (mg/kg wet weight)

Tissues	Selenium Concentration (mg/kg wet weight)		
	Minimum	Maximum	Mean
Muscle	0.10	1.3	0.74
Liver	0.35	0.91	0.69

mg/kg = milligram per kilogram
Note: The concentrations of contaminants are wet weight.

Table C-12 Maximum Contaminant Concentrations in Aquatic Plants (mg/kg dry weight)

Contaminant	Maximum Concentration (mg/kg dry weight)	Vegetable Intake Rate (g/kg/day, wet weight)	Percentage (%)	Exposure Dose (mg/kg/day)
Aluminum	45000	10	10	0.06
Antimony	1	10	10	0.0000013
Arsenic	2.2	10	10	0.0000029
Cadmium	11.5	10	10	0.000015
Chromium	45.2	10	10	0.000060
Cobalt	2.4	10	10	0.0000032
Copper	11.4	10	10	0.000015
Nickel	23.9	10	10	0.000032
Selenium	39.4	10	10	0.000053
Vanadium	24.4	10	10	0.000033
Zinc	162	10	10	0.00022

Mg/kg = milligram per kilogram
g/kg/day = gram per kilogram per day
Note: The concentrations of contaminant are dry weight; the vegetable intake rate is as consumed (wet weight) (EPA 1997); the exposure doses were based on the recommended 95th percentile vegetable intake rate of 10 g/kg/day (EPA 1997), the adult body weight of 75 kilogram (165 lbs) (BVRHS 2001), assuming the aquatic plants containing about 90% water, and the plants from the Resource Area which were consumed was about 10% of the total vegetable intake rate.

Appendix D

Exposure Pathways for Southeast Idaho Phosphate Mining Resource Area

Table D-1. Exposure Pathways for Southeast Idaho Phosphate Mining Resource Area

PATHWAY NAME	ENVIRONMENTAL MEDIA & TRANSPORT MECHANISMS	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSURE POPULATION	TIME	NOTES	STATUS
Soil	Spillage onto soil; erosion of waste to surface soils; deposition of fugitive dust	Soil in the Resource Area	Incidental ingestion, inhalation, dermal exposure	Recreational users (hunters, anglers, collectors) and nearby residents	Past, present, future	Population may include children.	Complete
Surface water	Surface water runoff over contaminated soil to river; dissolution of contaminants from sediment	Rivers and reservoirs in the Resource Area	Incidental ingestion, inhalation, dermal exposure	Recreational users (hunters, anglers, collectors) and nearby residents	Past, present, future	Population may include children.	Complete
Sediment	Spillage; deposition from surface water runoff into river	Rivers and reservoirs in the Resource Area	Incidental ingestion, dermal exposure	Recreational users (hunters, anglers, collectors) and nearby residents	Past, present, future	Population may include children.	Complete
Groundwater	Infiltration to groundwater	Groundwater wells supplying drinking water taps	Ingestion, inhalation, dermal exposure	Nearby residents	Past, present, future	Population may include children.	Complete
Biota (fish, elk, beef, and plants)	Bioaccumulation of contaminants from surface water and sediments in fish	Meals prepared using fish, elk, beef, and plants from the Resource Area	Ingestion	Hunters, anglers, collectors, people who buy beef raised in the Resource Area, and their families	Past, present, future	Population may include children.	Complete

Appendix E

ATSDR Interim Public Health Hazard Categories

Table E-1 Interim Public Health Hazard Categories

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

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

Appendix F

Health Consultation: Evaluation of Selenium in Groundwater

HEALTH CONSULTATION

Evaluation of Selenium in Groundwater in the Southeast Idaho Phosphate Resource Area

(a.k.a. Southeast Idaho Selenium Project)
EPA Facility ID: IDN001002245

Soda Springs, Caribou County, Idaho

September 2001

Prepared by:

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

Background and Statement of Issue

The Idaho Department of Health and Welfare, Division of Health, Bureau of Environmental Health and Safety (BEHS) has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). As part of the cooperative agreement, BEHS is writing this Health Consultation for the Southeast Idaho Phosphate Resource Area (SEIPRA) to evaluate selenium in groundwater. This Health Consultation attempts to address the following question: Are people in the SEIPRA being exposed to selenium through groundwater at levels that may cause harm?

This health consultation will only address the public health significance of exposure to selenium from well water draw from groundwater in the area. Other exposure pathways, for example, consumption of wild game and livestock were addressed in a previous health consultation, "Evaluation of Selenium in Beef, Elk, Sheep, and Fish in the Southeast Idaho Phosphate Resource Area" (BEHS 2001). This consultation does not address ecological risk. BEHS and ATSDR will collaboratively address specific concerns for Native Americans in a separate health consultation

Ten historic and four operating mines are located in this 1,200 square mile resource area. They are located in Caribou, Bingham, Bannock, and Bear Lake counties in southeastern Idaho (Appendix A). Phosphate has been mined from the area since 1919. Some of the ore is seleniferous, containing selenium levels that are much higher than background levels. In the late 1990s, several horses and sheep pastured around mines were diagnosed with chronic selenosis. Hunters from the area reported dead cattle and sheep near mines and were concerned about the potential selenium exposure from the environment. In 1997, the Idaho Mining Association (IMA) formed a Selenium Area Wide Advisory Committee (SeAWAC) to address this issue and BEHS became involved in 1999. Tetra Tech EMI, an environmental contractor for Idaho Department of Environmental Quality (IDEQ), is currently conducting an area wide investigation including reviewing studies conducted by Montgomery Watson (MW). The IDEQ as part of the investigation is now sponsoring the SeAWAC. MW, a contractor hired by the IMA, has completed multiple reports on surface water, vegetation, soil, and animal tissue selenium levels (MW 1998, 1999abc, 2000) and is currently revising its human health risk assessment report. Most recently, IDEQ reported finding about 200 dead sheep around the Conda Mine in spring 2001. Multiple involved agencies and organizations suggested groundwater testing be completed as a part of the IDEQ area wide investigation. Idaho Department of Water Resources provided well logs of the resource area to BEHS. The Idaho Southeastern District Health Department, working with BEHS, has collected groundwater samples from all registered wells in SEIPRA and had them tested for selenium.

Discussion

Selenium

The general health and toxicity information about selenium is presented in the following paragraphs. This information is intended to assist the reader with a better understanding about the issue. The described health and toxicity effects are not specifically related to the site but are rather general information about the potential effects of selenium exposure.

Selenium is an essential nutrient for humans and animals. The recommended daily allowance (RDA) of selenium for maintaining good health is 55 μg/day for women and 70 μg/day for men (approximately 1 microgram per kilogram of body weight per day = 1 μg/kg/day). However, selenium can harm people and animals when consistently consumed in amounts higher (5 to 10 times the RDA) than those needed for good nutrition.

The seriousness of the effects of excess selenium depends on how much and how often selenium is eaten. Accidentally swallowing large amounts of selenium (for example, selenium supplement pills) can be life threatening without immediate medical treatment. Eating moderate excess levels (5 to 10 times the RDA) of selenium constantly over long periods of time can cause signs and symptoms of selenosis which include brittle hair and deformed nails. In extreme cases, people may lose feeling and control in their arms and legs (ATSDR 1996).

Selenium can be found in several forms. Most forms of selenium probably do not cause cancer. The International Research Agency for Research on Cancer did not classify selenium and selenium compounds as carcinogens. However, the U.S. Environmental Protection Agency (EPA) has determined that selenium sulfide (one specific form of selenium) is a probable human carcinogen because it shows cancer-causing effects in some animal studies (IRIS 1993). According to IDEQ, selenium sulfide is not the predominate form found in the resource area. Reproductive effects and developmental effects of selenium in humans and mammals have not been studied adequately.

Well Water Data

BEHS and the Southeastern District Health Department tested all private wells (seven total) located within the SEIPRA (see Appendix A for well locations). All well water samples were collected and tested for possible selenium contamination. Except for well #7, which was at the detectable level of 5 μg/L (5ppb), selenium levels in the other wells were below the detection limit (<5 μg/L). Only the detected selenium concentration from well #7 is compared to available health comparison values.

Public drinking water was not analyzed in this BEHS evaluation. However, according to IDEQ's Public Water System record (1983-2001), the selenium levels (3-26 μg/L) in the SEIPRA public water system are significantly lower than the EPA drinking water regulatory standard, 50 μg/L (IDEQ 2001).

Health Comparison Values

The selenium concentration of well #7 is lower than multiple health-based drinking water guidelines that range from 50 to 200 μg/L. The multiple guidelines and how they were derived are described in the following paragraphs. When concentrations or exposures are below those levels, adverse health effects are not likely to occur.

ATSDR defines a Minimal Risk Level (MRL) as an estimate of daily human exposure to a substance that is likely to be without appreciable risk of adverse, noncarcinogenic effects over a specified duration of exposure. The long-term MRL for selenium is 0.005 mg/kg/day (5μg/kg/day) and is based on information from a human study in China (ATSDR 1996). The EPA has also derived an oral exposure guideline for selenium. EPA defines the Reference Dose (RfD) as an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effect during a lifetime (IRIS 1991). The RfD is identical to the MRL established by ATSDR.

The long-term MRL can be used to calculate the drinking water Environmental Media Evaluation Guide (EMEG) for children and adults. The EMEG represents the concentration of selenium in drinking water that people could drink daily without being harmed. Assuming children weigh about 22 pounds and drink about 32 ounces of water per day and adults weigh about 155 pounds and drink about 64 ounces of water per day, the EMEG for selenium is 50 μg/L for children and 200 μg/L for adults.

The EPA selenium Maximum Contaminant Level (MCL) for drinking water is 50 μg/L. The MCL is a regulatory standard derived from a no-effect level in a human study.

The selenium concentration from well #7 (and all other wells) is lower than both ATSDR's EMEGs and EPA's MCL. Therefore, BEHS concludes that adverse health effects are unlikely to occur from drinking and/or using groundwater from SEIPRA.

Conclusions and Recommendations

Within the resource area, selenium levels are undetectable in six of the seven tested private wells, among which four wells serve as a drinking water source for local residences. Only one out of the seven private wells has a detected selenium level of 5 μg/L, which is below the health-based drinking water standards. Based on this information, there is <u>no apparent public health hazard</u> from drinking and/or using groundwater from SEIPRA (see Appendix B for ATSDR Interim Public Health Hazard Categories). BEHS has no recommendation at this time regarding groundwater taken from private wells.

Public Health Actions

The following actions and activities are in progress:

1. BEHS will continue to remain involved with the ongoing IDEQ SeAWAC, as well as, collaborate with the IDEQ on their Area Wide Investigation activities.
2. MW will publish a revised human health risk assessment: The 1999-2000 Remedial Investigation Report.

3. BEHS in collaboration with ATSDR, will further assess the potential health hazards for Native Americans consuming selenium-contaminated wild game, fish, livestock, and other food stuffs taken from the resource area. BEHS will address potential Native American exposures on State and private land and ATSDR will address Federal and Tribal land. A separate, combined Health Consultation will be completed.

Reference

ATSDR 1996. *Toxicological Profile for Selenium*. Agency for Toxic Substances and Disease Registry. August.

BEHS 2001. Health Consultation. *Evaluation of Selenium in Beef, Elk, Sheep, and Fish in the Southeast Idaho Phosphate Resource Area.* Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho. Bureau of Environmental Health and Safety, Division of Health, Idaho Department of Health and Welfare and Agency for Toxic Substances and Disease Registry. May.

IDEQ 2001. *Selenium in Public Water System*. Personal e-mail Communication with Jerri Henry, Drinking Water Regulatory Analyst, Idaho Department of Environmental Quality, September 11.

IRIS 1991. *Selenium and Compounds.* Integrated Risk Information System. U.S. Environmental Protection Agency.

IRIS 1993. *Selenium Sulfide.* Integrated Risk Information System. U.S. Environmental Protection Agency.

MW 1998. *Draft 1998 Regional Investigation Report – Southeast Idaho Phosphate Resource Area Selenium Project*. Prepared for the Idaho Mining Association's Selenium Subcommittee. Steamboat Springs, Colorado. Montgomery Watson. June.

MW 1999a. *Responses to Comments on the Draft 1998 Regional Investigation Report – Southeast Idaho Phosphate Resource Area Selenium Project.* Bureau of Land Management (BLM) comments*;* K. Ford, BLM-DEN[Memo to P. Oberlandacher, BLM-BOI]. June *and* Idaho Department of Environmental Quality (IDEQ) Comments. August. and US Forest Service (USFS) Comments*; A. Lemly, USFS-Blacksburg, Virginia to J Jones, USFS-Soda Springs, Idaho.* Montgomery Watson. July.

MW 1999b. *1999-2000 Remedial Investigation Field Sampling Plan. Part 1 – Field Sampling Plan*. Prepared for the Idaho Mining Association's Selenium Subcommittee. Montgomery Watson. August.

MW 1999c. *Final 1998 Regional Investigation Report – Southeast Idaho Phosphate Resource Area Selenium Project.* Prepared for the Idaho Mining Association's Selenium Subcommittee. Steamboat Springs, Colorado. Montgomery Watson. December.

MW 2000. *DRAFT Interim Investigation Data Report for the Southeast Idaho Phosphate Resource Area Selenium Project.* Prepared for the Idaho Mining Association's Selenium Subcommittee. Steamboat Springs, Colorado. Montgomery Watson. April.

Preparers of Report and Certification

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Certification:

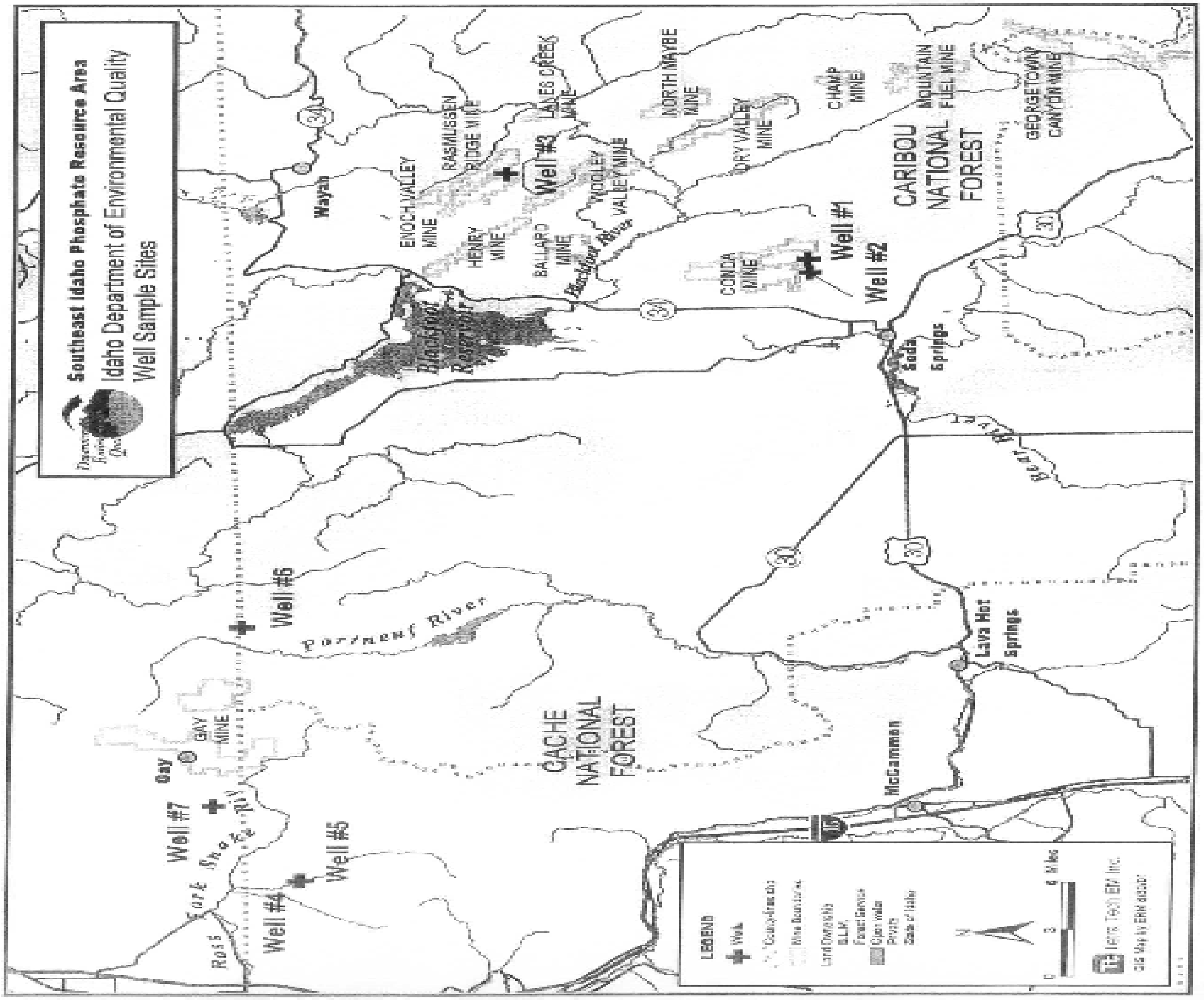
The Idaho Bureau of Environmental Health and Safety prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

____
Technical Project Officer, SPS, SSAB, DHAC

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

____
Chief, SSAB, DHAC, ATSDR

Appendix A. Well Sampling Locations in SEIPRA.



Southeast Idaho Phosphate Resource Area
Idaho Department of Environmental Quality
Well Sample Sites
Wayan
ENOCH VALLEY MINE
RASMUSSEN RIDGE MINE
LANES CREEK MINE
NORTH MAYBE MINE
CHAMP MINE
MOUNTAIN FUEL MINE
GEORGETOWN CANYON MINE
HENRY MINE
BALLARD MINE
WOODLEY VALLEY MINE
DRY VALLEY MINE
Well #3
Blackfoot River
Blackfoot Reservoir
CONDA MINE
Well #1
Well #2
CARIBOU NATIONAL FOREST
Soda Springs
Bear River
Lava Hot Springs
McCammon
CACHE NATIONAL FOREST
Portneuf River
Well #6
GAY MINE
Gay
Well #7
Well #4
Well #5
LEGEND

Appendix B. ATSDR Interim Public Health Hazard Categories

CATEGORY/DEFINITION	DATA SUFFICIENCY	CRITERIA
Urgent Public Health Hazard This category is used for sites where short-term exposures (<1yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgement based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicated that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the pre of serious physical or safety hazards.
Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposure (>1yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgement based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one of more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.
Indeterminate Public Health Hazard This category is used for sites in which “critical” data are insufficient with regard to extent of exposure and/or toxicological properties at estimated exposure levels.	This determination represents a professional judgement that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	The health assessor much determine, using professional judgement, the “criticality” of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.
No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgement based on critical data, which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures, exposure to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
No Public Health Hazard This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.	Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future.	

Appendix G

Health Consultation: Selenium in Fish in Streams of the Upper Blackfoot River Watershed

HEALTH CONSULTATION

SELENIUM IN FISH IN STREAMS OF THE UPPER
BLACKFOOT RIVER WATERSHED

Southeast Idaho Selenium Project
Caribou County, Idaho
EPA Facility ID: IDN001002245

February 2003

Prepared by:

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

BACKGROUND AND STATEMENT OF ISSUE

The Bureau of Environmental Health and Safety (BEHS), Division of Health, Idaho Department of Health and Welfare has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct public health assessments and consultations for hazardous waste sites in Idaho. As part of the cooperative agreement, BEHS prepared this health consultation for the Southeast Idaho Phosphate Resource Area (SEIPRA) to evaluate selenium in fish in streams of the upper Blackfoot River watershed. This Health Consultation addresses the following question: Are people in the SEIPRA being exposed to selenium through fish in streams of the upper Blackfoot River watershed at levels that may cause harm?

This health consultation only addresses the public health significance of exposure to selenium from fish in streams of the upper Blackfoot River watershed. Consumption of wild game and livestock was addressed in a previous health consultation, "Evaluation of Selenium in Beef, Elk, Sheep, and Fish in the Southeast Idaho Phosphate Resource Area" (BEHS 2001). BEHS and ATSDR will collaboratively address specific concerns for Native Americans in a separate health consultation.

