Health Consultation

Fish Sampling in Silver Creek Analysis of Metals
and Potential Health Impacts

SILVER CREEK TAILINGS

PARK CITY, SUMMIT COUNTY, UTAH

EPA FACILITY ID: UTD980951404

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

Health Consultation: A Note of Explanation

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

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

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SILVER CREEK TAILINGS

PARK CITY, SUMMIT COUNTY, UTAH

Prepared by:

Utah Department of Public Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Background and Statement of Issues

The Silver Creek watershed is located between the towns of Wanship and Park City, in Summit County, Utah (Figure 1). In the late 1800's and early 1900's, as many as 10 ore processing mills operated along the banks of Silver Creek. The middle portion of the creek was historically used as a washout area for mine tailings. This section of the creek extends more than 12 miles from the northern boundary of Richardson Flat to the confluence with the Weber River in Wanship, Utah. Silver Creek is the primary drainage in the watershed extending from Park City to Wanship. Water from Silver Creek historically has been used for stock watering, irrigation, and mining/milling purposes (UDEQ 2002).

Access to Silver Creek generally is obtained by the Historic Union Pacific Rail Trail. The Rail Trail follows an abandoned railroad right-of-way 28 miles along Interstate 80 (I-80) connecting Park City to Echo Reservoir. The Rail Trail allows non-motorized access to recreational activities including hiking, mountain biking, horseback riding, jogging, cross-country skiing, wildlife watching, and occasional fishing (USPR 2001). Numerous signs mark access to the trail and three parking lots with pit toilets are available for visitors (Figure 2).

In the spring of 2003, 19 fish were collected from Silver Creek and were analyzed for a spectrum of metals (see Appendix A). The metals of particular health concern were inorganic arsenic, cadmium, lead, mercury, selenium, and zinc. Stakeholders involved in this investigation include the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), the Utah Department of Environmental Quality (UDEQ), the Utah Department of Natural Resources (UDNR), the U.S. Geological Survey (USGS) and the Summit County Health Department. The stakeholders have requested that the Environmental Epidemiology Program (EEP) of the Utah Department of Health (UDOH) conduct a health consultation addressing the health impacts associated with consumption of fish from Silver Creek.

Demographics

Silver Creek is located in Summit County and begins near Park City and flows northward to the confluence with the Weber River in Wanship, Utah. According to the 2002 U.S. Census Bureau, the total population of Summit County was 29,736 (US Census 2002). The projected population for Summit County in 2005 was estimated at 35,162 (Utah Online 2004). The exact population of Wanship is not currently known, however, the Utah Almanac reported an estimated 68 people living in Wanship in 1990 (Utah Almanac 2001). In 2000, the population of Park City was estimated to be 7,371. Rapid growth has occurred in Summit County since that time, with many large homes currently under construction in and around the Silver Creek watershed.

The area around the stream is generally a well-vegetated riparian habitat. A small family dairy, known as the Pace Dairy at Atkinson, operates 1.3 miles east of Silver Creek Junction (intersection of I-80 and Highway 40). The southern portion of the Lower Silver Creek site, up-stream from the dairy, is being quickly surrounded by residential and commercial expansion (UDEQ 2002). At the intersection with I-80, the creek continues to flow northeast between the east and westbound lanes of I-80 towards Wanship (Figure 3).

It is unknown how many people actually harvest and consume fish from Silver Creek. A site visit on a Friday afternoon in June 2004 and second on a Sunday evening in July 2004 revealed no evidence of fishers. One resident with a fence line enclosing the creek stated that her family does not fish from the creek, but during the construction of her home, the contractors did fish the creek in the evenings. A worker at the dairy also stated that even though he does not fish the creek, other people do (EEP 2004b). An observation of the creek itself revealed no evidence of fishers. Heavy vegetation restricts direct access to the creek and no foliage appeared worn down by frequent fishers. Fence lines surrounding private fields enclose much of the creek near Wanship, Utah. Fishers may access Silver Creek by foot, bicycle, or horseback on the Rail Trail. Motorized vehicles are prohibited from the Rail Trail. Steep hillsides and emergency pullouts with "No Parking" signs posted along the interstate also limit vehicular access to the creek. The creek is very small, ranging from 3 – 4 feet in width and no more than a foot deep in July. Additional, and possibly more favorable, fishing opportunities do exist in other nearby areas, such as Rockport, Echo and Jordanelle reservoirs, as well as the Weber River.