The Blackfoot River watershed has several active and inactive phosphate mines that potentially could adversely affect aquatic resources in several tributaries of the Blackfoot River (Appendix A). Phosphate has been mined from the area since 1919. Some of the ore is seleniferous, containing selenium levels that are much higher than background levels. In the late 1990s, several horses and sheep pastured around mines were diagnosed with chronic selenosis. Hunters from the area reported dead cattle and sheep near mines, and were concerned about potential selenium exposure from the environment. Idaho Department of Environmental Quality (IDEQ) reported finding about 200 dead sheep around the Conda Mine in the Spring 2001. In 1997, the Idaho Mining Association (IMA) formed a Selenium Area Wide Advisory Committee (SeAWAC) to address this issue and BEHS became involved in 1999. Recent concerns about the potential impact on aquatic and terrestrial ecosystems from phosphate mining activities have been the subject of several reports (MW 1998, 1999abc, 2000, 2001). Elevated concentrations of selenium have been reported in limited samples of fish fillets and aquatic invertebrates (MW 1999c).

Since 2000, Tetra Tech EMI, an environmental contractor for IDEQ, conducted a Selenium Area Wide Investigation and reviewed studies conducted by Montgomery Watson. In the study, they found the selenium concentrations in some fish were above 2 micrograms per gram (mg/kg) or parts per million (ppm) wet weight. The IDEQ Area Wide Risk Assessment report cited that consumption advisories to protect human health were issued in California when selenium concentrations in edible tissues exceeded 2 ppm (wet weight), while health professionals advised against any human consumption when selenium concentrations in edible tissues exceeded 5 ppm. Because some of the levels of selenium in fish were above 2 ppm, Rick Clegg, IDEQ, requested that BEHS review the data to determine if a fish advisory should be issued for fish consumed from streams of the upper Blackfoot River watershed.

DISCUSSION

Bio-monitoring Data

Since 1997, SeAWAC investigated the occurrence and potential release of metals associated with phosphate mining activities in the Southeast Idaho Phosphate Resource Area. Fish from the streams in the upper Blackfoot River watershed in southeast Idaho were collected by the mining companies' contractor, Montgomery Watson, in September 1998, September 1999 and May 2000. Fish samples were analyzed for selenium concentrations in the skin-on fillets. The edible fish tissue samples were collected only for harvest fish exceeding 4 inches in length. The summary analytical data are presented in Appendix B. The focus area is about 600 square miles of the watershed above but not including the Blackfoot Reservoir (Appendix A). The upper Blackfoot River and its tributaries provide regional sport fisheries primarily for Cutthroat Trout, but also other cold water species. There are some "catch and release" provisions for Yellowstone Cutthroat Trout in the area based on size limitations. To date the site studies have been focused on the regional impacts of selenium releases from historic phosphate mining activities.

Health Comparison Value

The U.S. Environmental Protection Agency (EPA) has developed reference doses (RfD) and recommended screening values (SV) for target contaminants (EPA 1995). The RfD is defined as an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA 2000). The RfD of 0.005 milligram per kilogram per day (mg/kg/day) was derived for clinical selenosis using a No-Observed-Adverse-Effect Level (NOAEL) of 0.015 mg/kg/day. The RfD was based on a human epidemiological study published by Yang et al. (1989a). A NOAEL is the highest dose of a chemical where no observed adverse health effects are seen. An uncertainty factor of 3 was applied to the NOAEL to account for sensitive individuals. A full factor of 10 was not deemed necessary because similar NOAELs were identified in two moderately sized human cohorts exposed to selenium in excess of the National Research Council's Recommended Dietary Allowances (RDA) throughout a lifetime without apparent clinical signs of selenosis (EPA 2000). The RDA is 0.070 mg/day for males and 0.055 mg/day for females for vitamin supplements.

ATSDR defines a Minimal Risk Level (MRL) as an estimate of daily human exposure to a substance that is likely to be without appreciable risk of adverse, non-carcinogenic effects over a specified duration of exposure. The chronic oral MRL derived by ATSDR for selenium is 0.005 mg/kg/day, which is the same as EPA's RfD value. This is based on a NOAEL of 0.015 mg/kg/day for dermal effects (nail disease) identified in chronically exposed people in China as reported by Yang et al. (1989a, 1989b), and divided by an uncertainty factor of 3 to account for sensitive individuals. ATSDR (2001) believes its MRL is consistent with NOAELs observed by Longnecker et al. (1991).

Screening values are target chemical concentrations in fish tissue that are of potential public health concern and are used as standards against which levels of contaminants in similar tissue collected from the ambient environment can be compared. Exceeding the screening values indicated that more intensive site-specific monitoring and/or evaluation of human health risk should be conducted (EPA 1995). The SVs are equal to the exposure levels at the RfD for non-carcinogens, given average ingestion rates (IR) of 6.5 grams per day (g/d) and body weights (BW) of 70 kg, for the general adult population. The EPA's SV for selenium in fish is 50 ppm. On the basis of a SV of 50 ppm, no fish advisory for general adult population would be warranted for fish consumed from streams of the upper Blackfoot River watershed.

Several states, including California, use a SV of 2 ppm. The California Environmental Protection Agency (CEPA) has questioned the use of the 6.5 g/d default ingestion rate that was used to calculate the SV of 50 ppm (Gassel 1997). CEPA's recommended default ingestion rate for sport fishing populations in California is 21 g/d for the median value, 50 g/d for the mean, 107 g/d for the 90th percentile, and 161 g/d for the 95th percentile rate when estimating consumption of both marine and freshwater sources of sport fish and shellfish in California. This may explain the low 2 ppm health advisory level for some states, including California, as cited in the IDEQ Area Wide Risk Assessment report. However, the California fish IRs, which include marine sources, are not considered representative of fish consumption rates that would be expected from the focus area of the streams of the upper Blackfoot River watershed (freshwater).

Exposure Assumption

BEHS adopts the standard risk assessment procedures developed by EPA with minor exposure assumption adjustment to best fit Idahoan's needs. The risk assessment assumptions are listed in Table 1. BEHS considers the "no consumption restriction" category when consumption of more than two 8 ounce fish meals per week is considered safe. Two 8 ounce meals per week yield an average of 65 g/day that is protective for 95% of the general population and reasonably represents the consumption rate of Native Americans.

Table 1. General risk assessment assumptions and action levels for selenium in fish

Population	General Population	Pregnant Women[a]	Children[b]
Body Weight (kg)[c]	80	70	20
Meal Size Uncooked (oz)[d]	8	8	4
Screening Values of Selenium in Fish (mg/kg)[e]	6.2	5.4	3.1

a: pregnant women, women may become pregnant, and nursing mothers
b: children less than 7 years old
c: adjusted from Idaho Behavioral Risk Factors (BVRHS, 2001)
d: 1 oz = 0.0283 kg; 8 oz = 0.2268 kg
e: Reference dose of selenium is 0.005 mg/kg/day (EPA)

Calculation for Screening Values

$$SV = \frac{RfD \times BW \times 365}{EF \times MS}$$

Where,
SV: Screening Value (mg/kg)
RfD: Reference Dose (mg/kg/day) (0.005 mg/kg/day for Selenium)
BW: Body weight (kg)
EF: Exposure Frequency (104 days/year)
MS: Meal Size Uncooked (kg)

The calculated screening values for selenium in fish (Table 1) are 6.2, 5.4, and 3.1 mg/kg respectively for the general population, pregnant women and children less than 7 years old. For the general population and pregnant women, the average fish tissue selenium concentrations (Appendix B) of different fish species at all the locations are lower than their screening values, while the screening values are also 3 times lower than the maximum selenium concentrations (Appendix B) (BEHS 2002). Thus, there is no consumption of fish restriction for the general population and pregnant women (BEHS 2002).

With the exception of Yellowstone Cutthroat and Brook Trout from the East Mill Creek (Appendix B), all other average fish tissue selenium concentrations are lower than the screening value for children, while the screening values are also 3 times lower than the maximum selenium concentrations (Appendix B) (BEHS 2002). Therefore, Yellowstone Cutthroat and Brook Trout from the East Mill Creek are the only fish species contributing to an advisory for children (BEHS 2002).

Limited Meals

For the Yellowstone Cutthroat and Brook Trout from the East Mill creek, we further calculated the limited meals for children by the following equation.

$$Meals\,/\,Month = \frac{\frac{RfD \times BW}{Conc} \times 30.44 days\,/\,mo}{MS}$$

Where,
RfD: Reference Dose (mg/kg-day) (0.005 mg/kg/day for selenium)
BW: Body weight (kg)
Conc: Fish tissue concentration (mg/kg)
days/mo: Days per month
MS: Meal Size Uncooked (kg)

Consumption of Yellowstone Cutthroat and Brook Trout from the East Mill Creek for children should be limited to five (4 oz) meals per month.

Temporary Selenium Fish Advisory

The goal of the Idaho Fish Consumption Advisory Program (IFCAP) is to protect the public from adverse health risks associated with consuming contaminated fish from Idaho's waters. In accordance to the IFCAP's categories (BEHS 2002), consumption of Yellowstone Cutthroat and Brook Trout from the East Mill Creek for children should be adjusted to four (4 oz) meals per month. Because of the small sample number (less than 10), only a temporary selenium fish advisory has been issued (Table 2).

Table 2. Temporary selenium fish advisory for streams of the upper Blackfoot River watershed

Species	**Locations**	**Selenium Concentration (mg/kg)**		**Consumption Advisory**		
		Mean	**Range**	**General Population**	**Pregnant Women**	**Children**
Rainbow Trout	All the locations[a]	0.72	0.13-1.4	No fish consumption restriction [b]	No fish consumption restriction [b]	No fish consumption restriction [c]
Yellowstone Cutthroat and Brook Trout	East Mill Creek	4.8	1.7-7.9	No fish consumption restriction [b]	No fish consumption restriction [b]	Four meals (4 oz.) per month [c]
	Locations except of East Mill Creek	0.85	0.1-2.5	No fish consumption restriction [b]	No fish consumption restriction [b]	No fish consumption restriction [c]

[a] Locations including the Upper Segment and Lower Segment of Blackfoot Reservoir, Blackfoot River, Angus Creek, Spring Creek, East Mill Creek, Timber Creek, and Stewart Creek

[b] More than two 8 oz. fish meals per week for general population and pregnant women

[c] More than two 4 oz. fish meals per week for children

CONCLUSIONS AND RECOMMENDATIONS

Children under the age of seven should not eat more than four (4 oz meal) meals per month of Yellowstone Cutthroat and Brook Trout from the East Mill Creek. There is no consumption restriction of Rainbow Trout nor are Yellowstone Cutthroat and Brook Trout restricted at other locations for children under the age of seven.

There is no fish consumption restriction for the general public and pregnant women at any location.

BEHS suggests sampling more Yellowstone Cutthroat and Brook Trout from the East Mill Creek to confirm that the Yellowstone Cutthroat and Brook Trout continue to pose a health threat. Issuance of a formal selenium fish advisory by IFCAP will be made after sufficient sampling is conducted to fulfill the IFCAP protocol requirements. Future sampling for other areas of the Blackfoot Reservoir and the streams is recommended only when future resources are available.

Issuance of the temporary fish consumption advisory for the East Mill Creek is a precautionary action. Idaho fishing regulations designate the Upper Blackfoot River watershed as “catch and release”. Keeping Yellowstone Cutthroat Trout from the river is illegal. Fish from the East Mill Creek are very limited. Subsistence use of this area is considered highly unlikely.

PUBLIC HEALTH ACTIONS

The following actions and activities are in progress:

4. IFCAP will continue to remain involved with the ongoing IDEQ SeAWAC, as well as, collaborate with the IDEQ on their Area Wide Investigation activities.
5. MW will publish a revised human health risk assessment: The 1999-2000 Remedial Investigation Report.
6. BEHS in collaboration with ATSDR, will further assess the potential health hazards for Native Americans consuming selenium-contaminated wild game, fish, livestock, and other food stuffs taken from the resource area. BEHS will address potential Native American exposures on the State and private land and ATSDR will address the Federal and Tribal land. A separate, combined Health Consultation will be completed.

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CERTIFICATION

The Idaho Bureau of Environmental Health and Safety prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

____
Technical Project Officer, SPS, SSAB, DHAC

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

____
Chief, SSAB, DHAC, ATSDR

Appendix A. Streams of the Upper Blackfoot Watershed

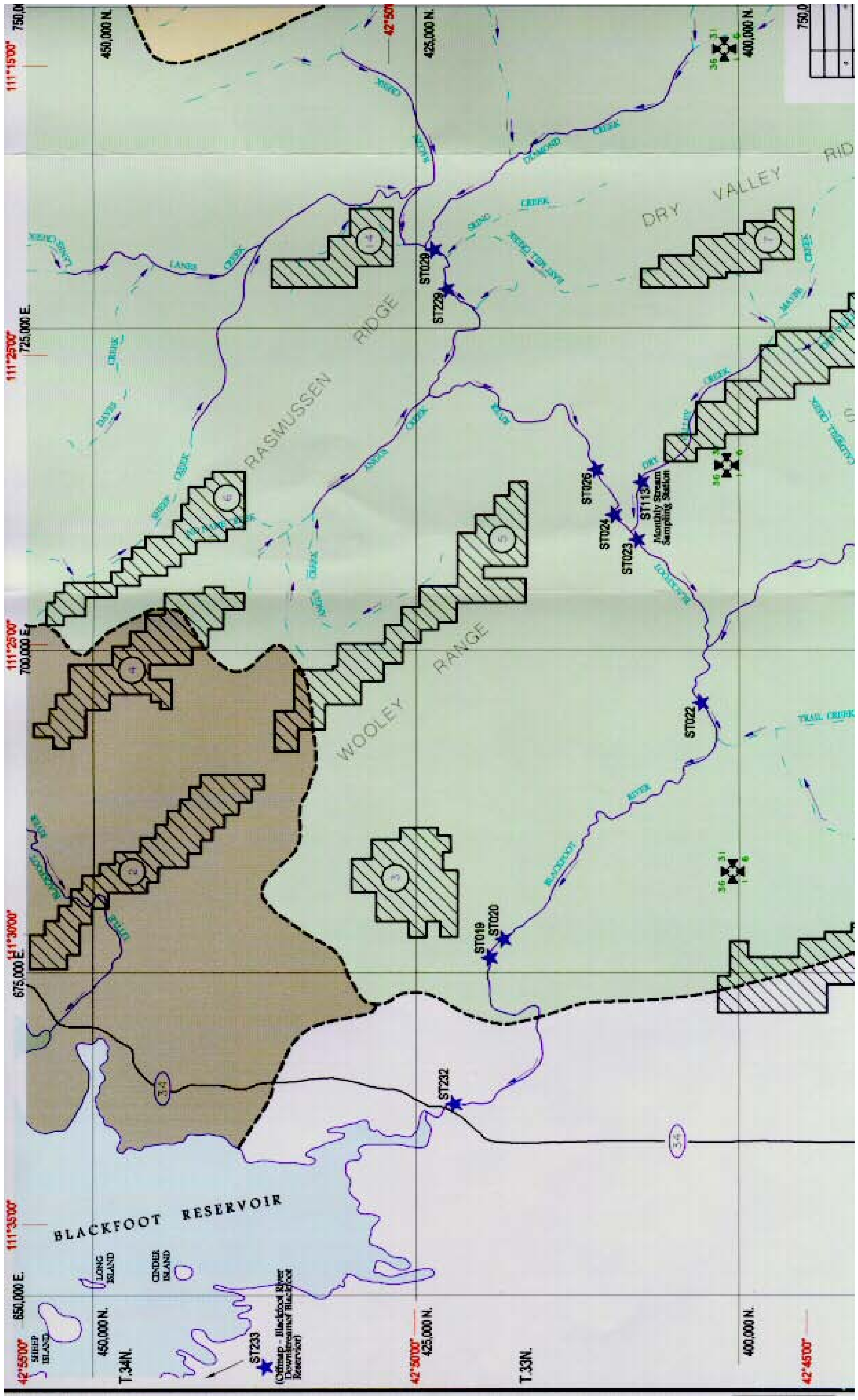

Figure A-1 Streams of the Upper Blackfoot Watershed

Appendix B. Fish Selenium Concentration Data (1998, 1999 and 2000) in the Streams of the Upper Blackfoot River Watershed

Table B-1. Fish Selenium Concentration Data (1998, 1999 and 2000) in the Streams of the Upper Blackfoot River Watershed

Station ID	Station Description	Fish Species	Concentration (mg/kg – wet weight) Range	Mean	# Fish
Blackfoot Reservoir					
RV001	Upper segment	Rainbow Trout	0.13-0.22	0.18	2
		Yellowstone Cutthroat	0.19-0.71	0.45	2
RV002	Upper segment	Yellowstone Cutthroat	0.59-0.80	0.7	6
RV003	Upper segment	Yellowstone Cutthroat	0.19-0.78	0.51	8
RV004	Upper segment	Yellowstone Cutthroat	0.65-0.79	0.72	2
RV005	Upper segment	Yellowstone Cutthroat	0.68-0.75	0.72	2
RV008	Lower segment	Rainbow Trout		0.69	1
Streams					
ST019	Blackfoot River, downstream of Ballard Creek	Yellowstone Cutthroat	0.17-2.2	1.1	6
ST021	Blackfoot River, downstream of Trail Creek	Yellowstone Cutthroat	0.65-1.5	1	6
ST023	Blackfoot River, downstream of Dry Valley Creek	Yellowstone Cutthroat	0.1-1.6	0.7	6
ST026	Blackfoot River, downstream of The Narrows	Yellowstone Cutthroat	0.52-2.5	1.55	9
ST029	Blackfoot River, upstream of Spring Creek	Yellowstone Cutthroat	0.66-2.4	1.14	6
ST129	Angus Creek, downstream of Wooley Valley Mine	Yellowstone Cutthroat	0.20-0.41	0.28	3
ST145	Spring creek, downstream of East Mill Creek	Brook Trout	0.37-0.93	0.65	2
		Yellowstone Cutthroat	0.36-0.89	0.61	4
ST148	Spring Creek, upstream of East Mill Creek	Brook Trout	0.47-1.1	0.89	3
		Yellowstone Cutthroat	0.15-0.19	0.17	2
ST227 (1999, 2000 data)	East Mill Creek	Brook Trout	3.2-6.6	4.9	2
		Yellowstone Cutthroat	1.7-4.1	2.9	2
ST227 (1998 Data)	East Mill Creek	Yellowstone Cutthroat	Maximum: 7.9 Average: 6.0 (for these three fish)		2
		Brook Trout			1
ST229	Blackfoot River, downstream of Spring Creek	Brook Trout	0.41-0.91	0.66	2
		Rainbow Trout		1.1	1
		Yellowstone Cutthroat	0.21-1.9	1	5
ST232	Blackfoot River, upstream of Blackfoot Reservoir	Rainbow Trout	0.91-1.4	1.2	2
		Yellowstone Cutthroat	0.28-1.6	0.95	4
ST236	Timber Creek	Rainbow Trout		0.59	1
		Yellowstone Cutthroat	0.19-1	0.66	5
ST237	Stewart creek	Yellowstone Cutthroat	0.7-1.4	0.94	6

Appendix H

Health Consultation: Evaluation of Selenium in Beef, Elk, Sheep, and Fish

HEALTH CONSULTATION Error! Bookmark not defined.

Evaluation of Selenium in Beef, Elk, Sheep, and Fish

Southeast Idaho Selenium Project

(a/k/a Southeast Idaho Phosphate Resource Area)

Greater Soda Springs Area, Soda Springs, Caribou County, Idaho

EPA Facility Number: IDN001002245

Prepared by:

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

LIST OF ACRONYMS

ADI	Acceptable Daily Intake
ATSDR	Agency for Toxic Substances and Disease Registry
BEHS	Bureau of Environmental Health and Safety
BLM	Bureau of Land Management
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FSIS	Food Safety and Inspection Service
HQ	Hazard Quotient
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IMA	Idaho Mining Association
kg/day	kilograms per day
MRL	Minimal Risk Level
MW	Montgomery Watson
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NOAEL	No Observed Adverse Effect Level
oz/day	ounces per day
ppm	parts per million
RDA	Recommended Dietary Allowances
RfD	Reference Dose - by Environmental Protection Agency
SeAWAC	Selenium Area Wide Advisory Committee
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
μg/day	micrograms per day
μg/kg	micrograms per kilogram

I. BACKGROUND AND STATEMENT OF ISSUE

A. Statement of Issue

As part of a cooperative agreement, the State of Idaho, Division of Health, Bureau of Environmental Health and Safety (BEHS) with funding from the Agency for Toxic Substances and Disease Registry (ATSDR) conducted the following health consultation for the Southeast Idaho Selenium Project site (a/k/a Southeast Idaho Phosphate Resource Area). An extensive review of existing data on fish, beef, sheep, elk and other game and livestock was conducted to address the following question: Are people in the Southeast Idaho Phosphate Resource Area being exposed to selenium through the consumption of beef, elk, sheep and fish at levels that may cause harm?

This health consultation will only address the public health significance of exposure to selenium in wild game and livestock. Other potential exposure pathways will be evaluated in subsequent health consultations. This consultation does not consider the public health implications of selenium exposure to Native Americans who may have different exposure pathways as a result of their lifestyle and dietary practices. The public health implications of selenium exposures to Native Americans, specifically, the Shoshone-Bannock Tribe located on the Fort Hall Indian Reservation, will be addressed in separate, future, ATSDR health consultation. This consultation does not address ecological risk.

A large number of stakeholders have been involved in the Southeast Idaho Phosphate Resource Area Selenium Project for years. Although some of the information gathered for this consultation was obtained from telephone conversations with various stakeholders, written reports and existing data compiled by the Idaho Mining Association's Selenium Subcommittee were the primary sources of information used.

B. Site Description and History

Phosphate has been mined from the Southeast Phosphate Resource Area since 1919. Ten historic and four operating mines are located in the region. The area encompasses 1,200 square miles in Caribou, Bingham, Bannock, and Bear Lake counties in Southeastern Idaho (See Attachment A). Based on variations of relief, climate, and ore chemistry, the Resource Area has been delineated into three districts:

- Western district – Gay Mine on the Fort Hall Indian Reservation and phosphate ore lease area west of the Blackfoot Reservoir;
- Central district – the Ballard, Champ, Conda, Dry Valley, Enoch Valley, Georgetown Canyon, Henry, Lanes Creek, Mountain Fuel, North Mabey, Rasmussen Ridge and Wooley Valley Mines and the Dairy Syncline lease tract;
- Eastern district – the Smoky Canyon Mine and associated leases, and the Diamond Creek

phosphate lease.

The project area is characterized by north- and northwest-trending mountain ranges and valleys, and lies near the western base of the Aspen Range. Elevations range from 4,528 feet to 9,957 feet above mean sea level. The two principal river systems that drain the Resource Area are the Bear River and the Snake River. The Upper Blackfoot River watershed is a tributary to the Snake River.

The project area is sparsely populated with concentrated population centers located in Pocatello, Fort Hall, Montpelier and Soda Springs, Idaho, and Afton, Wyoming. A significant portion of the project area land is within the Caribou National Forest, or the Fort Hall Indian Reservation, or is administered by the Bureau of Land Management (BLM). Farming and ranching are dominant land uses. Recreation is also an important regional land use, with the most popular activities being hunting, fishing, and camping. Four companies, Agrium, Astaris (formerly FMC Corporation), J.R. Simplot Company, and Monsanto, Inc., are now mining phosphate minerals in the area for use as elemental phosphorus and phosphate fertilizer.

C. Historical Activities at the SiteError! Bookmark not defined.

Phosphate mining and ore processing are important economically to Southeast Idaho. Some of the ore is seleniferous, containing selenium levels that are much higher than typical background levels found in soil and rock. This was reported in a 1981 environmental impact statement prepared by the United States Forest Service (USFS) and the BLM. Laboratory studies performed at that time suggested that selenium would not leach from the rock in amounts sufficient to be of public health concern.

In 1996, several horses pastured downstream of a historic mine were diagnosed with chronic selenosis. In 1997, another group of horses pastured on a different piece of mine property were also diagnosed with selenosis. These poisonings, along with problems reported in sheep, prompted public and agency concern about potential releases of selenium to the environment from mining activities and the impact on human health (Montgomery Watson [MW] 1999a).

In 1997, a voluntary ad hoc committee of the Idaho Mining Association (IMA) was formed and named the Selenium IMA Subcommittee. The committee was organized to characterize and identify mitigation methods to address selenium in mining waste. The Subcommittee addressed concerns about selenium released to the environment from all of the 14 mines (MW 1999b). In 1997, the Subcommittee initiated the Selenium Project, expanded the Subcommittee, and renamed it the Interagency Phosphate Industry Selenium Working Group. The Selenium Working Group was made up of representatives from member companies of the Selenium IMA Subcommittee as well as representatives of federal, state, local and tribal agencies. MW was the lead contractor doing much of the work for the Selenium Working Group and the mining companies. The University of Idaho and University of California at Davis have also been involved in the analytical work. The Subcommittee has also used "local technical communications experts in the areas of agricultural science and veterinary medicine to assist in preparation of public education materials and in the organization of public education events"

(MW 1999c). Local technical experts included the Caribou County extension agent affiliated with the University of Idaho, as well as Doctors of Veterinarian Science.

In June 1999, the BEHS, became involved in the activities at the site by attending a two-day field workshop of the Southeast Idaho Selenium Project. The BEHS continued its involvement with the site throughout the course of the next year. In the fall of 2000, the BEHS began developing this health consultation.

In July 2000, an Interagency Memorandum of Understanding was signed designating the Idaho Department of Environmental Quality (IDEQ) as the lead agency for the Area Wide Investigation. The previous Selenium Working Group was redesignated the IDEQ Selenium Area Wide Advisory Committee (SeAWAC). The Advisory Committee is currently composed of representatives from the mining companies, Shoshone-Bannock Tribe, BEHS, IDEQ, Department of Lands, MW, BLM, Bureau of Indian Affairs, University of Idaho, Environmental Protection Agency (EPA), USFS, Idaho Department of Fish and Game (IDFG), and staff from Idaho's Senators' and Representatives' offices. Regular, public meetings are convened to address issues at the site and to oversee the remedial investigation work and a human and ecological risk assessment conducted by IDEQ and its contractor. Concomitant to the Advisory Committee and IDEQ activities, MW, contractor to the mining companies, is continuing development of the 1999-2000 Remedial Investigation.

D. Site Visits

In June 1999, the project manager for the Idaho Superfund-Related Environmental Health Education Project, BEHS, participated in a two-day field workshop related to the Southeast Idaho Selenium Project. Representatives from state, local and federal agencies, as well as, mining industry were in attendance. The workshop included presentations from various agencies and companies conducting investigations into biological impacts of selenium leaching from waste rock in reclaimed areas of the phosphate mining sites.

Additionally, the workshop included field trips to the Dry Valley and Wooley Valley mining sites. The mining sites were remote from large population centers, however, ranches were evident in proximity. Statements from various individuals indicated that fish were previously seen in creeks and ponds, but are no longer found. Evidence of wildlife use of the surface water was abundant. Elk, deer, moose, raccoon, fox, and various bird prints and droppings were seen. The BEHS project manager was told that people hunt deer, elk and other game in the Southeast Idaho Phosphate Resource Area.

The Bureau staff also spoke with the local health department and local IDFG staff about their impression of the site and the concerns they have heard expressed by the citizens in the area. The Southeastern District Health Department staff stated that their informal conversations with community members indicate that some of the public is concerned about selenium contamination in the food and private well water supplies. The district staff also thought that due to the heavy concentration of mines in the area and the potential for ecological and human health impacts, the site should be closely monitored. Hunters from the area have contacted the local fish and game staff with concerns about animals harvested from the area. One hunter brought an elk into the office concerned that the papillomas on the elk were caused by exposure to selenium. The IDGF told the hunter that papillomas were a common ailment on elk regardless of location. Other hunters reported seeing dead cattle and sheep near mines and stating that they will not hunt in the Resource Area any longer because they are concerned about contaminated game.

This health consultation attempts to answer what a person's possible exposure would be to selenium if they consumed contaminated elk, beef, fish, or sheep taken from the area. It does not address potential selenium contamination in food and private wells. Selenium contamination in private wells and drinking water will be addressed in a separate, future health consultation.

II. DISCUSSION

A. Environmental Data and Animal Studies

Almost all of the data reviewed for this consultation were reported in the various IMA Selenium Subcommittee reports listed throughout the resources section of this health consultation. The 1999-2000 Remedial Investigation, currently being conducted by MW for the Subcommittee, is generating more data that will be relevant to assessing human health risk from eating livestock or wild game such as: post-mortem beef data from cattle grazed on reclaimed mine pastureland; elk tissue samples collected by the IDFG; and trout filet data collected in September 1999 and May 2000. The trout data have not yet been compiled and are not currently available. A preliminary analysis of some of the beef and elk data were presented in MW's 2000 Draft Interim Investigation Data Report and are summarized in this consultation (MW 2000).

1). Surface Water Data

Reports published in 1998 suggest that the concentrations in surface water range from less than the detection limit of 0.00074 mg/L (ppm) to 1.55 mg/L. Several monitoring stations have concentrations greater than 0.05 mg/L, the upper range of a veterinary "advisory level" for livestock drinking water. Two sampling stations had concentrations greater than 0.5 mg/L, a level known to cause chronic selenosis in certain mammals (MW 1998). In 1997, concentrations in surface waters supporting sport fish were compared to the State of Idaho's cold water quality standard of 0.005 mg/L. The Blackfoot River, Lincoln Creek, Little Blackfoot River, North Fork Sage Creek, Ross Fork, Slug Creek and Spring Creek had concentrations less than the standard. East Mill Creek, a recognized spawning stream, had a concentration of 0.0336 mg/L(MW 2000) which exceeds the State standard of 0.005 mg/L.

2). Vegetation and Soil DataError! Bookmark not defined.

Vegetation samples were collected in 1997 near the Conda Mine to help determine if two 1997 animal kills near the mine were related to selenosis. The vegetation near the mine ranged from 0.5 to 50 mg/kg selenium dry weight (MW 1999c). Selenium concentrations in vegetation growing on overburden dumps were greater than 4.0 mg/kg, which MW (1999c) used as the preliminary risk-base benchmark for the potential development of chronic selenium in livestock. Results of the vegetation and soil sampling done in 1998 were summarized in the 1998 Regional Investigation Report (MW 1999c). The data suggest that waste rock dump seeps, french drains below waste rock dumps, mine pits ponds, tailings ponds, sedimentation ponds and stock ponds built from, or on top of, waste rock generally contained elevated selenium concentrations. Soil and vegetation samples from waste rock dump seeps had elevated selenium concentrations (MW 1998). These data are being used by the Selenium Working Group for assessing ecological risk.

3). Animal Studies

A preliminary human health risk assessment, based on data collected during 1998, was conducted by MW and was described in Chapter 5 and Appendix H of the final 1998 Regional Investigation Report – Southeast Idaho Phosphate Resource Area Selenium Project (MW 1999c). The assessment included risk statements about consumption of beef and fish. The assessment is summarized in Attachment B. The report concluded, "there is no substantial and immediate risk to ... human ... health." Federal agencies responded with a disclaimer letter stating that they did not agree with MW's conclusions.

Several studies on wildlife are being done to help assess ecological risk. Some selenium concentration data for elk and cutthroat trout are available and are summarized in this health consultation (Table 1.0). Data on selenium concentrations in moose, deer, birds and other wild game are not available. The Blackfoot River Basin is used extensively by resident populations of moose, mule deer and elk year around. The migration patterns of the elk and deer are generally east-west with winter range in the lower interior mountain valleys and summer range in the upper drainages (BLM 1999). It may be that elk have higher concentrations of selenium than other animals, and so provide a good basis for assessing risk from wild game. Unlike elk, moose do not concentrate in specific wintering areas and are more widely dispersed in aspen and conifer forest year-round (BLM 1999). Mule deer and moose live in the Resource Area but data on selenium concentrations in muscle tissues have not been collected.

The preliminary ecological risk assessment in MW's Remedial Investigation (1999c) suggests that mallard ducks and moose are not affected by selenium in the area. However, fish, snipe, muskrat, redwing blackbirds, sheep, horses and cattle may be at potential risk of being affected by selenium. The United States Fish and Wildlife Service (USFWS) has expressed concerns that selenium in Mabey Creek and Dry Valley Creek may pose a health risk to waterfowl and shorebirds (BLM 1999).

Beef, elk and trout data were assessed for this health consultation because monitoring data for these are available and their consumption would probably contribute the most to overall exposure.

Currently, no data on selenium concentrations in tissues for sheep, moose and mule deer are available. Limited information was collected from interviews with veterinarians and others about sheep.

Preliminary results of a beef study were summarized for a report to the Food Safety and Inspection Service (FSIS) requesting that the beef be allowed to be donated to the Idaho Food Bank (Talcott et. al. 2000).

The IDFG recently completed a study of elk but a final report of the data has not yet been issued. Because they were considered time-critical human health issues, preliminary results from these ongoing or recently completed studies were published in the Draft Interim Investigation Data Report for April 2000 (MW 2000). More detailed information on beef, sheep and elk are presented below and in Attachment B.

Fish data from 1998 and earlier sampling efforts have been reported in IMA reports. More data on trout will be collected for the 1999-2000 report.

a). <u>Beef</u>

Reclaimed mining land is a valued resource for ranchers whose livestock graze on these areas. Livestock move around the pasture within each grazing allotment and they do not graze on the reclaimed areas for the entire period of time they are on the pasture. Herds move in and out of the reclaimed areas. There is no fencing in these areas. Livestock is not confined to the reclaimed mine areas, nor are they restricted from them. Since high selenium levels were found in Mabey Canyon Creek in December 1996, all permittees with grazing allotments in the Soda Springs Ranger District have been aware of a potential problem. Permittees have been given written information explaining the symptoms of selenium toxicosis. Permittees have been reluctant to prevent livestock from grazing the reclaimed areas because the areas provide up to ten times the amount of palatable forage as the natural areas (USFS 1999).

In 1998, the USFS thought that beef on grazing allotments in the area presented little health hazard and that a person would have to consume an unreasonable amount of meat over a very short period of time to have any ill effects. At that time the USFS concluded that eliminating grazing from reclaimed areas was not warranted from either an agency liability standpoint, or because of a threat to human health. They felt that 60 days on a feedlot was more than enough time for selenium to return to normal levels in cattle (USFS 1999).

In 1996, Solutia (currently Monsanto) began a livestock grazing study at Henry Mine. The study was done in cooperation with the Idaho Department of Lands and the University of Idaho, Department of Food Science and Toxicology. The Henry Mine grazing study which evolved into the IMA Depuration Study, was initiated to learn more about pasture yields on reclaimed mine waste shales and help make long-term grazing management decisions (Talcott et. al. 2000a). The original purpose of the study was to determine the effects of duration and intensity of cattle grazing on the vegetation of a reclaimed phosphate mine. J. Kingrey, with the University of Idaho conducted the initial study (MW 2000). The beef data were recently compiled for the FSIS by request so that the agency could determine if the meat was fit for human consumption and therefore donated to the Idaho Food Bank (Talcott et. al. 2000a). Ultimately, the meat was not donated. Preliminary results from the Depuration Study were also reported in the Draft Interim Investigation Data Report in April 2000. Study protocols can be found in that report (MW 2000). More details about the grazing/depuration study are presented in Attachment B.

Initially, 45 steers were pastured for nine weeks on reclaimed overburden dumps at the Henry Mine that were reclaimed approximately 20 years ago (MW 2000). Initially, the average selenium content in the muscle at the time of slaughter – defined as "typically five months following removal from reclaimed land – one month on lowland pasture and four months in feedlot" – was estimated using correlations between blood and muscle. The 30 days on nonselineferous forage and 4 months in the feed lot was said to be "typical of normal cattle handling practices in the area, in which, cattle are grazed on lowland pasture prior to shipment to a feedlot."(MW 2000). Selenium concentrations in muscle and other tissues were measured after the animals were slaughtered at the end of the study. None of the steers exhibited symptoms of selenium toxicosis during the duration of the study. Although this is a useful study for depuration and can be used to estimate exposure of people eating beef from steers subject to 150 days off seleniferous pasture, it is not very helpful for estimating exposure for the rancher, owner of a steer or someone illegally killing a steer while it is still on the seleniferous pasture, then consuming it or selling it for consumption.

b). <u>Sheep</u>

Bollar (2000) believes that several herds of sheep, approximately 3,000 animals, are grazed for 30 – 60 days on pasture in the area under USFS permits during the summer months. Exactly what happens to most of the sheep after they are taken off these lands is unclear. Some of the lambs may go directly to slaughter. Many of the lambs may go onto feedlots. Most of the ewes are likely grazed on other pasture. Many of these sheep may be sent to California for the winter (Bollar 2000; Talcott 2000). It is unknown how many are consumed and when, in relation to their time on the reclaimed mine pasture.

The deaths of several groups of sheep have been rumored to have been caused by selenium, but evidence is not well documented. A diagnosis of acute myocardial necrosis and degeneration was determined from several sheep samples analyzed by the University of Idaho. This condition is associated with selenium exposure, but may also be caused by exposure to plant toxins, rodenticides and other substances. Selenium levels in the tissues were high and selenium toxicosis was thought to be the most likely diagnosis. Acute exposure to a selenium source was suspected (Talcott 2000). Water and plants near the area where animals had died were collected but a definite source for acute exposure was not identified. Samples have not been taken from all of the sheep reported to have died. It is unclear how selenium exposure contributed to the death of these sheep, how they were exposed to selenium, and where the exposure occurred. There are many questions about the as-yet unexplained finding of another group of dead sheep at the Wooley Valley Mine Overburden dump. It appears that selenium's contribution to the death of those sheep is still not understood.

MW (2000) believes that sheep receive lower potential exposures than cattle because sheep spend less time on reclaimed mine sites. Others agree that sheep probably prefer wooded areas and would not spend as much time grazing on reclaimed mine areas as cattle (Bollar 2000).

Tissue analysis of selenium in sheep has been done from time to time for diagnostic purposes but no studies have been conducted to determine selenium levels in sheep used for food. The available data are insufficient for estimating selenium concentrations in sheep muscle to potentially be consumed by people. We recommend that a study to determine plausible exposure scenarios for people eating sheep or lambs, information about depuration and an analysis of the selenium content of sheep be done.

c). <u>Elk</u>

Elk are exposed to selenium in forage growing on overburden dumps associated with Mabey Creek, Dry Valley Creek and probably other areas. Elk are very mobile and forage over many areas that are not elevated in selenium. Therefore, forage levels and elk meat levels may not be correlated (BLM 1999). Whether elk ingest enough selenium to cause health effects within the elk or humans that consume elk had not been investigated until last year.

The IDFG collected elk muscle and liver tissue from elk harvested by hunters (Jones 2000). In September 1999, IDFG sent letters to hunters holding permits in game management units 76 and 66a, (which contain the central and eastern parts of the resource area) asking for their cooperation in a study. IDFG took muscle samples at check stations and asked hunters to save a part of the liver while dressing out the carcass and to give those samples to IDGF at the check stations between October 23 and November 7 (MW 1999b; MW 2000). The hunter's name, the age and sex of the elk, and the date and location of the kill were recorded. Elk killed 10 miles or more from a phosphate mine were considered controls. Levels of selenium and cadmium in muscle and liver tissue were determined. Samples were analyzed at the University of Idaho's Analytical Sciences Laboratory. The data suggest there was a difference between control and mine area animals. Preliminary results of this elk investigation were published by MW (2000). One hundred-sixty liver and 90 muscle samples were analyzed. Concentrations as high as 0.92 mg/kg in elk muscle and 13 mg/kg in elk liver tissue were found in elk killed near mining areas (Table 1.0).

d). <u>Fish</u>

The Blackfoot River and several of its tributaries are classified as high-quality trout streams by the USFS. Cutthroat trout have been studied more than the other fish species in the area and subjected to the most management. They ascend from the Blackfoot Reservoir into the tributaries to spawn. Rainbow trout spawn in the main river. Brook trout also spawn in the tributaries (BLM 1999). Although Cutthroat trout are the most important fish species for conservation, brook trout, brown trout and rainbow trout would also be of interest for human consumption.

Selenium generally concentrates in the liver and kidney, especially in trout (A.A. Rich 1999). Fish flesh and sometimes liver and kidneys of trout from the Blackfoot River and several tributaries were sampled in 1998 and 1999. Cutthroat trout flesh from East Mill Creek had the highest levels of selenium, 7.9 mg/kg, found in 1998 (Table 1.0).