No subsistence fishers[1] are believed to harvest from Silver Creek because of its limited size, lack of vehicular access, and the opportunity for more successful fishing at the nearby stocked reservoirs.

Methods

A total of 19 fish (13 cutthroat, five brown and one rainbow trout) were collected in the spring of 2003 from several sites along Silver Creek (Figure 1). This region of the creek was selected because it contains a higher quality in-stream habitat that may support a recreational fishery, and therefore is more likely to provide a potential exposure pathway to anglers that consume fish captured from the stream (UDEQ 2002). The following fish were collect from Silver Creek and delivered to Trace Element Research Laboratory at Texas A & M University.

The fish were collected from the following locations, which are marked in Figure 1:

- Upper Silver Creek (USC)
  - USC-1: at Bonanza Road (near City Park) – 1 rainbow trout
- Lower Silver Creek (LSC)
  - LSC-2: Mid-canyon – 6 cutthroat trout
  - LSC-3: Lower Canyon (below Alexander Canyon, above Wanship) - 1 cutthroat trout, 5 brown trout
  - LSC-5: Upper canyon; about ½ mile below the Pace Dairy at Atkinson - 6 cutthroat trout

(Figure 4 shows one of the fish collected for analysis.)

The Silver Creek fish were filleted with the skin on and analyzed for 25 metals (Appendix A). Arsenic was one metal of particular health concern. Although inorganic arsenic is often a minor component of total arsenic in fish tissue, health risks are much greater for inorganic arsenic because of its ability to cause adverse health effects in humans. Therefore, the EPA recommends that inorganic arsenic be evaluated for use in fish consumption advisories (EPA 2000a). Inorganic arsenic was analyzed using hydride generation-atomic fluorescence spectroscopy, and total arsenic, lead, cadmium, and chromium were determined by inductively coupled plasma-

[1] A subsistence fisher: one who consumes almost 10 times more fish than an average adult or sport fisher.

mass spectroscopy. Total mercury[2] was analyzed by cold vapor atomic absorption; other elements were determined by inductively coupled plasma-optical emission spectroscopy (Appendix A) (TERL 2004). The results of the analysis are summarized by collection site in Table 4.

In addition to the metals analyses, all tissue samples were analyzed for moisture and lipid content (USFWS 2004). Moisture content was reported as a percent of the wet-weight sample; metals were reported in units of milligrams per kilogram[3] fish weight (mg/kg) on a dry-weight basis.

Results

Wet-weight results were calculated using percent moisture and the corresponding dry-weight result (Appendix B), and were used to evaluate potential health impacts, as recommended by the EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. When dry-weight results were reported as "less than" (<) the detection limit, wet-weight results were calculated using half of the detection limit.

Results from the Silver Creek fish sampling are summarized as follows.

1. All trout sampled contained minute levels of all metals tested; most metals were less than health-based screening values, with the exception of inorganic arsenic and lead. Cadmium, mercury, and selenium were investigated further as recommended in EPA's Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories. These metals were not found at levels of health concern. Inorganic arsenic and lead were selected as the contaminants of concern.
2. Only one rainbow trout was available for analysis. This lone trout was collected from the stream directly in Park City and had levels of inorganic arsenic and lead that suggests further investigation of this species.
3. All brown trout samples had inorganic arsenic levels less than the dry-weight detection limit. The calculated range was 0.0078 – 0.0082 mg/kg, with an average of 0.0080 mg/kg.
4. Only five of the 13 cutthroat trout sampled had inorganic arsenic levels greater than the detection limit. The average amount of inorganic arsenic in cutthroat trout was 0.013 mg/kg. The range was 0.0076 – 0.0268 mg/kg.
5. Levels of lead in brown trout ranged from 0.154 – 0.232 mg/kg, with an average of 0.017 mg/kg. Lead in cutthroat trout ranged from 0.100 – 1.039 mg/kg with an average of 0.343 mg/kg.
6. The average amounts of inorganic arsenic and lead were lowest in the fish collected from location LSC-3, above Wanship. The average lead concentration was greatest at site location LSC-5, below the Pace Dairy at Atkinson.
7. No correlation was found between metal concentration and fish weight.