Table 1.0 Levels of Selenium Found in Beef, Elk and Fish[a]

Media	Specifics	Max-imum Level in (mg/kg[b])	Approximate 95th percentile level (mg/kg)	Geometric Mean (mg/kg)	Standard Deviation from the mean (mg/kg)	Reference
Beef	Muscle Tissue After depuration[c]		2.9	2.5	0.63	MW1999c
Beef	Muscle Tissue Estimated concentrations		2.0	0.91		Talcott et. al.. 2000a
Beef	Muscle Tissue Measured concentrations	1.25	0.86	0.74		Talcott et. al.. 2000a
Beef	Muscle Tissue Measured concentrations	1.3	1.0	0.72	0.22	Wright 2000
Elk	Liver	13.0	8.3	3.8	2.4	Wright 2000
	Muscle Tissue	0.92	0.71	0.37	0.18	Wright 2000
Fish	Trout, skin on filets, East Mill Creek	7.9 [d]		6.5	3.7	MW 1999c
	Cutthroat Trout filet, Dry Valley Creek			2.7	0.6	BLM 1999
	Dace, Dry Valley Creek			10.5	3.9	BLM 1999
	Cutthroat Trout, Blackfoot River	1.8		1.2	0.82	Wright 2000

a Sheep data is not included due to limited availability
b Wet weight
c All beef values reported in the table were estimated or measured after the animals had been off of seleniferous pasture for 5 months
d Fish from East Mill Creek are very limited and fishing is not allowed

B. Exposure Pathways

To determine whether people are exposed to selenium, the environmental and human components that lead to human exposures are evaluated. This exposure pathway analysis consists of several elements: a source of contamination; transport through and environmental medium; route of human exposure; and a receptor population. ATSDR classifies exposure pathways into three groups: completed pathways, that is, those in which exposure is reasonably likely to have occurred, to occur, or to occur in the future; potential pathways, that is those in which exposure might have occurred, may be occurring, or may yet occur; and eliminated pathways, that is, those that can be eliminated from further analysis because one of the five elements is missing and will never be present, or in which no contaminants of concern can be identified.

It does not appear that information on the selenium concentrations in deer, moose, or game birds is available. No obvious mention of concern about human consumption of deer or game birds like pheasant, grouse and chuckar is contained in the documents reviewed. It also does not appear that the consumption of frog legs and other unusual foods has been examined (Fromm 2000; Jones 2000; Talcott 2000; Wright 2000). Published data about selenium concentrations in sheep and human consumption of sheep grazed in this area was not available. Therefore, for the purposes of this health consultation, these exposure pathways are not included.

According to the studies reviewed, the maximum concentration in beef muscle after 9 weeks of continuous grazing and 150 days of depuration was 1.3 mg/kg. A consumption of 4 oz/day (0.1136 kg/day) would predict an intake of about 147 µg/day. A consumption of 8 oz/day (0.227 kg/day) would predict an intake of about 295 µg/day. The 95th percentile concentration was about 1.0 mg/kg. Exposures to selenium in beef from cattle grazing on, but not confined to, pasture on reclaimed mines and then out on pasture with background selenium levels and feedlots for 120-150 days are probably not of concern. However, selenium levels in cattle that have been grazing on the mine land (beef not subjected to depuration), are unknown. They may be similar to levels found in elk from the area, or they may be higher. Selenium levels in beef not spending time on a feed lot might be higher than beef studied by Talcott et. al. (2000), depending on whether depuration or confinement on the reclaimed mine land depletes or contributes more to selenium concentrations. The biopsy data currently being analyzed may provide information to help answer this concern.

Animals taken directly off pasture is an exposure scenario that would involve the rancher, the cattle owner or illegal rustler killing a steer, cow or calf while it is still on the seleniferous pasture, then consuming it or selling it for consumption. Cull cattle, or cattle that are injured or for some other reason are not taken to a feed lot but are taken to slaughter directly from the range land might also be an example for this scenario. Although it is possible for people, especially owners of the animals or ranch workers to take lambs and cattle directly from the pasture for consumption, this is not a common practice. Dr. Bollar, a veterinarian in Soda Springs who has been involved in investigations of dead livestock and works with local ranchers, thought the possibility was remote. Most ranchers prefer more ‘finished’ steer or lamb, fed on grain in a feedlot for a time. Selenium in meat taken directly from the pasture might be of concern for a few individuals but would probably not be of concern for most people. More information on whether an exposure scenario involving cattle or sheep taken directly from the pasture is feasible and what levels of selenium might be reached in such animals is needed to evaluate the human health hazard.

It is unclear which exposure scenarios for wild game are most appropriate for people in the area. A person who poaches elk and fish or a has a subsistence type of existence on wild game and fish may not be a realistic exposure scenario for this area. This type of scenario would probably represent the worst case exposure resulting in health risk. Realistically, the exposure scenario for an elk poacher might not be different than a hunter scenario. Elk are large animals and most people would probably harvest one a year, legally or illegally. A hunter might be expected to eat the same amount of meat per day as a poacher.

The maximum level in elk muscle was 0.92 mg/kg. The 95th percentile value for the distribution was about 0.71 mg/kg. Maximum exposures to contaminated elk meat could be defined in a scenario where a hunter eats 8 ounces of elk meat each day. Total intake for such a scenario might be about 208 µg/day using the maximum muscle concentration, or about 161 µg/day using the 95th percentile value. The maximum level found in elk liver was 13 mg/kg.

Adult elk livers likely weigh from 5 to 10 pounds. Hunters that like to eat liver are most likely to eat it fresh and in larger amounts initially, rather than freezing it and eating smaller amounts throughout the year. Toxicity data and EPA or ATSDR health comparison values to assess risk from this type of short-term exposure are lacking. Chronic consumption of elk liver might not be of health concern for most people, but effects from short-term exposure to liver containing 13 mg/kg selenium could be important for the few people who eat a lot of liver.

Appropriate exposure scenarios for fish eaten in the area are difficult to define. MW (1999a) reported that IDFG believes that most of the cutthroat trout in the Upper Blackfoot drainage live in Blackfoot Reservoir and migrate into tributary streams of the Blackfoot River to spawn in the spring. East Mill Creek, the creek from which fish with the highest selenium concentrations were taken, is very small and is “easily straddled at some locations” (Wright 2000). The creek provides spawning and nursery habitat for the Cutthroat trout (MW 1999a). It is not populated by large numbers of trout year around (Wright 2000). People would not be able to catch enough fish from the creek to support a chronic intake.

Idaho fishing regulations designate the Upper Blackfoot River as “catch and release.” Keeping Cutthroat trout from the river is illegal. Most of the fish kept for consumption in the area are Rainbow trout from the Blackfoot Reservoir. The maximum concentration in trout sampled from the river in 1998 was 1.8 mg/kg. Someone eating 4 oz/day (0.1136 kg/day) of this fish might have a chronic intake of about 205 µg/day. People who consume the kidney of the fish might have a higher exposure than those who do not.

In summary, completed exposure pathways of concern for this site include consumption of game animals, fish and livestock such as beef and sheep that might be taken directly off pasture. Livestock that spend four months or more in feedlots prior to consumption are probably not of concern. Fish with elevated selenium levels can spawn in several of the streams, but realistically, these fish are very few, if any, rendering this an unimportant pathway. Fish from the Blackfoot River, where people do catch fish, have low levels of selenium.

It is also important to consider selenium intake from other dietary sources and from supplements, such as vitamins. The average daily dietary intake of selenium in the United States is about 100 μg/day. About 25 μg/day of this amount comes from exposure to selenium in beef (Talcott et. al. 2000). People who take selenium supplements or vitamins with selenium will have increased exposure and risk for health effects.

C. Public Health Implications

1). Health Effects of Selenium

Selenium toxicity has been described clinically as acute, subacute or chronic selenosis. Acute selenosis is caused by consumption of high levels of selenium over a relatively short period of time and involves cardiological, neurological and other human health effects. Subactute selenosis results from exposure to large doses of selenium over a longer period of time and causes neurological dysfunction and respiratory distress. This is typically and most frequently seen in livestock feeding on selenium-accumulating plants and has been referred to in the literature as “blind staggers” or ataxia. In animals prolonged exposure to moderate levels of selenium, or chronic selenosis, can cause skin lesions involving alopecia (hair loss), hoof necrosis, emaciation and increased serum transaminases, and alkaline phosphatase (liver enzymes). In humans, chronic selenosis is characterized by fatigue, anorexia, dermatitis, gastroenteritis, liver degeneration, enlarged spleen and increased concentrations of selenium in hair and nails (EPA 2000).

Studies of carcinogenicity are considered to be ‘inadequate’ by the EPA, but studies of laboratory animals and humans suggest that most selenium compounds probably do not cause cancer. Selenium sulfide is classified by the EPA as a B2, probable human carcinogen, based on studies of rats and mice, but most selenium compounds are probably not carcinogenic to humans (EPA 2000; ATSDR 1996). Selenium compounds may cause birth defects in some birds but have not been shown to cause teratogenic or developmental effects in people or mammals. Reproductive effects have not been studied adequately (EPA 2000).

2). Health Comparison Values

The health-based comparison values used in this consultation are concentrations of contaminants that the literature suggests probably do not cause adverse health effects. If exposure levels are less than the potentially toxic levels, then effects are not likely to occur. In this section health guidelines, risk-based standards or other threshold levels are compared to predicted exposure levels. When exposure is below these levels, adverse health effects are unlikely to occur.

The EPA's reference dose (RfD) is defined as an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA 2000). It has an uncertainty spanning an order of magnitude. The oral RfD for selenium was last revised September 01, 1991. The most recent carcinogenicity assessment was conducted in July 1993. The RfD of 0.005 mg/kg/day or 5 µg/kg/day was derived for clinical selenosis using a No Observed Adverse Effect Level (NOAEL) of 0.015 mg/kg/day. The RfD was based on a human epidemiological study published by Yang et. al. (1989a). A NOAEL is the highest dose of a chemical where no observed adverse health effects are seen. An uncertainty factor of 3 was applied to the NOAEL to account for sensitive individuals. A full factor of 10 was not deemed necessary because similar NOAELs were identified in two moderately sized human cohorts exposed to selenium in excess of the National Research Council's Recommended Dietary Allowances (RDA) throughout a lifetime without apparent clinical signs of selenosis (EPA 2000). The RDA is 0.070 mg/day for males and 0.055 mg/day for females for vitamin supplements.

Another study reviewed by the EPA as they derived a RfD was by Longnecker et. al. in 1991. Correlations were found between intake, blood selenium concentration and disease in residents of South Dakota and Wyoming. These results were similar to those found by Yang et. al. (1989a; 1989b). Yang et. al. reported clinical signs of selenosis in 50% of a population ingesting a range of 3.2 to 6.7 mg/day (average 5 mg/day or 5000 μg/day), but no selenosis occurred in people with intakes ranging from 0.24 to 1.51 mg/day (average 0.75 mg/day or 750 μg/day)(EPA 2000). Both studies suggested a selenium uptake of up to 0.853 mg/day, or 853 µg/day, was not associated with the characteristic nail or hair loss typically seen in people with selenium toxicity (EPA 2000).

ATSDR defines a Minimal Risk Level (MRL) as an estimate of daily human exposure to a substance that is likely to be without appreciable risk of adverse, noncarcinogenic effects over a specified duration of exposure. The chronic oral MRL derived by ATSDR for selenium is 0.005 mg/kg/day or 375 µg/day for a 75 kg adult. This is based on a NOAEL of 0.015 mg/kg/day for dermal effects (nail disease) identified in chronically exposed people in China as reported by Yang et. al.. (1989a;1989b), and divided by an uncertainty factor of 3 to account for sensitive individuals. ATSDR (1996) believes its MRL is consistent with NOAELs observed by Longnecker et. al. (1991).

The EPA Maximum Contaminant Limit for selenium in drinking water is 0.05 mg/L based on a no-effect level of 0.4 mg/person/day as derived from the Yang et. al.. (1989a) study (ATSDR 1996). The United States Food and Drug Administration (FDA) has not established a selenium standard for food. Talcott et. al. (2000) reported that Australia had promulgated a standard of 1.0 mg/kg for skeletal muscle. Talcott (2000) also reported that the FDA had used the 1.0 mg/kg as a decision criterion for an event of selenium poisoning of swine in California.

Two other studies, which may be relevant, are a study by Yu et. al. 1990 in which 20 adult miners in China were given selenium supplements for one year. No adverse effects were reported at doses of 0.0043 mg/kg/day or about 310 μg/day. Clausen et. al. (1989) reported that 48 elderly residents of a nursing home were given a selenium supplement daily for one year. At 0.004

mg/kg/day (about 300 μg/day) improvements in psychological test scores were found and the selenium supplement was considered to provide a positive health effect (ATSDR 1996).

The various health comparison values of selenium identified in the information above are summarized in the following table.

Table 2.0 Summary of Health Comparison Values for Selenium

Agency or Entity	**Level**	**Value**
EPA	Reference Dose (RfD)	0.005 mg/kg/day
ATSDR	Minimal Risk Level (MRL)	0.005 mg/kg/day
Yang, et. al.. 1989a; 1989b	NOAEL in a Chinese Epidemiological Study	0.015 mg/kg/day
Australia	Standard for beef skeletal muscle	1.0 mg/kg
Clausen et. al. 1989	Improvement in psychological test scores	0.004 mg/kg/day
Yu, et. al.. 1991	NOAEL in 20 Chinese Miners	0.0043 mg/kg/day

Considering these values, it appears that a chronic intake of 0.004 mg/kg/day or 4 μg/kg/day of selenium would not be expected to cause adverse health effects for either children or adults. This corresponds to a daily intake of about 300 μg for a 75 kg adult. The toxicity threshold levels have been developed are for assessing chronic health effects from long term exposures. The concentrations of selenium that would be safe to consume over a short time period have not been established. The EPA, FDA and other federal agencies have not established a level that can be used as a health comparison value for acute exposures and ATSDR found that data was insufficient to derive an acute oral MRL. Acute exposure thresholds should be used for assessing risk from ingestion of elk or beef liver, but these have not been determined.

3). Children and Susceptible Adult Health Issues

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. For many reasons children are often at greater risk than adults from some kinds of exposures to hazardous substances. However, children do not seem to be more sensitive to the chronic effects of selenium than adults. People with iodine or thyroid deficiencies and the elderly may be more susceptible (ATSDR 1996). Based on data available, the RfD for selenium appears to be protective of these populations.

4). Comparison of Site-Specific Exposure Levels to Health Comparison Values

For the purposes of the initial screening and assessment of the need for further, more detailed and realistic analysis, the maximum observed levels in beef muscle, elk muscle, elk liver and fish muscle tissue can be used for comparison with reference values described above. People who might eat the maximum amounts of elk or beef muscle and elk liver with the highest concentrations detected in 1998 and fish from the Blackfoot River with the highest concentration found (such as subsistence hunters and fishermen), could have a chronic selenium intake approaching 600 - 700 µg/day which is above the threshold level of 300 µg/day. However, a subsistence hunter and fisherman who ate fish, beef or elk each day is a very unlikely and perhaps unrealistic scenario for the Resource Area.

A more realistic, typical (non-subsistence lifestyle) person eating typical serving sizes of 4 ounces (0.1136 kg) of fish for approximately 100 days each year and 8 ounces (0.227 kg) of beef or elk for about 300 days each year, all with the highest concentrations observed, might have a selenium intake of about 262 µg/day (55 μg/day from fish plus 207 μg/day from beef or elk). Fish and beef/elk may be consumed on the same day. This is below the level of exposure at which we might expect health effects of 300 µg/day for chronic intake. The highest observed concentrations are 1.8 mg/kg for fish from the Blackfoot River and 1.3 mg/kg for beef. The maximum concentration in elk meat is 0.92 mg/kg. Table 1.0 shows 7.9 mg/kg as the highest observed level for fish in East Mill Creek, however, fish from this creek are not allowed to be harvested.

A scenario for acute ingestion of elk liver might involve a person who eats 10 pounds or 4.54 kg of elk liver over a time period of several weeks. Hunters in Idaho have told us that some people who especially like fresh elk liver may eat 3 to 5 pounds over several days in a hunting camp. Therefore, assuming 10 pounds over a two week time period may not be unrealistic. Eating 4.54 kg of liver with the maximum reported concentration of 13 mg/kg would result in an intake of 59 mg, or an average fo 4200 μg/day. Someone who ate 5 pounds of liver would have a daily average intake over two weeks of 2100 μg/day. This represents an acute exposure scenario for which we lack toxicity data on which to base a health comparison value.

Recently, in order to assist the IDFG interpret their elk sampling data, MW and the University of Idaho researchers consulted the literature and derived a NOAEL from medical case studies. They derived a value of 0.0118 mg/kg/day (which corresponds to about 885 μg/day for a 75 kg person), which was greater than the National Academy of Sciences 1999 Chronic Upper Tolerable Intake Level for selenium of 0.0073 mg/kg/day (corresponds to approximately 550 μg/day). They also used a safety factor of 3 applied to a NOAEL of 0.035 mg/kg/day for nausea, which was derived from Lombeck, et. al. (1987). A person eating elk liver for two weeks would have to eat less than 0.95 kg or about 2 pounds each day to stay below the 885 μg/day acute exposure value. People taking selenium supplements or vitamins with selenium would have an increased intake and risk for health effects.

For hunters who might freeze elk liver and eat it in small amounts throughout the year, we could calculate a consumption of 10 pounds averaged over a year resulting in a selenium intake of about 160 μg/day which is below the chronic health comparison value of 300 μg/day.

It should be recognized that many people around the Resource Area do not eat elk. Many people who eat elk do not eat elk liver. However, elevated selenium levels in elk liver could present a hazard for those who do. More information is needed about selenium levels in elk liver, typical amounts of elk liver consumed, and what levels might cause health effects when consumed over a short time period.

III. CONCLUSIONS

An adult consuming large amounts of contaminated elk liver could experience adverse health effects like nausea. People who take selenium supplements or vitamins with selenium will have an increased exposure and risk for health effects. However, the amount of elk liver hunters consume is not well understood. We would not expect health effects from typical consumption of beef subject to depuration, elk or fish. Consumption of elk livers, sheep, lamb or beef taken directly off pasture needs to be evaluated further.

Cutthroat trout from East Mill Creek contain high amounts of selenium. If people were eating large amounts of Cutthroat trout from East Mill Creek, this would be of concern. However, the creek does not support a large fishery, therefore, this pathway does not present a public health hazard.

At the maximum concentration of selenium detected in elk muscle and muscle of cattle subjected to depuration, estimated exposures for adults (typical, non-subsistence hunter for elk exposures) and children are not considered a public health hazard because levels are below what would be expected to cause adverse health effects. According to ATSDR's hazard classifications, this exposure would represent a no apparent public health hazard.

Sheep or cattle taken directly off of pasture to slaughter, and the liver of elk grazing on pasture with elevated selenium could present a hazard, but more information is needed to assess this risk. These potential exposure routes are considered an indeterminate public health hazard.

Restricting access of livestock and wild game to the reclaimed mine areas may not be feasible. Far more information would be needed to justify such actions.

IV. RECOMMENDATIONS

Further sampling of livestock, fish and wildlife is needed. Studies to determine selenium contamination of sheep should be conducted and data and information about human consumption of sheep and lamb grazed in the area should be collected. Information on hunting practices, incidence of poaching, concentrations of selenium in game birds, and consumption of game birds should be conducted. The importance of these animals to a realistic exposure scenario and whether selenium concentrations in the meat of these animals are high enough to warrant concern should be determined.

Exposure scenarios for Native Americans should be assessed and a separate health consultation or appropriate evaluation should be conducted to address their concerns.

As studies are completed on fish, sheep, beef and elk or other media of concern, resulting data should be evaluated in additional health consultations.

Acute exposure thresholds for assessing risk from ingestion of elk or beef liver should be determined by the appropriate agency or agencies.

Because of concerns that have been expressed to BEHS about selenium contamination in private wells and drinking water, a separate, future health consultation should be conducted.

V. PUBLIC HEALTH ACTION PLAN

The purpose of the Public Health Action Plan is to ensure that this document not only identifies any current or potential exposure pathways or related health hazards, but also provides a plan of action to mitigate and prevent adverse human health effects resulting form exposures to hazardous substances in the environment. The first section of the Plan contains a description of completed or ongoing actions to mitigate exposures to environmental contamination. The second section contains a description of future or planned public health actions.