[2] The majority of mercury found fish tissue is methylmercury. Methylmercury is harmful to humans and costly to analyze in fish. Therefore, the EPA recommends that total mercury be used in fish contaminant monitoring programs and that the conservative assumption be made that all mercury is present as methylmercury (EPA 2000a).
[3] Milligrams per kilogram (mg/kg) can also be reported as parts per million (ppm); 1 ppm is equal to 1 milligram of metal per kilogram of wet weight fish weight (mg/kg).

Discussion

Contaminants of Concern

When a chemical exceeds a health-based screening value (SV), further evaluation of that chemical is warranted. Several fish collected from Silver Creek showed levels of inorganic arsenic above the SVs for both children and adults. SVs have not been calculated for lead because the health effects of lead are often expressed in terms of internal exposure, (blood lead levels), rather than external exposure (such as in the use of SVs). EPA's Integrated Exposure Uptake Biokinetic model allows for this evaluation. Therefore, inorganic arsenic and lead have been selected as the contaminants of concern.

Exposure Pathways Analysis

To determine whether people are exposed to contaminants at a site, the environmental and human components that make up a human exposure pathway are evaluated. An exposure pathway consists of five elements (ATSDR 1992):

(1) A source of contamination;
(2) Transport through an environmental medium;
(3) A point of exposure;
(4) A route of human exposure; and
(5) An exposed population.

Exposure pathways are categorized as *completed, potential, or eliminated*. In a *completed* exposure pathway, all five elements exist and indicate that exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In a *potential* exposure pathway, at least one of the five elements has not been confirmed, but may exist. Exposure to a contaminant may have occurred in the past, may be occurring, or may occur in the future. An exposure pathway can be *eliminated* if at least one of the five elements is missing and will never be present (ATSDR 1992).

Only one exposure pathway was identified in this health consultation. This *potential* exposure pathway includes adults, sport fishers, and children who consume fish with elevated levels of inorganic arsenic and lead from Silver Creek. However, one of the five elements for this pathway is missing. It is unknown if an exposed population is present; several site visits have observed no evidence of fishers in the area. If an exposed population cannot be confirmed, the risk for potential human exposure may be low.

Public Health Implications

Levels of contaminants that exceed SVs will not necessarily cause adverse health effects upon exposure. The potential for exposed persons to experience adverse health effects depends on many factors, including:

(1) The amount of each chemical to which a person is or has been exposed;

(2) How long a person is exposed;

(3) The route by which a person is exposed (breathing, drinking, skin contact);

(4) The health condition of the person;

(5) The nutritional status of the person; and

(6) Exposure to other chemicals (such as cigarette smoke or chemicals in the work place).

For the purpose of determining whether the concentrations of inorganic arsenic and lead found in the fish from Silver Creek pose a public health threat, consumption rates have been calculated to determine how many meals of fish can be safely consumed per month with no adverse health effects (Appendix B). Consumption limits and pertinent toxicity information are discussed in the following section.

Toxicological Evaluation and Consumption Limits

Arsenic (As)

Arsenic is a naturally occurring element. Forms of arsenic can be divided into two categories: (1) inorganic arsenic (arsenic combined with oxygen, iron, and sulfur), and (2) organic arsenic (arsenic combined with carbon and hydrogen). Exposures to inorganic forms of arsenic are usually more harmful than exposures to the organic forms. Most inorganic and organic arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most compounds have no special taste. In most cases, one cannot sense if arsenic is present in food, water, or air (ATSDR 2000).

The human body has the ability to change inorganic arsenic to less toxic organic forms that are more readily excreted in urine. In addition, inorganic arsenic is also directly excreted in the urine. It is estimated that by means of these two processes, more than 75% of the absorbed arsenic dose is excreted in the urine (ATSDR 2000).