A. Completed or Ongoing Actions

In 1997 the IMA initiated the Selenium Project and formed an ad hoc committee called the Selenium IMA Subcommittee to address concerns about selenium released to the environment from all of the 14 mines and to characterize and identify mitigation methods for selenium in mining waste. This group also initiated the beef, fish and elk studies. The lead contractor for this work was MW. MW published the 1998 Regional Investigation report for the area that included risk statements about consumption of beef and fish.

B. Planned Actions

There are several activities that will continue or are planned for the future related to the Southeast Idaho Phosphate Resource Area.

- The BEHS will continue to remain involved with the ongoing SeAWAC as well as collaborate with the IDEQ on their activities at the site. BEHS will also investigate the feasibility of conducting a health consultation for the area regarding groundwater as a potential pathway for humans. BEHS will conduct community involvement and health education activities at the site as necessary.

- The IDEQ will continue to coordinate the SeAWAC (now known as the Interagency Selenium Area Wide Technical Group) in addition to leading the Area Wide Investigation. The Area Wide Investigation will: establish area wide remedial action objectives, remediation goals and risk-based cleanup levels for selenium and other contaminants of concern; develop a monitoring plan that will assess the effectiveness of future remedial activities in the Resource Area; develop Best Available Technologies and Remediation Techniques for area wide use; and provide information to support future remedial investigations and corrective actions and other land use activities on selenium-impacted lands within the Resource Area. Data collected for remedial investigations, feasibility studies and risk assessments may include wildgame, livestock and fish data, which could be used to further evaluate human health hazard.

- MW will publish a revised human health risk assessment: The 1999-2000 Remedial Investigation Report (data not included in this health consultation).

- ATSDR will further assess health hazards for Native Americans consuming selenium-contaminated wildgame, fish and livestock taken from the Resource Area.

- Selenium contamination in private wells and drinking water will be addressed in a separate, future health consultation by ATSDR and BEHS.

VI. REFERENCES

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VII. ATTACHMENTS

ATTACHMENT A

Map of Southeast Idaho Phosphate Resource Area

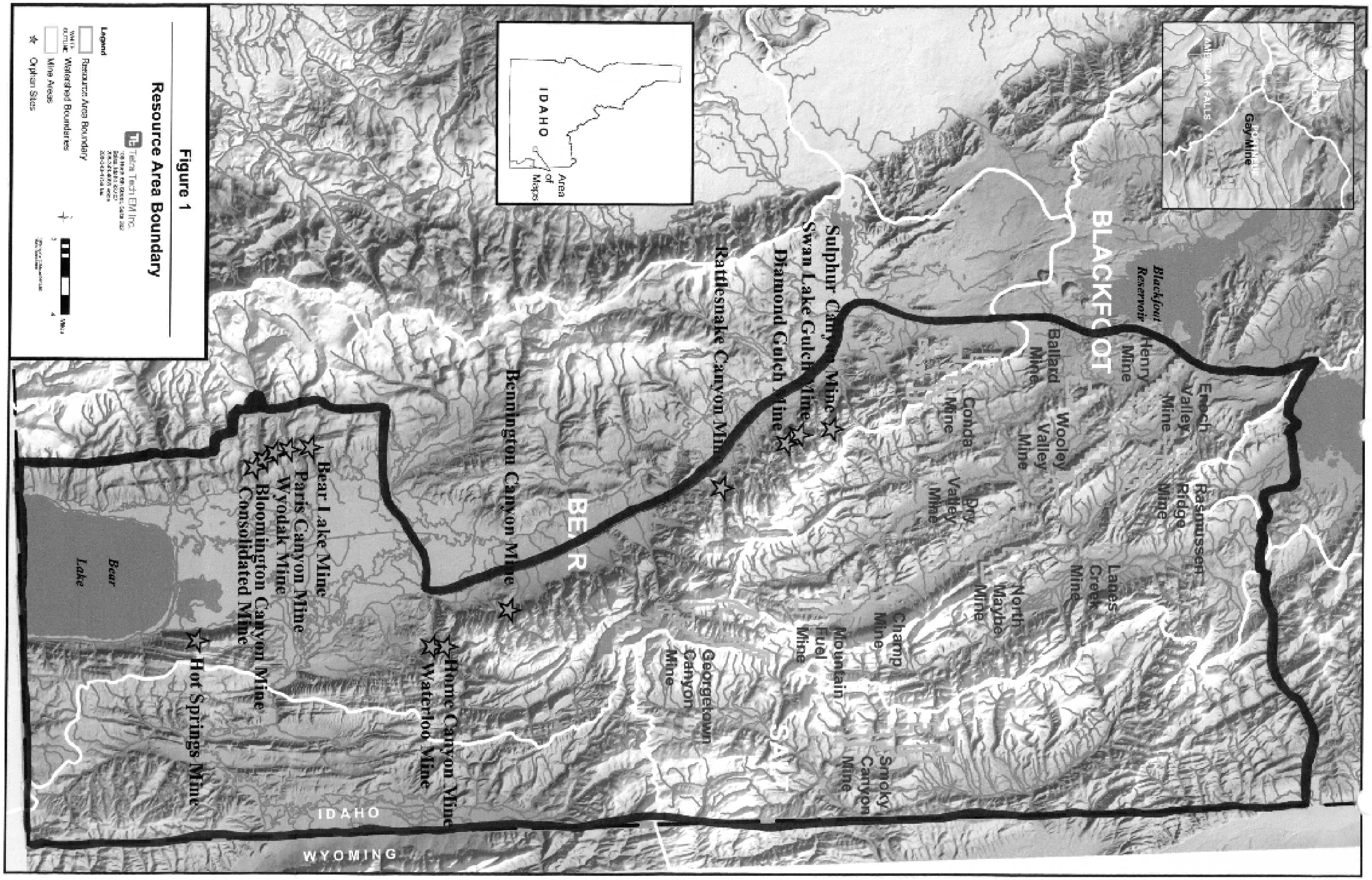

Figure 1
Resource Area Boundary
Legend
Resource Area Boundary
Watershed Boundaries
Mine Areas
Orphan Sites
Tetra Tech EM Inc.
IDAHO
Area of Maps
Gay Mine
BLACKFOOT
Blackfoot Reservoir
Enoch Valley Mine
Henry Mine
Ballard Mine
Rasmussen Ridge Mine
Woolley Valley Mine
Conda Mine
Dry Valley Mine
Lanes Creek Mine
North Maybe Mine
Champ Mine
Mountain Fuel Mine
Smoky Canyon Mine
Georgetown Canyon Mine
Sulphur Canyon Mine
Swan Lake Gulch Mine
Diamond Gulch Mine
Rattlesnake Canyon Mine
Bennington Canyon Mine
BEAR
Bear Lake Mine
Paris Canyon Mine
Wyodak Mine
Bloomington Canyon Mine
Consolidated Mine
Hot Springs Mine
Home Canyon Mine
Waterloo Mine
Bear Lake
IDAHO
WYOMING

ATTACHMENT B

Summary of Studies Used to Estimate Potential Concentrations of Contaminants in Beef, Elk Meat and Liver, and Fish Flesh

A. Summary of Montgomery Watson's Preliminary Human Health Risk Assessment

A preliminary human health risk assessment, based on data collected during 1998, was conducted by Montgomery Watson (MW) and was described in Chapter 5 and Appendix H of the final 1998 Regional Investigation Report – Southeast Idaho Phosphate Resource Area Selenium Project (MW 1999c). The assessment included risk statements about consumption of beef and fish.

Maximum observed selenium concentrations in soil, surface water, and tap water were screened against EPA Preliminary Remediation Goals and were well below benchmarks, therefore these exposure pathways were not considered in the preliminary risk assessment. Both a deterministic and probabilistic risk assessment was done and included a fish ingestion and beef ingestion scenario. The fish consumed was assumed to be skin-on filets. Skeletal muscle but not internal organs were considered for the beef pathway. The receptor was defined as an adult resident, recreational fisherman, who consumes fish caught downstream of phosphate mines and consumes beef grazed on waste rock dumps. The exposure pathway included ingestion of background dietary selenium, multi-vitamin and mineral supplements, seleniferous fish and seleniferous beef. A contribution analysis suggested that 88% of the selenium in a hypothetical Acceptable Daily Intake (ADI) was from the background diet, 7% from supplements, 3 % from fish and 2% from beef (MW 1999c). Initially the two scenarios were evaluated and presented separately but comments on the draft caused MW to combine them for the final assessment.

In their preliminary human health risk assessment, MW (1999c) calculated risk using the concentration of selenium in beef skeletal muscle at the time the cattle are removed from seleniferous pasture. The muscle concentration was estimated using a regression analysis. The estimate for muscle selenium concentration was derived from blood selenium concentrations during a study on selenomethionine ingestion provided to MW from P. Talcott, University of Idaho, via personal communication. The probabilistic assessment was done using a 10,000-trial Monte Carlo simulation. The 95th percentile of the probabilistic estimate was 2.9 mg/kg wet weight. (All tissue selenium concentrations in this consultation are reported on a wet weight basis unless otherwise noted.) Based on 9 samples, the distribution of concentrations in beef skeletal muscle had a mean of 2.5 mg/kg and a standard deviation of 0.63. The background concentration of selenium in beef, estimated from a market survey was represented by a distribution with a mean of 0.22 mg/kg. A depuration time, defined as the length of time an animal is removed from the seleniferous pasture before being slaughtered, was estimated. The deterministic estimate was 40 days and a triangular distribution that ranged to 150 days appeared to be used. A biological half-life value for beef of 250 days was used for the deterministic assessment and the uniform distribution used ranged from 10 to 300 days. The ingestion rate for beef was 0.22 kg/day. The fraction of beef ingested that was exposed to seleniferous pasture was also factored into the risk calculations. The deterministic value of 0.157 kg/day was the 95th

percentile of the probabilistic estimate, relating to the fraction of cattle on leased pasture with the potential of cattle to be exposed to selenium.

The deterministic value estimated for the concentration of selenium in skin-on trout filets was 7.9 mg/kg, the highest observed concentrations in salmonid filets sampled in 1998. The probabilistic estimate was complex, and tried to account for concentrations in fish from different streams and rivers, and differences in fishing pressure for various locations. A deterministic value of 0.48 mg/kg was used for the level of selenium in background fish tissue. An ingestion rate of 0.025 kg/day, the 95^{th} percentile of the distribution used for the probabilistic assessment, was used for the ingestion rate of fish. The distribution ranged from 0.008 to 0.0103 kg/day with a mean of 0.008 kg/day. The exposure frequency was 350 days per year (MW 1999c).

The deterministic estimate of risk or hazard quotient (HQ) was 1.7. This HQ was said to be at the 99.9^{th} percentile of the distribution determined by the probabilistic assessment. The 95^{th} percentile of the estimate was 0.53. The semistochastic HQ, which was calculated using the 95^{th} percentile of the dose estimate divided by EPA's point estimate of the RfD, was 0.80. A HQ greater than 1.0 suggests a potential for increased health risk. The sum of the deterministic HQs, (1.0 for fish ingestion plus 2.2 for beef ingestion) was 3.22 (MW 1999c). The last sentence of the executive summary concluded "...the data do indicate that there is no substantial and immediate risk to ... human...health." (MW 1999c).

The methodology, especially the stochastization of the RfD, was criticized by reviewers and agency representatives. Although the reviewers may not have disagreed with the scientific assumptions used, some of these assumptions did not adhere to regulatory requirements. The addition of background exposures by including exposures to selenium in food, supplements and vitamins was also criticized. Reviewers questioned whether the conclusions drawn were correct given their concerns about the methods used (MW 1999b; Wright 2000; Jones 2000; Fromm 2000). In April, 2000, the agencies involved in the study wrote a letter disagreeing with preliminary conclusions in the Regional Investigation Report. However, this report is a good source of information on potential contamination of - and exposure to – selenium in beef and fish.

B. Beef Depuration Studies

In 1996, Solutia (formerly Monsanto) began a livestock grazing study at Henry Mine. The study was done in cooperation with the Idaho Department of Lands and the University of Idaho, Department of Food Science and Toxicology. The grazing study, also called the IMA Depuration Study, was initiated to learn more about pasture yields on reclaimed mine waste shales and help make long-term grazing management decisions (Talcott et. al. 2000). The original purpose of the study was to determine the effects of duration and intensity of cattle grazing on the vegetation of a reclaimed phosphate mine. J. Kingrey, with the University of Idaho conducted the initial study (MW 2000). Many of the data for the study will be published in the 1999-2000 Regional Investigation Report, However, the muscle data were recently compiled for the FSIS by request (Talcott et. al. 2000) so that the agency could pass the meat as being fit for human consumption and it could be donated to the Idaho Food Bank. Preliminary results from the

Depuration Study were also reported in the Draft Interim Investigation Data Report in April 2000. Study protocols can be found in that report (MW 2000).

Initially, 45 steers were pastured for nine weeks on reclaimed overburden dumps at the Henry Mine that were reclaimed approximately 20 years ago (MW 2000). In 1997, after questions about whether or not cattle grazed in the Resource Area were safe to eat, the researchers decided to alter the study design and agreed to collect blood at the end of the 9-week grazing period (Talcott et. al 2000). Serum selenium levels from 9 steers that grazed on pasture on the reclaimed mine averaged 1.91 ppm. Normal serum levels range from 0.12 – 0.25 ppm. Whole blood levels of the nine steers averaged 3.54 ppm and levels in normal steers range from 0.120-0.3 ppm. The average selenium content in the muscle at the time of slaughter – defined as “typically five months following removal from reclaimed land – one month on lowland pasture and four months in feedlot” – was estimated using correlations between blood and muscle. The average selenium content was estimated to be 0.91 mg/kg with a 95 percent upper confidence bound of 2.0 mg/kg. Background values from the literature of 0.22 mg/kg with a 95 percent confidence interval of 0.39 mg/kg were used for comparison (Talcott et. al. 2000). None of the steers exhibited symptoms of selenium toxicosis during the duration of the study.

These studies continued in July and August 1999. Twenty steers were utilized with five controls and 15 experimental steers. The experimental steers were pastured on a Henry Mine reclaimed overburden dump for nine weeks. The steers were confined to pasture on the reclaimed areas for 9 weeks then pastured for one month on lowland, nonseleniferous pasture followed by four months in a feed lot consuming a diet with a selenium content of 0.3 mg/kg. The 30 days on nonselineferous forage and 4 months in the feed lot was said to be “typical of normal cattle handling practices in the area, in which, cattle are grazed on lowland pasture prior to shipment to a feedlot.”(MW 2000).

Muscle and liver biopsy samples were taken at 37, 80, 130 days from the end of the grazing period. Samples of muscle, heart, liver and kidney were taken at the time of slaughter. The steers were slaughtered in February 2000 and preliminary postmortem data for skeletal muscle, liver, heart and kidney were reported in MW (2000). A University of Idaho graduate student is currently analyzing the data.

The muscle from cattle grazing on seleniferous pasture had selenium concentrations ranging from 0.51 mg/kg to 1.25 mg/kg. The control cattle muscle concentrations ranged from 0.097 to 0.113 mg/kg. By the time of slaughter these steers had undergone at least 22 weeks (154 days) of selenium depuration (feedlot exposures). Talcott et. al. (2000) reported that the average selenium concentration in skeletal muscle of the fifteen steers on Henry’s Mine pasture was 0.74 mg/kg and the upper 95% Confidence Interval on the average was 0.86 mg/kg (Talcott et. al. 2000).

For all tests combined (serum, blood, and muscle), the maximum concentration observed in the 15 cattle grazed on seleniferous pasture was 1.3 mg/kg (Wright 2000). The mean value for selenium concentrations in beef from this study was 0.72 mg/kg, (with a standard deviation of

0.22 mg/kg and a standard error of 0.11 mg/kg), and the 95th percentile level was about 1.0 mg/kg (Wright 2000).

Talcott et. al. (2000) reported that the FDA had used 1.0 mg/kg as a decision criterion for an event of selenium poisoning of swine in California. Two of the Henry's Mine steers were greater than 1.0 mg/kg with levels of 1.24 and 1.25 mg/kg. The average and the 95th percentile levels were less than 1.0 mg/kg.

Talcott et. al. (2000) performed what they called a "simple bounding estimate of risk" to demonstrate to FSIS that the steers were safe to eat. The intake from consumption of this beef was compared to a 400 µg upper bound advisory for daily intake they said was being proposed by the National Academy of Science and a NOAEL of 1000 µg reported by Yang et. al. (1989). Talcott et. al. (2000) assumed 4 oz/day of beef consumption, and a concentration of 1.25 mg/kg which predicted a maximum daily intake of 142 µg. They then subtracted the average daily intake of selenium found in beef throughout the United States, 25 µg/day, to conclude the net increase of daily selenium intake was 117 µg. They believed eating the contaminated beef would add 117 µg to the average daily intake of 100 µg resulting in a daily intake of 217 µg of selenium, well below the 400 µg/day advisory (Talcott et. al. 2000).

MW felt the depuration study represented a worst case scenario because the animals in the study were confined to the reclaimed mine area and not allowed to graze off of the mine site. MW (2000) said that the US Department of Agriculture had suggested that 120 days is representative of the finishing period that area cattle undergo prior to slaughter. Apparently, the feedlot depuration period used for the study was increased from 100 days to 120 days for this reason (MW 2000). The USFS believes that livestock from this area are normally sent to feed lots for at least 60 days before being sold for processing (USFS 1999).

Although this is a useful study for depuration and can be used to estimate exposure of people eating beef from steers subject to 150 days off seleniferous pasture, it is not very helpful for estimating exposure for the rancher, owner of a steer or someone illegally killing a steer while it is still on the seleniferous pasture, then consuming it or selling it for consumption. The muscle biopsy samples may be useful for predicting exposure to people eating cattle that have not been taken off the seleniferous pasture, however the biopsy data is not yet available. The samples have been sent to Washington State University for analysis by neutron activation because the methods used initially at the University of Idaho had too high of a detection limit given the small sample quantities obtained for the biopsies (Wright 2000).

Another study of cattle, currently being conducted by Nu-West, using grazing areas downstream of the South Mabey Mine (MW 1999a), may provide additional information on the potential concentrations of selenium in beef.

C. Elk Studies

The IDFG collected elk muscle and liver tissue from elk harvested by hunters (Jones 2000). In September 1999, IDFG sent letters to hunters holding permits in game management units 76 and

66a, (which contain the central and eastern parts of the resource area) asking for their cooperation in a study. IDFG took muscle samples at check stations and asked hunters to save a part of the liver while dressing out the carcass and to give those samples to IDFG at the check stations (MW 1999b; MW 2000). The IDFG check station on Idaho Highway 34 just north of Soda Springs and another just east of Georgetown, Idaho operated between October 23 and November 7 (MW 1999b). The hunter's name, the age and sex of the elk, and the date and location of the kill were recorded. Levels of selenium and cadmium in muscle and liver tissue were determined. Samples were analyzed at the University of Idaho's Analytical Sciences Laboratory. Preliminary results of this elk investigation were published in the Draft Interim Investigation Data Report (MW 2000) in April 2000. Approximately 229 elk were sampled and 313 samples total were collected. Both liver and skeletal muscle were collected. Liver samples were collected from 94 elk killed and muscle samples were taken from the 94 elk plus from an additional 45 elk. One hundred and sixty liver and 90 muscle samples were analyzed (MW 2000).

A IDFG study by Kuch (1984) was used by MW to describe the foraging patterns of elk. Elk migration patterns were said to vary substantially among individuals and in different years. The mean year-around home range for elk was reported to be 26 square miles, with a mean migration distance of 4.1 miles between summer and winter range. Elk killed 10 miles or more from a phosphate mine were considered controls. The data suggest there was a difference between control and mine area animals. The selenium levels in liver and muscle were significantly and positively correlated with one another and both were significantly and negatively correlated with kill-site distance.

The highest observed elk concentration in muscle was 0.92 mg/kg. The highest observed liver concentration was 13 mg/kg. Preliminary statistical analyses of these data suggest that the 95th percentile value for the distribution of the elk muscle data is about 0.71 mg/kg and the 95th percentile of the mean is about 0.43 mg/kg. Preliminary statistical analysis of the elk liver data suggest a 95th percentile value for the distribution of 8.3 mg/kg and a 95th percentile of the mean of about 4.6 mg/kg (Wright 2000).

MW (2000) said that, "the Selenium Subcommittee performed a simple conservative bounding estimate of risk to demonstrate that an elk with an observed liver selenium content of 13 mg/kg (wet), which was the highest liver selenium content measured in Selenium Project elk is safe to consume on a chronic consumption basis." Their analysis of risk assumed that 4 oz of muscle, with a concentration of 0.36 mg selenium/kg, was eaten per day and a 5 pound elk liver, with a concentration of 13 mg selenium/kg, was consumed over 1 year. This resulted in a consumption of 0.08 mg selenium from elk liver and 0.04 mg from elk muscle. MW subtracted background beef consumption, which they said the elk was replacing. An average daily intake of 100 µg was added to this consumption for a total of 197 µg, which they said, was 56% of the RfD (MW 2000).

D. Fish Studies

A biological effects threshold for fish has been proposed for skeletal muscle (8 mg/kg) and liver (12 mg/kg). The highest selenium concentrations (averaging 42.5±13(S.D.) mg/kg) in 1998 were from livers and kidneys of four cutthroat trout taken from Dry Valley Creek immediately upstream from the confluence with the Blackfoot River. However, muscle tissue samples from these fish were low, averaging 2.7±0.6 mg/kg. The next highest levels of 40 mg/kg were found in the liver of a dace taken from Dry Valley Creek downstream from Mabey Creek. Muscle tissue in several dace taken from this location averaged 10.5± 3.9 mg/kg (BLM 1999). Concentrations in trout from the upper Blackfoot River were not significantly different than those in trout obtained from a stream with selenium levels near background. Brown trout and brook trout were sampled from the Blackfoot river and had selenium concentrations similar to control trout. The Cutthroat trout from East Mill Creek were distinctly higher and were used as the worst-case for the preliminary human health risk assessment done by MW (1999c). The deterministic value estimated for the concentration of selenium in skin-on trout filets for MW's Preliminary Human Health Risk Assessment was 7.9 mg/kg, the maximum concentration found in salmonid filets sampled in 1998. The fish with this concentration came from East Mill Creek. The mean of the levels found that in three trout sampled at this same location was 6.0 mg/kg. For the probabilistic assessment, a lognormal distribution with a mean of 6.5 ± 3.7 mg/kg, was used (MW 1999c).

The remedial investigation report states, "the selenium concentrations from salmonid tissues from East Mill Creek, while elevated, do not appear to be sufficiently elevated to cause a human health concern. However the salmonid tissue samples were obtained in September and may underestimate average selenium concentrations. Consequently additional salmonid tissue characterization is necessary to refine the human health risk assessment." (MW1999c*)*.

The highest concentration in fish sampled in 1998 from the Blackfoot River was 1.8 mg/kg. The mean for the three fish taken from the river was 1.2 mg/kg. The concentrations in fish sampled in 1999 are similar to those found in 1998 (Wright 2000).

USFS commented on the Preliminary Human Health Risk Assessment (MW 1999c), saying that: " Kesterson Reservoir, CA used values where the upper limit on recommended daily intake is 200 µg and the toxic threshold is 500 µg. A 4 ounce serving of fish with a concentration of 5.0 mg/kg of selenium (wet weight) would contribute 565 µg of selenium, which exceeds the toxic threshold... The State of California recommended that consumption of fish with 2-4 mg/kg selenium be limited to one meal (4-oz) per 2 weeks for healthy adults...Using this method, the fish from East Mill Creek would be deemed unacceptable for human consumption - period." (MW 1999a). MW's response to the comment identifies several references leading back to the source of the toxicity threshold of 0.5 mg/day. They said this was actually not a threshold but was based on Japanese studies of daily intakes in Japanese men and an estimated margin of safety for selenium of 10 - 200 times the normal intake rate. They point out that the daily, recommended intake and toxicity levels are not related. They also noted that the RfD is for chronic daily intake and East Mill Creek would never support a 4 oz meal per day intake because the fish are few and small (MW 1999a).

There has also been a great deal of discussion on the appropriateness of literature values for bioconcentration and toxicity thresholds for trout. This discussion is very relevant to ecological risk for trout but not necessarily for human health assessment (MW 1999a). Several studies of an ecological risk nature (as opposed to research designed to assess the risk to human health) are being done or have been proposed. Hardy (2000) has begun a study to determine the effects of selenium on Cutthroat trout fry and the effects of dietary intake on the reproduction and growth of Cutthroat trout. Trout from the Blackfoot River are being studied to see if genetic variation, hatchability and malformation of their fry are different than fish taken from a control area. The project involves an egg-viability study, a feeding trial to assess whether selenium affects growth rates, survivorship or subsequent breeding success and a genetic analysis. The 1999 egg collection did not yield enough fish fry for statistical comparisons so additional sampling was planned for 2000 spawning season (MW 2000). Although very useful for predicting toxic effects for the fish, this study is not helpful for assessing human exposure.

In 1999 MW proposed to sample for trout and forage fish at 26 stations. Rainbow trout from Blackfoot reservoir will also be sampled (MW 1999c). Results of the sampling will be presented in the 1999-2000 Remedial Investigation Report.

ATTACHMENT C

ATSDR Interim Public Health Hazard Categories

Table 1: Interim Public Health Hazard Categories

CATEGORY/DEFINITION	DATA SUFFICIENCY	CRITERIA
Urgent Public Health Hazard This category is used for sites where short-term exposures (<1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgement based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicated that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious
Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposures (>1 yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgement based on critical data, which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one of more public health interventions. Such site-specific exposures may include the presence of serious physical or
Indeterminate Public Health Hazard This category is used for sites in which "critical" data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.	This determination represents a professional judgement that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	The health assessor must determine, using professional judgement, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the
No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgement based on critical data, which ATSDR considers sufficient to support a decision. This does not necessarily im0ply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
No Public Health Hazard This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.	Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future.	

*Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical, and epidemiologic data; monitoring and management plans.

VIII. PREPARERS OF REPORT AND CERTIFICATION

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CERTIFICATION

This Health Consultation was prepared by the Idaho Bureau of Environmental Health and Safety under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

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Technical Project Officer, SPS, SSAB, DHAC

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

_____________-______________________________

Acting Chief, SSAB, DHAC, ATSDR

Appendix I

Cancer Incidence Evaluation

Table I-1 Comparison of Cancer Incidence Rates Between Caribou County Which is Fully Located in the Resource Area and the Remainder of the State of Idaho (1999-2003)

		Caribou County						Remainder of Idaho		
Cancer Site/Type	Sex	Observed Cases	Person Years	Crude Rate (1)	A.A.I. Rate (1,2)	Expected Cases (3)	P-Value (4)	Observed Cases	Person Years	Crude Rate (1)
All Sites Combined	Total	156	36,400	428.6	384.1	172.8	0.212	27,954	6,569,036	425.5
All Sites Combined	Male	88	18,169	484.3	433.4	91.6	0.758	14,854	3,292,170	451.2
All Sites Combined	Female	68	18,231	373.0	337.2	80.6	0.172	13,099	3,276,866	399.7
Bladder	Total	7	36,400	19.2	16.8	8.1	0.881	1,278	6,569,036	19.5
Bladder	Male	5	18,169	27.5	24.5	6.3	0.787	1,023	3,292,170	31.1
Bladder	Female	2	18,231	11.0	9.4	1.6	0.980	255	3,276,866	7.8
Brain	Total	2	36,400	5.5	5.2	2.6	1.000	446	6,569,036	6.8
Brain	Male	1	18,169	5.5	5.3	1.6	1.000	276	3,292,170	8.4
Brain	Female	1	18,231	5.5	5.2	1.0	1.000	170	3,276,866	5.2
Breast	Total	25	36,400	68.7	62.6	25.5	1.000	4,187	6,569,036	63.7
Breast	Male	-	18,169	-	-	0.3	1.000	54	3,292,170	1.6
Breast	Female	25	18,231	137.1	126.1	25.0	1.000	4,133	3,276,866	126.1
Breast in situ	Total	3	36,400	8.2	7.6	4.6	0.643	766	6,569,036	11.7
Breast in situ	Male	-	18,169	-	-	0.0	1.000	3	3,292,170	0.1
Breast in situ	Female	3	18,231	16.5	15.4	4.5	0.668	763	3,276,866	23.3
Cervix	Female	1	18,231	5.5	5.5	1.2	1.000	214	3,276,866	6.5
Colorectal	Total	11	36,400	30.2	26.5	17.4	0.143	2,753	6,569,036	41.9
Colorectal	Male	4	18,169	22.0	19.6	8.8	0.121	1,429	3,292,170	43.4
Colorectal	Female	7	18,231	38.4	33.1	8.5	0.760	1,324	3,276,866	40.4
Endometrium	Female	4	18,231	21.9	20.1	4.1	1.000	667	3,276,866	20.4
Esophagus	Total	1	36,400	2.7	2.5	1.7	0.966	280	6,569,036	4.3
Esophagus	Male	1	18,169	5.5	5.0	1.3	1.000	211	3,292,170	6.4
Esophagus	Female	-	18,231	-	-	0.4	1.000	69	3,276,866	2.1
Hodgkin Lymphoma	Total	-	36,400	-	-	1.1	0.694	195	6,569,036	3.0
Hodgkin Lymphoma	Male	-	18,169	-	-	0.5	1.000	99	3,292,170	3.0
Hodgkin Lymphoma	Female	-	18,231	-	-	0.5	1.000	96	3,276,866	2.9
Kidney and Renal Pelvis	Total	4	36,400	11.0	9.9	4.7	0.991	762	6,569,036	11.6
Kidney and Renal Pelvis	Male	3	18,169	16.5	14.8	2.7	1.000	445	3,292,170	13.5
Kidney and Renal Pelvis	Female	1	18,231	5.5	4.9	2.0	0.835	317	3,276,866	9.7
Larynx	Total	2	36,400	5.5	4.9	1.4	0.790	219	6,569,036	3.3
Larynx	Male	2	18,169	11.0	9.7	1.1	0.621	180	3,292,170	5.5
Larynx	Female	-	18,231	-	-	0.2	1.000	39	3,276,866	1.2
Leukemia	Total	10	36,400	27.5	24.7	5.1	0.074	831	6,569,036	12.7
Leukemia	Male	5	18,169	27.5	25.0	2.8	0.320	469	3,292,170	14.2
Leukemia	Female	5	18,231	27.4	24.3	2.3	0.160	361	3,276,866	11.0
Liver and Bile Duct	Total	1	36,400	2.7	2.5	1.2	1.000	190	6,569,036	2.9
Liver and Bile Duct	Male	1	18,169	5.5	4.9	0.8	1.000	122	3,292,170	3.7
Liver and Bile Duct	Female	-	18,231	-	-	0.4	1.000	68	3,276,866	2.1
Lung and Bronchus	Total	8	36,400	22.0	19.3	21.4	0.002 **<<**	3,392	6,569,036	51.6
Lung and Bronchus	Male	4	18,169	22.0	19.4	12.1	0.014 **<<**	1,933	3,292,170	58.7
Lung and Bronchus	Female	4	18,231	21.9	19.3	9.2	0.094	1,459	3,276,866	44.5
Melanoma of the Skin	Total	5	36,400	13.7	12.9	7.6	0.464	1,286	6,569,036	19.6
Melanoma of the Skin	Male	4	18,169	22.0	20.4	4.5	1.000	751	3,292,170	22.8
Melanoma of the Skin	Female	1	18,231	5.5	5.3	3.1	0.368	535	3,276,866	16.3
Myeloma	Total	-	36,400	-	-	2.0	0.276	317	6,569,036	4.8
Myeloma	Male	-	18,169	-	-	1.1	0.661	180	3,292,170	5.5
Myeloma	Female	-	18,231	-	-	0.9	0.839	137	3,276,866	4.2
Non-Hodgkin Lymphoma	Total	4	36,400	11.0	9.9	7.2	0.316	1,163	6,569,036	17.7
Non-Hodgkin Lymphoma	Male	3	18,169	16.5	15.1	3.5	1.000	585	3,292,170	17.8
Non-Hodgkin Lymphoma	Female	1	18,231	5.5	4.9	3.6	0.252	578	3,276,866	17.6
Oral Cavity and Pharynx	Total	8	36,400	22.0	19.8	4.2	0.126	680	6,569,036	10.4
Oral Cavity and Pharynx	Male	6	18,169	33.0	29.7	2.9	0.141	466	3,292,170	14.2
Oral Cavity and Pharynx	Female	2	18,231	11.0	9.8	1.3	0.768	214	3,276,866	6.5
Ovary	Female	2	18,231	11.0	10.1	2.7	0.976	449	3,276,866	13.7
Pancreas	Total	6	36,400	16.5	14.4	4.1	0.459	646	6,569,036	9.8
Pancreas	Male	3	18,169	16.5	14.8	1.8	0.562	300	3,292,170	9.1
Pancreas	Female	3	18,231	16.5	14.0	2.3	0.788	346	3,276,866	10.6
Pediatric Age 0 to 19	Total	1	12,395	8.1	8.1	2.3	0.654	386	2,065,218	18.7
Pediatric Age 0 to 19	Male	-	6,261	-	-	1.2	0.581	210	1,058,987	19.8
Pediatric Age 0 to 19	Female	1	6,134	16.3	16.2	1.1	1.000	176	1,006,231	17.5
Prostate	Male	36	18,169	198.1	174.0	29.7	0.287	4,722	3,292,170	143.4
Stomach	Total	3	36,400	8.2	7.3	2.1	0.686	332	6,569,036	5.1
Stomach	Male	3	18,169	16.5	14.7	1.3	0.267	203	3,292,170	6.2
Stomach	Female	-	18,231	-	-	0.8	0.880	129	3,276,866	3.9
Testis	Male	-	18,169	-	-	0.9	0.779	188	3,292,170	5.7
Thyroid	Total	4	36,400	11.0	11.1	2.9	0.648	523	6,569,036	8.0
Thyroid	Male	1	18,169	5.5	5.2	0.7	1.000	126	3,292,170	3.8
Thyroid	Female	3	18,231	16.5	17.2	2.1	0.709	397	3,276,866	12.1

Notes: 1. Rates are expressed as the number of cases per 100,000 persons per year (person-years).
2. Age and sex-adjusted incidence (A.A.I.) rates for county used age and sex-specific crude rates for the remainder of the state as standard
3. Expected cases are based upon age and sex-specific rates for the remainder of the state of Idaho (compare to observed).
4. P-values compare observed and expected cases, are two tailed, based upon the Poisson probability distribution.
"<<" denotes significantly fewer cases observed than expected, ">>" denotes significantly more cases observed than expected (p=.05).

Statistical Note: Rates based upon 10 or fewer cases (numerator) should be interpreted with caution.

Table I-2 Comparison of Cancer incidence Rates Between the Four Counties which Are Fully or Partially Located in the Resource Area and the Remainder of the State of Idaho (1999-2003)

		Bannock, Bear Lake, Bingham, Caribou Counties						Remainder of Idaho		
Cancer Site/Type	Sex	Observed Cases	Person Years	Crude Rate (1)	A.A.I. Rate (1,2)	Expected Cases (3)	P-Value (4)	Observed Cases	Person Years	Crude Rate (1)
All Sites Combined	Total	2,296	657,587	349.2	371.7	2,680.6	0.000 <<	25,814	5,947,849	434.0
All Sites Combined	Male	1,263	326,226	387.2	408.6	1,417.1	0.000 <<	13,679	2,984,113	458.4
All Sites Combined	Female	1,033	331,361	311.7	334.6	1,263.9	0.000 <<	12,134	2,963,736	409.4
Bladder	Total	108	657,587	16.4	17.6	121.7	0.227	1,177	5,947,849	19.8
Bladder	Male	86	326,226	26.4	27.9	97.2	0.278	942	2,984,113	31.6
Bladder	Female	22	331,361	6.6	7.2	24.3	0.735	235	2,963,736	7.9
Brain	Total	37	657,587	5.6	5.8	43.9	0.331	411	5,947,849	6.9
Brain	Male	19	326,226	5.8	6.0	27.4	0.119	258	2,984,113	8.6
Brain	Female	18	331,361	5.4	5.7	16.4	0.764	153	2,963,736	5.2
Breast	Total	341	657,587	51.9	55.4	400.3	0.003 <<	3,871	5,947,849	65.1
Breast	Male	5	326,226	1.5	1.6	5.1	1.000	49	2,984,113	1.6
Breast	Female	336	331,361	101.4	109.2	396.6	0.002 <<	3,822	2,963,736	129.0
Breast in situ	Total	54	657,587	8.2	8.8	74.1	0.018 <<	715	5,947,849	12.0
Breast in situ	Male	-	326,226	-	-	0.3	1.000	3	2,984,113	0.1
Breast in situ	Female	54	331,361	16.3	17.5	74.0	0.018 <<	712	2,963,736	24.0
Cervix	Female	12	331,361	3.6	3.9	21.2	0.045 <<	203	2,963,736	6.8
Colorectal	Total	215	657,587	32.7	35.0	263.2	0.002 <<	2,549	5,947,849	42.9
Colorectal	Male	120	326,226	36.8	39.0	135.4	0.196	1,313	2,984,113	44.0
Colorectal	Female	95	331,361	28.7	31.0	127.7	0.003 <<	1,236	2,963,736	41.7
Endometrium	Female	57	331,361	17.2	18.5	63.7	0.445	614	2,963,736	20.7
Esophagus	Total	22	657,587	3.3	3.6	26.8	0.415	259	5,947,849	4.4
Esophagus	Male	19	326,226	5.8	6.2	19.9	0.962	193	2,984,113	6.5
Esophagus	Female	3	331,361	0.9	1.0	6.8	0.181	66	2,963,736	2.2
Hodgkin Lymphoma	Total	17	657,587	2.6	2.6	19.7	0.645	178	5,947,849	3.0
Hodgkin Lymphoma	Male	6	326,226	1.8	1.9	10.1	0.249	93	2,984,113	3.1
Hodgkin Lymphoma	Female	11	331,361	3.3	3.3	9.6	0.728	85	2,963,736	2.9
Kidney and Renal Pelvis	Total	52	657,587	7.9	8.4	74.2	0.008 <<	714	5,947,849	12.0
Kidney and Renal Pelvis	Male	28	326,226	8.6	9.1	43.4	0.017 <<	420	2,984,113	14.1
Kidney and Renal Pelvis	Female	24	331,361	7.2	7.7	30.7	0.256	294	2,963,736	9.9
Larynx	Total	20	657,587	3.0	3.2	20.8	0.972	201	5,947,849	3.4
Larynx	Male	18	326,226	5.5	5.8	17.0	0.870	164	2,984,113	5.5
Larynx	Female	2	331,361	0.6	0.7	3.8	0.529	37	2,963,736	1.2
Leukemia	Total	57	657,587	8.7	9.1	82.6	0.004 <<	784	5,947,849	13.2
Leukemia	Male	37	326,226	11.3	11.8	45.7	0.218	437	2,984,113	14.6
Leukemia	Female	20	331,361	6.0	6.4	36.7	0.004 <<	346	2,963,736	11.7
Liver and Bile Duct	Total	20	657,587	3.0	3.2	17.8	0.661	171	5,947,849	2.9
Liver and Bile Duct	Male	13	326,226	4.0	4.2	11.5	0.724	110	2,984,113	3.7
Liver and Bile Duct	Female	7	331,361	2.1	2.3	6.3	0.898	61	2,963,736	2.1
Lung and Bronchus	Total	208	657,587	31.6	33.7	331.2	0.000 <<	3,192	5,947,849	53.7
Lung and Bronchus	Male	132	326,226	40.5	42.7	187.1	0.000 <<	1,805	2,984,113	60.5
Lung and Bronchus	Female	76	331,361	22.9	24.7	144.0	0.000 <<	1,387	2,963,736	46.8
Melanoma of the Skin	Total	97	657,587	14.8	15.7	123.9	0.014 <<	1,194	5,947,849	20.1
Melanoma of the Skin	Male	63	326,226	19.3	20.5	71.3	0.356	692	2,984,113	23.2
Melanoma of the Skin	Female	34	331,361	10.3	11.0	52.5	0.009 <<	502	2,963,736	16.9
Myeloma	Total	30	657,587	4.6	4.9	29.7	1.000	287	5,947,849	4.8
Myeloma	Male	21	326,226	6.4	6.8	16.4	0.310	159	2,984,113	5.3
Myeloma	Female	9	331,361	2.7	2.9	13.2	0.301	128	2,963,736	4.3
Non-Hodgkin Lymphoma	Total	97	657,587	14.8	15.7	111.3	0.186	1,070	5,947,849	18.0
Non-Hodgkin Lymphoma	Male	46	326,226	14.1	14.9	56.2	0.190	542	2,984,113	18.2
Non-Hodgkin Lymphoma	Female	51	331,361	15.4	16.5	55.0	0.653	528	2,963,736	17.8
Oral Cavity and Pharynx	Total	67	657,587	10.2	10.9	64.3	0.772	621	5,947,849	10.4
Oral Cavity and Pharynx	Male	46	326,226	14.1	14.9	44.0	0.807	426	2,984,113	14.3
Oral Cavity and Pharynx	Female	21	331,361	6.3	6.8	20.3	0.926	195	2,963,736	6.6
Ovary	Female	46	331,361	13.9	14.8	42.4	0.624	405	2,963,736	13.7
Pancreas	Total	68	657,587	10.3	11.1	60.3	0.354	584	5,947,849	9.8
Pancreas	Male	30	326,226	9.2	9.7	28.2	0.787	273	2,984,113	9.1
Pancreas	Female	38	331,361	11.5	12.4	32.1	0.340	311	2,963,736	10.5
Pediatric Age 0 to 19	Total	40	223,407	17.9	17.8	42.1	0.825	347	1,854,206	18.7
Pediatric Age 0 to 19	Male	19	114,335	16.6	16.5	23.1	0.458	191	950,913	20.1
Pediatric Age 0 to 19	Female	21	109,072	19.3	19.1	19.0	0.699	156	903,293	17.3
Prostate	Male	422	326,226	129.4	136.5	449.1	0.207	4,336	2,984,113	145.3
Stomach	Total	35	657,587	5.3	5.7	31.0	0.519	300	5,947,849	5.0
Stomach	Male	20	326,226	6.1	6.5	19.2	0.912	186	2,984,113	6.2
Stomach	Female	15	331,361	4.5	4.9	11.8	0.423	114	2,963,736	3.8
Testis	Male	24	326,226	7.4	7.8	17.0	0.127	164	2,984,113	5.5
Thyroid	Total	29	657,587	4.4	4.6	52.5	0.001 <<	498	5,947,849	8.4
Thyroid	Male	5	326,226	1.5	1.6	12.6	0.027 <<	122	2,984,113	4.1
Thyroid	Female	24	331,361	7.2	7.5	40.3	0.008 <<	376	2,963,736	12.7

Notes: 1. Rates are expressed as the number of cases per 100,000 persons per year (person-years).
2. Age and sex-adjusted incidence (A.A.I.) rates for county used age and sex-specific crude rates for the remainder of the state as standard
3. Expected cases are based upon age and sex-specific rates for the remainder of the state of Idaho (compare to observed).
4. P-values compare observed and expected cases, are two tailed, based upon the Poisson probability distribution.
"<<" denotes significantly fewer cases observed than expected, ">>" denotes significantly more cases observed than expected (p=.05).

Statistical Note: Rates based upon 10 or fewer cases (numerator) should be interpreted with caution.

Table I-3 Comparison of Cancer Incidence Rates Between the Zip Codes in the Resource Area and the Remainder of the State of Idaho (1997-2003)

		The Resource Area (zip codes: 83203, 83217, 83234, 83241, 83246, 83250, 83254, 83276, 83285)						Remainder of Idaho		
Cancer Site/Type	Sex	Observed Cases	Person Years	Crude Rate (1)	A.A.I. Rate (1,2)	Expected Cases (3)	P-Value (4)	Observed Cases	Person Years	Crude Rate (1)
All Sites Combined	Total	469	113,260	414.1	356.1	556.4	0.000 <<	343,439	81,296,474	422.5
All Sites Combined	Male	280	56,448	496.0	422.4	295.2	0.395	181,439	40,750,164	445.2
All Sites Combined	Female	189	56,812	332.7	290.1	260.3	0.000 <<	162,000	40,546,310	399.5
Bladder	Total	23	113,260	20.3	16.9	26.5	0.572	15,862	81,296,474	19.5
Bladder	Male	17	56,448	30.1	25.3	20.9	0.469	12,655	40,750,164	31.1
Bladder	Female	6	56,812	10.6	8.8	5.4	0.908	3,207	40,546,310	7.9
Brain	Total	8	113,260	7.1	6.6	8.6	1.000	5,698	81,296,474	7.0
Brain	Male	3	56,448	5.3	4.9	5.2	0.487	3,435	40,750,164	8.4
Brain	Female	5	56,812	8.8	8.2	3.4	0.518	2,263	40,546,310	5.6
Breast	Total	60	113,260	53.0	46.5	82.4	0.012 <<	51,951	81,296,474	63.9
Breast	Male	1	56,448	1.8	1.5	0.9	1.000	566	40,750,164	1.4
Breast	Female	59	56,812	103.9	91.9	81.4	0.011 <<	51,385	40,546,310	126.7
Breast in situ	Total	11	113,260	9.7	8.6	14.7	0.407	9,403	81,296,474	11.6
Breast in situ	Male	-	56,448	-	-	0.1	1.000	45	40,750,164	0.1
Breast in situ	Female	11	56,812	19.4	17.4	14.6	0.431	9,358	40,546,310	23.1
Cervix	Female	3	56,812	5.3	5.2	4.0	0.849	2,841	40,546,310	7.0
Colorectal	Total	50	113,260	44.1	36.9	57.7	0.347	34,609	81,296,474	42.6
Colorectal	Male	30	56,448	53.1	44.9	29.2	0.932	17,808	40,750,164	43.7
Colorectal	Female	20	56,812	35.2	29.1	28.4	0.125	16,801	40,546,310	41.4
Endometrium	Female	12	56,812	21.1	18.4	13.5	0.823	8,403	40,546,310	20.7
Esophagus	Total	4	113,260	3.5	3.0	5.6	0.695	3,398	81,296,474	4.2
Esophagus	Male	4	56,448	7.1	6.1	4.3	1.000	2,651	40,750,164	6.5
Esophagus	Female	-	56,812	-	-	1.3	0.567	747	40,546,310	1.8
Hodgkin Lymphoma	Total	1	113,260	0.9	0.9	3.2	0.352	2,321	81,296,474	2.9
Hodgkin Lymphoma	Male	-	56,448	-	-	1.6	0.402	1,188	40,750,164	2.9
Hodgkin Lymphoma	Female	1	56,812	1.8	1.8	1.5	1.000	1,133	40,546,310	2.8
Kidney and Renal Pelvis	Total	12	113,260	10.6	9.2	15.0	0.538	9,303	81,296,474	11.4
Kidney and Renal Pelvis	Male	10	56,448	17.7	15.3	8.6	0.726	5,372	40,750,164	13.2
Kidney and Renal Pelvis	Female	2	56,812	3.5	3.0	6.4	0.094	3,931	40,546,310	9.7
Larynx	Total	2	113,260	1.8	1.5	4.1	0.442	2,536	81,296,474	3.1
Larynx	Male	2	56,448	3.5	3.0	3.4	0.666	2,095	40,750,164	5.1
Larynx	Female	-	56,812	-	-	0.7	0.997	441	40,546,310	1.1
Leukemia	Total	25	113,260	22.1	19.2	16.3	0.053	10,181	81,296,474	12.5
Leukemia	Male	16	56,448	28.3	24.9	9.2	0.052	5,825	40,750,164	14.3
Leukemia	Female	9	56,812	15.8	13.7	7.1	0.559	4,356	40,546,310	10.7
Liver and Bile Duct	Total	5	113,260	4.4	3.8	3.8	0.670	2,326	81,296,474	2.9
Liver and Bile Duct	Male	2	56,448	3.5	3.0	2.4	1.000	1,483	40,750,164	3.6
Liver and Bile Duct	Female	3	56,812	5.3	4.4	1.4	0.349	843	40,546,310	2.1
Lung and Bronchus	Total	38	113,260	33.6	28.0	70.4	0.000 <<	42,073	81,296,474	51.8
Lung and Bronchus	Male	25	56,448	44.3	36.7	40.1	0.014 <<	24,032	40,750,164	59.0
Lung and Bronchus	Female	13	56,812	22.9	19.2	30.1	0.001 <<	18,041	40,546,310	44.5
Melanoma of the Skin	Total	17	113,260	15.0	13.7	23.7	0.196	15,517	81,296,474	19.1
Melanoma of the Skin	Male	14	56,448	24.8	22.3	13.7	1.000	8,932	40,750,164	21.9
Melanoma of the Skin	Female	3	56,812	5.3	4.9	9.9	0.022 <<	6,585	40,546,310	16.2
Myeloma	Total	4	113,260	3.5	3.0	6.2	0.511	3,776	81,296,474	4.6
Myeloma	Male	2	56,448	3.5	3.0	3.5	0.632	2,167	40,750,164	5.3
Myeloma	Female	2	56,812	3.5	3.0	2.7	0.999	1,609	40,546,310	4.0
Non-Hodgkin Lymphoma	Total	23	113,260	20.3	17.6	23.0	1.000	14,251	81,296,474	17.5
Non-Hodgkin Lymphoma	Male	14	56,448	24.8	21.7	11.4	0.522	7,231	40,750,164	17.7
Non-Hodgkin Lymphoma	Female	9	56,812	15.8	13.6	11.4	0.588	7,020	40,546,310	17.3
Oral Cavity and Pharynx	Total	14	113,260	12.4	10.7	13.7	1.000	8,536	81,296,474	10.5
Oral Cavity and Pharynx	Male	8	56,448	14.2	12.3	9.5	0.785	5,941	40,750,164	14.6
Oral Cavity and Pharynx	Female	6	56,812	10.6	9.1	4.2	0.506	2,595	40,546,310	6.4
Ovary	Female	6	56,812	10.6	9.3	9.3	0.355	5,898	40,546,310	14.5
Pancreas	Total	15	113,260	13.2	11.1	12.6	0.560	7,563	81,296,474	9.3
Pancreas	Male	8	56,448	14.2	12.1	5.9	0.494	3,655	40,750,164	9.0
Pancreas	Female	7	56,812	12.3	10.2	6.6	0.987	3,908	40,546,310	9.6
Pediatric Age 0 to 19	Total	6	39,004	15.4	15.5	6.9	0.938	4,602	25,998,203	17.7
Pediatric Age 0 to 19	Male	2	19,978	10.0	10.0	3.7	0.563	2,482	13,300,301	18.7
Pediatric Age 0 to 19	Female	4	19,026	21.0	21.1	3.2	0.776	2,120	12,697,902	16.7
Prostate	Male	92	56,448	163.0	135.3	95.8	0.746	57,418	40,750,164	140.9
Stomach	Total	10	113,260	8.8	7.5	6.8	0.300	4,139	81,296,474	5.1
Stomach	Male	7	56,448	12.4	10.6	4.2	0.269	2,594	40,750,164	6.4
Stomach	Female	3	56,812	5.3	4.4	2.6	0.948	1,545	40,546,310	3.8
Testis	Male	2	56,448	3.5	4.0	3.0	0.852	2,428	40,750,164	6.0
Thyroid	Total	6	113,260	5.3	5.3	8.8	0.458	6,330	81,296,474	7.8
Thyroid	Male	1	56,448	1.8	1.7	2.2	0.717	1,484	40,750,164	3.6
Thyroid	Female	5	56,812	8.8	9.1	6.5	0.726	4,846	40,546,310	12.0

Notes: 1. Rates are expressed as the number of cases per 100,000 persons per year (person-years).
2. Age and sex-adjusted incidence (A.A.I.) rates for county used age and sex-specific crude rates for the remainder of the state as standard.
3. Expected cases are based upon age and sex-specific rates for the remainder of the state of Idaho (compare to observed).
4. P-values compare observed and expected cases, are two tailed, based upon the Poisson probability distribution.
"<<" denotes significantly fewer cases observed than expected, ">>" denotes significantly more cases observed than expected (p=.05).

Statistical Note: Rates based upon 10 or fewer cases (numerator) should be interpreted with caution.
Rates shown for ZIP Code analyses are not comparable to those in state or county analyses due to population estimation procedures.

Appendix J

ATSDR Glossary of Terms

ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

General Terms

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

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

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

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

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

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

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

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

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

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

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

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

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

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

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

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

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

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

CAP [see Community Assistance Panel.]

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

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

Carcinogen
A substance that causes cancer.

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

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

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

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

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

Chronic
Occurring over a long time [compare with acute].

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

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

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

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

Completed exposure pathway [see exposure pathway].

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

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

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

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

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

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

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

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

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

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

DOD
United States Department of Defense.

DOE
United States Department of Energy.

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

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

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

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

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can

occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

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

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

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

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

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

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

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

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

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

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

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

Half-life ($t_{½}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

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

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

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

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

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

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

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

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

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

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

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

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

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

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

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

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

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

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

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

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

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

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

Mutagen
A substance that causes mutations (genetic damage).

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

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

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

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

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

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

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

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

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

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

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

ppb
Parts per billion.

ppm
Parts per million.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Radionuclide
Any radioactive isotope (form) of any element.

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

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

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

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

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

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

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

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

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

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

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

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

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

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

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

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

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

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

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

Substance
A chemical.

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

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

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

Surveillance [see public health surveillance]

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

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

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

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

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

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

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

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

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

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

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:

NCEH/ATSDR Office of Communication, Information Service Center
1600 Clifton Road, N.E. (MS E-29)
Atlanta, GA 30333
Telephone: 1-888-422-8737

Appendix K

Public Health Assessment Public Release Review Comments Addressed

Response to Comments Received during the Public Comment Period

BCEH made this public health assessment available for public review and comment starting on November 16, 2005. We distributed this public health assessment to 42 persons or organizations. We also made copies available on the Idaho Department of Health and Welfare's (IDHW) web site and at the Bear Lake County Library, the Grace District Library, the Idaho State University Library, the Larsen Sant Library, the Pocatello office of the Idaho Department of Environmental Quality, the Shoshone-Bannock Tribes Selenium Project Office, and the Soda Springs Public Library. Further, we held a public availability meeting at the Soda Springs Health District Office to answer questions and collect written comments on December 15, 2005. Upon distribution of the public health assessment, we requested that comments be provided by December 16, 2005—a schedule that was announced in the Idaho State Journal, Post Register, and the Sho-Ban News. All references to page numbers in the following responses to public comments are from the public release version of the public health assessment.

Comment #1:

> We agree with your bottom-line decision to classify the resource area as posing no adverse impact to public health. In arriving at your ultimate conclusion you had to make certain assumptions. Many of these were quite conservative, and we'd like to take this opportunity to point some out.
>
> Despite the lack of public health impacts, we agree that the exposure pathways contributing most to any elevated doses of mining-related elements are those involving the ingestion of meat—specifically, fish, elk, and beef having elevated levels of selenium. Regarding the ingestion of plants, we would like to point out that neither watercress, water buttercup, wild onion, bitterroot, golden sage, nor red willow are known to grow upon phosphate mine interburden.

Response:

> BCEH identifies human exposure pathways by examining environmental and human components that might lead to contact with contaminants of concern. The above mentioned plants represented species that tribal members either ingest or use to brew teas (TtEMI 2002). According to TtEMI (2002), samples of plant tissue were collected in streams or riparian areas downstream of specific mines (impacted reaches) and from unimpacted (background) zones.

Comment #2:

> *{The commenter}* agrees that the levels of exposure to mining related elements—most importantly, selenium—is insufficient to cause adverse health effects in any group of individuals. We believe the most exposed group consists of a select few mine employees who also fish, hunt, and raise beef in the area, consuming their

harvest, and who also take high-dose selenium mineral supplements. We are unaware of the existence of any subsistence population in the area.

Response:

BCEH chose to look at exposure to a subsistence population as a worst case scenario in order to evaluate if there might be any adverse health effects for a population with high exposure. If the subsistence population did not suffer any adverse health effects, then it would be less likely that other populations with reduced exposure would have adverse health effects from exposure.

Comment #3:

Our findings demonstrate that elk muscle is always safe to consume, and that elk liver poses no threat via chronic consumption, and very little threat via subacute consumption. We evaluated selenium exposures through elk ingestion, but we note that your conclusions are derived from an evaluation of copper. Copper has not been documented to be a contaminant of concern associated with phosphate mining. To date, the only concern about copper that we have heard raised has been associated with potential livestock nutrient deficiencies. In fact, the Idaho Department of Environmental Quality's risk management plan for the region dismisses copper from detailed consideration because of mine-related concentrations being well within the observed range of regional background concentrations.

Response:

BCEH is obligated to evaluate all the available contaminant data (including copper) no matter whether or not the contaminants are associated with phosphate mining. As to the copper contamination in the Resource Area, BCEH did acknowledge that the high copper level in elk liver is not unique to the Resource Area (page 18), and BCEH did notice that copper in surface soil, surface water and sediment was not a contaminant of concern from a human health standpoint.

BCEH evaluated selenium in elk liver in a draft health consultation "*Evaluation of Selenium in Elk in the Southeast Idaho Phosphate Resource Area for Shoshone-Bannock Tribal Members*." This document has not yet been published. In that document BCEH states, "Shoshone-Bannock Tribal members with a body weight of 80 kg or 176 lb who consume fresh elk liver, should not eat more than two 10-ounce meals of elk liver within a two week period" because of high selenium concentration in the elk liver. This consumption guideline is still true with regard to selenium. However, when BCEH reviewed all contaminant data for this public health assessment, we found that the copper levels in elk liver was a more immediate concern because of the high levels found in elk liver taken from elk at the Resource Area. Since the recommended elk liver consumption rate was even less (10 ounces of elk liver per month for a 75-kg or 165 lb adult) and because of the copper concentrations, BCEH determined that any consumption guideline would need to be for copper.

Comment #4:

We agree that the consumption of beef raised in the area—even consumption of beef raised upon interburden for experimental purposes—poses no threat, even at high rates of consumption. Not only are few cattle exposed to interburden, but most beef raised in the area enters and is highly diluted within the nation's commodities market. Thus, there is little potential for long-term exposure to any selenium-elevated beef.

Response:

BCEH made the conclusion "it is unlikely that the selenium in beef muscle and beef liver will result in any adverse health effects for people eating up to eight ounces every day" based on currently available data and exposure scenarios.

Comment #5:

While it is reassuring to know that the regional cancer rates are the same or lower than those for the entire state, we are unaware of any carcinogens of concern associated with phosphate mine interburden. You identified arsenic, beryllium, and chromium as carcinogens. We are unaware of any data showing either arsenic or beryllium to be contaminants associated with phosphate mining. As you know, only hexavalent chromium is carcinogenic. In the absence of speciation data, it is common to assume that 14% of total chromium is in hexavalent form. Our studies have shown less than 2% of the chromium in the interburden to be hexavalent.

Response:

BCEH is obligated to evaluate the possible cancer risks based on available contamination data, no matter whether or not the carcinogens are related to the contamination site or just the high background level. Arsenic is a carcinogen. Beryllium and chromium (VI) are also carcinogens via inhalation. In this case, beryllium concentrations are similar to the background levels. Additionally, BCEH assumed that the ratio of hexavalent chromium to total chromium in the soil is 1 to 6, and used that as the worst case scenario.

Comment #6:

We appreciate that you qualified your recommended precaution about limiting a child's consumption of fish from East Mill Creek, but we believe it is worth repeating that this very small, nursery creek has an extremely limited fishery productivity due to size-limited habitat. It would thus be highly unlikely that anyone could depend upon obtaining a pound of edible fish tissue from the stream in a given month, let alone for the months at a time needed for a chronic exposure.

Response:

BCEH did mention that "fish from the East Mill Creek are very limited and subsistence consumption of fish from East Mill Creek is highly unlikely" (page 15).

Comment #7:

With regard to your Table 1 suggesting limitations on elk liver ingestion, we note again that your recommendation is based upon the copper content of the liver, yet copper is not considered a contaminant of concern associated with phosphate mining. In fact, the only concern raised about copper in the past decade is that of potential deficiency in feed for ungulates. Your toxicity benchmark for copper is 0.01 mg/kg/d (milligrams of copper per kilogram of body weight per day). Our Centrum® daily multivitamin contains 2 mg of copper. Assuming a 75-kg body weight, the daily copper dose from the multivitamin alone is 0.03 mg/kg/d—three times your benchmark.

Once again, we agree with your conclusions, but we believe the very conservative nature of the assessment cannot be overstated.

Response:

BCEH noted that U.S. Food and Drug Administration's reference daily intake for copper (2 mg) was based on the National Academy of Sciences' 1968 Recommended Dietary Allowances, while ATSDR's acute and intermediate minimal risk levels (MRLs) were based on studies in 1999 and 2003, respectively (see the following references). Since ATSDR's MRLs were based on the most recent studies, BCEH evaluated the health effects comparing the exposure doses of copper to ATSDR's MRLs.

Pizarro F, Olivares M, Uauy R, et al. 1999. Acute gastrointestinal effects of graded levels of copper in drinking water. Environ Health Perspect 107:117-121.

Araya M, Olivares M, Pizarro F, et al. 2003. Gastrointestinal symptoms and blood indicators of copper load in apparently healthy adults undergoing controlled copper exposure. Am J Clin Nutr 77:646-650.

Comment #8:

The purpose of this latest consult as stated on page four is "to determine if contamination at a hazardous waste site poses a public health risk and if actions are needed to protect the health [of local] community members." We question if the "waste site" under consideration is the many mining dump locations that are impacting an area covering some 2500 square miles. Based upon the health consults stated purpose, the *{commenter}* believes the conclusions of this 2005 health assessment to be overly optimistic and unsound.

Response:

In this public health assessment, BCEH revisited the conclusions and recommendations made in past health consultations for groundwater, beef, elk, sheep, and fish (BCEH 2001a, 2001b, 2003). BCEH also reviewed environmental data (soil, surface water, sediment), biological data (fish, elk, beef, plants), and community health concerns. Additionally, BCEH reviewed previous assessments conducted by Montgomery Watson (MW 1999a, 1999b, and 1999c) and Tetra Tech Inc. (TtEMI 2002). Personal communications with Idaho Department of Environmental Quality (IDEQ) staff were also used. Finally, BCEH conducted a cancer incidence analysis for the Resource Area in conjunction with the Cancer Data Registry of Idaho (CDRI).

On the basis of the available data and information reviewed, BCEH drew the conclusions and recommendations. In arriving at those conclusions, BCEH made certain assumptions. Many of these assumptions were cautious or protective. For example, BCEH used the maximum selenium concentrations to evaluate any health effects by consuming muscle and liver of elk and beef. In reality, it is highly unlikely for a person to eat elk or beef muscle with the maximum selenium concentration everyday for long periods of time. Based on the available data and information, BCEH believes the conclusions are sound and protective. Of course, if additional data or information becomes available for the Resource Area relevant to public health at a later time, BCEH will review them and the conclusions may be modified.

Comment #9:

We noticed that the current health assessment relies upon data collected in 2001 and earlier to evaluate fish consumption risks. Selenium is a known bio-accumulator and is growing in scope and concentrations in all measurable aquatic mediums.[1] Therefore for a health assessment to be of any value, up to date sampling is required.

One illustration of the growing problem follows. Smokey Canyon Mine's Pole Canyon dump site was filled between 1985 and 1990. Four years later, in 1993 (1994 report), quality monitoring showed that selenium contamination was beginning with Pole creek. That year's monitoring measured .17mg/L selenium, down grade of the mine, in the spring, which is remarkably higher than that same

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[1] Hill, Sheryl. Aquatic Systems Biologist. Pocatello, Idaho. An Analysis of Selenium Concentrations in Water and Biological Tissue Samples Collected in the Upper Blackfoot River and Salt River Watersheds from 1997 to 2003., 2005.

stream's control sample upgrade of the mine measuring .001 mg/L.[2] The 1993 (1994 report) monitoring year also noted a decrease in macroinvertibrate populations over previous years. This monitoring regimen continued to document annual increases in selenium concentrations, for 1994 came in at .262 µg/L and 1995 measured .5 µg/L Se. Corresponding with an increase in water selenium concentrations are lowered macroinvertibrate numbers not only in Pole creek but spreading to other streams in both the spring and summer under the monitoring program for Smokey Canyon Mine. In 1999 Pole Creek had samples averaging 2,350 µg/L Se.[3] To date, selenium continues to leach from this site at rates that have yet to stabilize,[4] although more than 2300 pounds of selenium are released annually from this location.[5] It should be noted that this is only one of many similar dump sites in the phosphate resource area. Notice that the time between the contamination being first noticed on Pole Creek of 0.17µg/L and the 2350 µg/L samples was five years and had grown considerably in that time. Obviously there are large quantities of selenium being released on a continual basis that is accumulating in the food chain and as such, could pose an increasing risk as selenium increases in concentration and scope over time. Selenium pollution has spread to other streams since the data for this latest health assessment was collected. Streams deemed "un-impacted" in 2001, for fish,[6] are now on the Environmental Protection Agency's 303 (d) impaired list of polluted streams due to selenium contamination. Two such streams are Sage Creek and Spring Creek.[7] Moreover another "un-impacted" fish tissue sample from Kendall Creek, in 2001, was electro-fished a year later by the Forest Service. The Forest Service did not find any fish even though the stream had held healthy populations of trout in the past.[8]

It is probable that the concentration of selenium is on the increase in fish populations. In a study done in May of 2001, twenty-two fish samples were collected from nine streams in the phosphate mining area. They ranged from 3.5 to15.2 µg/g Se whole fish tissue dry weight.[9] In July of 2005 twenty-one fish samples from seven streams were sampled in the same area and yielded fish that ranged from 5.29 to 34.9 µg/g Se whole fish tissue dry weight.[10] In the 2005 samples, there were nine above the highest 15.2 example in 2001, additionally there

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[2] Mariah Associates Inc. Laramie, Wyoming. Aquatic Monitoring Program for Smokey Canyon Mine. 1994 results. On file at Bureau of Land Management office. Pocatello, Idaho.

[3] Hill, Sheryl. Aquatic Systems Biologist Pocatello, Idaho. An Analysis of Selenium Concentrations in Water and Biological Tissue Samples Collected in the Upper Blackfoot River and Salt River Watersheds from 1997 to 2003.,pg. 8. 2005.

[4] SIR, Newfields, July 2005, Chapter 11, pgs. 11-15

[5] Ibid. Appendix F, pg. 18.

[6] Human Health and Environmental Risk Assessment, TetraTech EMI, 2002 Appendix H, Table H-16

[7] Draft 2002 Integrated 303(d)/305(b) Report, IDEQ 2004.

[8] USDA Forest Service, Caribou-Targhee National Forest, 2002 Cutthroat Trout Fish Distribution Survey Report, Kendall Creek. 26 June, 2002.

[9] Hamilton, S. J., Buhl, K.J., May, 2001. Selenium and other trace elements in Water, Sediment, Aquatic Plants, Aquatic Invertibrates, and Fish from Streams in Southeastern Idaho Near Phosphate Mining Operations. Pg. 24.

[10] Weber, Frank. Research Triangle Institute, Research Triangle Park, NC. Technical Report. RTI Project No.:08973.002.009, Sept. 19, 2005.

also existed seventeen samples that exceeded the proposed EPA standard of 7.91µg/g Se dry weight water quality criteria. The {*commenter*} noticed that in the 2005 draft health assessment there is maintained the consumption advisory for East Mill Creek based on the seven fish samples taken by Montgomery Watson five plus years ago. Those seven fish ranged from 1.7 mg/kg Se to 7.9 mg/kg Se with the mean tissue concentration of 4.8 mg/kg Se fillet wet weight. There can be little doubt that selenium contamination has increased in the impacted areas since those samples were taken. In 2005 the GYC (Greater Yellowstone Coalition) and the Idaho Department of Environmental Quality could not find any fish in East Mill Creek[11] as high selenium concentrations have apparently extirpated that creek's fish population. The apparent extirpation of the fish in East Mill Creek has made the consumption advisory there moot, although area wide elevated selenium concentrations in fish would presumably result in more advisories on other streams had current samples been collected and analyzed by the Idaho Department of Health and Welfare. For instance, in July of 2004, fish samples were collected for the Site Investigation Report from streams impacted by the Smokey Canyon Mine. One of the streams where fish still existed, Hoopes Spring, produced fish that ranged from 3.4 -7.43 mg/kg with a mean of 5.76 mg/kg Se wet weight.[12] These high levels found in other streams could mean more consumption advisories are warranted and should serve as a wake-up call that current samples need be collected and analyzed.

The sampling data is ephemeral because the amount of selenium in the environment is not only growing but also is ever changing. The mobile forms of selenium that occur from weathered mining wastes are transported into the environment through water runoff and infiltration of water.[13] As such the selenium contamination to the environment is highly dependant upon the amount of precipitation; the higher the precipitation, the higher the selenium loading. An example of this can be seen in East Mill Creek. During the spring runoff in 2005, the creek tested at 417µg/L Se, whereas later in the summer the same source measured 103 µg/L Se.[14] Drought conditions throughout much of the western United States has reduced traditional flows in the Blackfoot River water shed by almost 50%.[15] As a result there is the great possibility that selenium loadings to the watershed could increase 3 to 7 times the current amount with a return to normal flows,[16] that could be on the return this year.[17] This obviously would greatly exacerbate the already growing selenium risk

[11] Verbal communication. 30 Nov., 2005. Lynn VanEvery. Richard Clegg. Idaho Department of Environmental Quality.
[12] SIR, Newfields, July 2005. Table 6-18
[13] Desborough, G., E. De Witt, J. Jones, A. Meier, and G. Meeker. 1999. Preliminary Mineralogical and Chemical Studies Related to the Potential Mobility of Selenium and Associated Elements in Phosphoria Formation Strata, Southeastern Idaho. USGS Open File Report 99-120
[14] Weber, Frank. Research Triangle Institute, Research Triangle Park, NC. Technical Report. RTI Project No.:08973.002.009, May 19, 2005 & Sept. 19, 2005.
[15] Presser, T.S., Hardy, M., Huebner, M.A., and LaMothe, P.J. Selenium Loading through the Blackfoot River Watershed: Linking Sources to Ecosystems. *Life Cycle of the Phosphoria Formation: From Deposition to the Post-Mining Environment.* Pg.453. Edited by James R. Hein. 2004.
[16] Ibid. pg. 457.
[17] Post Register "Droughts demise". 7 December, 2005.

and is a compelling reason as to why current samples are necessary in order to evaluate consumption hazards.

Response:

As part of a cooperative agreement with ATSDR, BCEH only conducts evaluations to determine if contamination at a hazardous waste site poses a public health risk. BCEH does not evaluate the ecological health risk. As stated in the document, "the conclusions reached in this document are based on currently available data, …. If additional data or information becomes available, the conclusions may be modified at a later time" (page 8). Also, BCEH will review new environmental sampling data and studies for the Resource Area relevant to public health as they become available, as stated in the public health action plan (page 25).

The commenter submitted recent fish sample data from the Resource Area. Among the samples, only six samples were from edible fish, including three Yellowstone cutthroat trout, one brook trout, and two brown trout. The average selenium concentration for the six fish samples was 13.1 µg/g (dry weight). According to a health consultation done by Utah in 2002 (http://www.atsdr.cdc.gov/HAC/PHA/americanfork/afc_p1.html#T1), the average moisture for cutthroat trout, brown trout, rainbow trout, and rainbow hatchery trout was about 76%. Assuming that the moisture for the trout in the Resource Area was also 76%, the average selenium concentration for the six trout samples from the Resource Area would be 3.1 µg/g (wet weight), which is similar to the area-weighted average selenium concentration in the fish (2.88 mg/kg wet weight) from the Blackfoot watershed (page 43, Table C-6). For a 75 kg (165lbs) adult eating 70 grams of fish every day, the estimated exposure dose for selenium (0.0029 mg/kg/day) is lower than both the MRL and RfD. This means the selenium in the fish is unlikely to result in any adverse health effects to the general public, as well as the Native Americans subsistence population who may consume up to 70 grams of fish every day.

BCEH is interested in continuing to address the concern of selenium contamination in the fish tissue in the Resource Area. In order to better understand the amount of selenium in fish in the Resource Area, BCEH has added the following statement to the documents action plan: "BCEH will work with the Idaho Department of Fish and Game (IDFG) and the Idaho Department of Health and Welfare (IDHW) Bureau of Laboratories to analyze edible fish harvested from the Resource Area for selenium. BCEH will issue fish advisories if warranted."

Comment #10:

Because of the higher selenium levels in the environment the *{commenter}* feels that current samples need be obtained to ascertain the wildlife and beef consumption risks as may now exist. Fifteen steers grazed in a single controlled area test nearly seven years ago is presumably is not an accurate gage by which to make a decision regarding any possible consumption risk. Thresholds for acute and chronic poisoning for grazing animals occur "at numerous disturbed [reclaimed] sites" in the vicinity of the phosphate mines.[18] Moreover, with increasing concentrations of selenium in the streams where cattle and wildlife water, the amounts of selenium in muscle tissues could be growing. As identified in the health assessment, surface water is likely not an exposure pathway for humans though it surely is for livestock and wildlife that are consumed by humans and thus should be evaluated for any potential human risk.

As an anecdotal observation, this writer has raised steers for personal consumption and knows of others who have as well. It has been my experience that when a freezer is full of beef, that is what is consumed as the primary meat source for two or more meals a day. One usually doesn't purchase other meat sources when beef is available for free. Therefore, the consumption advisory of eight ounces a day, is very likely to be exceeded for a beef producer. Moreover you state the beef producer prefers a finished steer. I find this statement suspect, as a finished steer costs more to produce and is worth more thus goes to market for the greatest profit. I believe that for this reason, a steer or culled animal directly off the range more likely selected than a finished one, counter to the posits in the consult. There exists the very real potential that beef producers are exposed to chronic levels of selenium in the locally grazed beef they consume, opposite the premises of unknown origin in the consult.

Response:

BCEH reached the conclusion in this document based on currently available data. BCEH will review new environmental sampling data and studies for the Resource Area relevant to public health as they become available.

According to EPA's Exposure Factors Handbook (EPA 1997), in the U.S. West (including Idaho), the average beef consumption per person is 92.9 g/day. Therefore, eight ounce per day (227 g/day) used in this document represents a high or cautious/protective consumption rate. Additionally, BCEH used the maximum selenium concentration in the beef to evaluate the exposure, which is very protective.

Comment #11:

The *{commenter}* feels the data on which this current health assessment is dated and inadequate to assess the potential risk. Attached for your review is some of the available data showing that the impacts of selenium are extensive and widespread. Notice in the attached compilation of data that the problem is growing in scope and

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[18] Mackowiak, C.L., Amacher, M.C., Hall, J.O., and Herring, J.R. Uptake of Selenium and other contaminant elements into plants and implications for Grazing Animals in Southeast Idaho., *Life Cycle of the Phosphoria Formation: From Deposition to the Post-Mining Environment.* Pg. 546. Edited by James R. Hein. 2004.

concentration of selenium in all sampled mediums. We believe current data and analysis is fundamental to a health assessment if it is to be accurate and meaningful. Because of the growing and bio-accumulative impact of selenium, we would like to see the Idaho Department of Health and Welfare examine this issue using current fish samples from all streams in the impacted area (rather than streams deemed impacted) where fish can be found. Further, in cooperation with other state agencies, re-visit the beef and wildlife consumption issues utilizing current samples and sampling techniques that represent real consumption risks.

Response:

BCEH reached the conclusion in this document based on currently available data and information. BCEH did look at the enclosed data. For the surface water, BCEH evaluated the health effects of selenium based on the maximum concentration (1140 μg/L), the worst case scenario. The enclosed data does not change BCEH's conclusion.

Comment #12:

The Tribes object to being treated as a member of the public, we are a self-governing, federally recognized nation. Therefore we deserve and request to be considered a sovereign nation not a member of the general public. As a result of IDHW not recognizing the Tribes sovereign nation status, the Tribes are significantly underrepresented in this document. The Tribes were never formally consulted during the creation of this document, IDHW missed an opportunity to adequately include and address Tribal concerns.

Response:

This public health assessment was for the whole southeast Idaho phosphate mining resource area. The Gay mine which is located on the tribal land is just one part of the whole resource area. All the current available data are focused on the whole mining resource area. The available data were not Gay mine site-specific.

We respect the Tribes as a self-governing, federally recognized nation. To address the specific concerns from the Tribes, BCEH and ATSDR spent a great amount of time to complete a draft health consultation "*Evaluation of Selenium in Elk in the Southeast Idaho Phosphate Resource Area for Shoshone-Bannock Tribal Members*", which has been under Tribal review since April 2005. However, the Tribes have not released the health consultation for publication.

Comment #13:

The Tribes are very concerned with IDHW reliance on Montgomery Watson data collected in the early stages of the selenium investigation in Southeast Idaho. The detection limits used at the time by Montgomery Watson have been determined to be inadequate. Data collected during that time has been deemed not sufficient in so far as showing the extent of contamination.

Response:

BCEH conducted this public health assessment based on the currently available data. The data came from a variety of sources: Montgomery Waton reports prepared for the Idaho Mining Association's Selenium Subcommittee (MW 1999a, 1999b, 1999c, 2000, 2001), Tetra Tech EM Inc. reports prepared for IDEQ (TtEMI 2001, 2002), elk muscle and liver data collected in 2000 (Personal communication: R.L. Clegg, selenium project officer, IDEQ, email, July 2003), former BCEH health consultations (BCEH 2001a, 2001b, 2003), IDEQ's Public Water System record (1983-2001) (Personal communication: J. Henry, drinking water regulatory analyst, IDEQ, email, September 2001), and the Cancer Data Registry of Idaho data.

The conclusions reached in this document were based on currently available data, previous health consultations, information obtained from site visits, community concerns, and public and agency input. BCEH does not have the capacity to collect new environmental data and is thus reliant on any available data. BCEH is available to review any new, certified data when it becomes available. At that time, conclusions may be modified if warranted by the new data.

Comment #14:

In the conclusion section at the beginning of the document IDHW fails to include sheep. It has been proven that sheep are highly susceptible to selenium exposure, yet the document doesn't address sheep in any of the conclusions.

Response:

As stated in the health consultation "*Evaluation of Selenium in Beef, Elk, Sheep, and Fish in the Southeast Idaho Phosphate Resource Area*," tissue analysis of selenium in sheep has been done from time to time for diagnosis purposes but no studies have been conducted to determine selenium levels in sheep used for food. The available data are insufficient for estimating selenium concentrations in sheep muscle that potentially can be consumed by people. "BCEH will review new environmental sampling data and studies for the Resource Area relevant to public health as they become available," as stated in Page 25.

Comment #15:

Comments from Tribal members who reviewed the document are as follows:

- Why were elk the only big game included, and not deer and moose?
- There needs to be Tribal input in these important issues.
- Why were the Tribes not consulted?

The Tribes are not in agreement with the findings and conclusions IDHW has presented.

Response:

According to the U.S. Forest Service (USFS) and the Idaho Department of Environmental Quality (IDEQ), forage growing on old waste dump sites was more attractive to elk than to deer and moose. Therefore it was determined that elk was more likely to accumulate selenium than deer and moose. Additionally, elk in the Resource Area was more abundant than deer and moose. Those were the reasons for USFS and IDEQ to choose elk instead of deer and moose to represent the big game in the Resource Area (Personal communication: J.L. Jones, minerals management specialist, USFS, phone, January 2006; D. Tanner, regional environmental manager, IDEQ, phone, January 2006).

Currently, there are no environmental contamination data available for deer and moose in the Resource Area. When they become available in the future, BCEH will review the data and evaluate any possible health effects.

IDEQ and USFS did consult the Tribes for their input on choosing representative plants in the Resource Area (Personal communication: J.L. Jones, minerals management specialist, USFS, phone, January 2006). It should be noted that BCEH does not have the resources to collect any environmental data. BCEH did this public health assessment solely based on currently available data and information. This public health assessment focused on the whole Resource Area.

To address the specific concerns from the Tribes, BCEH and ATSDR worked to complete a draft health consultation "*Evaluation of Selenium in Elk in the Southeast Idaho Phosphate Resource Area for Shoshone-Bannock Tribal Members,*" which has been under Tribal review since April 2005. However, the Tribes have not released the health consultation for publication.