Exposure to arsenic should be avoided whenever possible. Exposure to high levels of inorganic arsenic may cause nausea, vomiting, diarrhea, abnormal heart rhythm, blood vessel damage, or a “pins and needles” sensation in hands and feet. Long-term exposure to low levels of inorganic arsenic may lead to a darkening of the skin and the appearance of small “corns” or “warts” on the palms, soles, and torso. Skin changes are not considered a health concern in their own right, but a small number of corns might ultimately become skin cancer. Swallowing sufficient amounts of arsenic also has been reported to increase the risk of developing cancer in the liver, bladder, kidneys, and lungs (ATSDR 2000).

Of the five brown trout collected for sampling, all dry-weight concentrations of inorganic arsenic were reported as “less than” (<) the detection limit. Wet-weight inorganic arsenic concentrations were estimated to range from 0.0078 mg/kg to 0.0082 mg/kg, with an average of 0.0080 mg/kg. These levels are less than the SVs for children and adults; therefore, adverse health effects are not likely.

Eight of the 13 cutthroat trout sampled had levels of inorganic arsenic less than the detection limit. Inorganic arsenic in cutthroat trout ranged from “less than” (<) 0.0080 – 0.027 mg/kg. The average was calculated to be 0.013 mg/kg, which is less than the SVs for adults and children. However, the maximum amount of inorganic arsenic detected in the cutthroat trout, 0.027 mg/kg, is equal to the SV for adults and exceeds that for children.

When SVs are exceeded, consumption limits can be estimated to determine how many meals of fish can safely be consumed each month (USEPA 2000b). Assuming an average adult weighs 70 kg (154 pounds) and eats 227 grams (approximately 8 ounces) of cutthroat trout per meal, and the trout has a concentration of inorganic arsenic of 0.027 mg/kg, adults or sport fishers can safely consume two meals of cutthroat trout from Silver Creek per month. Children and pregnant women can safely consume one meal (113 grams or 4 ounces) of cutthroat trout per month.

Only one Rainbow trout was collected from the creek. Therefore, adequate information does not exist to characterize inorganic arsenic contamination in this species.

Lead (Pb)

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of the environment. Much of it comes from human activities, including burning fossil fuels, mining, and manufacturing. Lead can affect almost every organ and system in the body. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. The connection between these effects and exposure to low levels of lead is uncertain (ATSDR 1999).

Infants, children, and pregnant women should avoid exposure to lead when possible because they are particularly susceptible to its toxicity. Many children are repeatedly exposed to lead during childhood. A mother with lead in her body can expose the fetus to lead through the placenta. Fetuses exposed to lead in the womb may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood also may slow mental development and lower intelligence later in childhood. Evidence has been found that neurobehavioral effects may persist beyond childhood (ATSDR 1999).

Compared to adults, a greater proportion of the amount of lead swallowed by children will enter the blood stream. Lead is stored in bones and can be released into the bloodstream when the body is stressed or when nutrition is poor, as when children refuse to eat healthy foods rich in iron and calcium (ATSDR 1999).

Lead concentrations in brown trout ranged from 0.154 mg/kg to 0.232 mg/kg. The average lead concentration in the brown trout was 0.183 mg/kg. Lead in cutthroat ranged from 0.100 mg/kg to 1.039 mg/kg, with an average of 0.343 mg/kg. The greatest average concentration of lead was found in a cutthroat trout collected from site LSC-5, below the Pace Dairy at Atkinson (Figure 1 and Table 1).

Data on the health effects of lead in humans are often expressed in terms of internal exposure, or blood lead levels, rather than external exposure levels (i.e., mg/kg/day). The Centers for Disease Control and Prevention considers blood lead levels to be elevated if they are greater than 10 µg/dL. This does not imply that a safe level of lead has been identified; in the last few years, several studies have been conducted and are still ongoing that suggest children may suffer neurological and developmental deficits at blood lead levels well below the current standard. While not universally accepted, these studies seem to suggest that prenatal and postnatal exposures at levels of 10 - 15 µg/dL are associated with low birth weight, reduced growth rate, cognitive deficits, and a reduction in neurological development as measured by IQ (ATSDR 1999). Some studies suggest that intelligence may be affected when children have blood lead levels as low as 7 µg/dL (CDC 1997; ATSDR 1999). Learning disabilities have been observed in children with blood lead levels exceeding 40 µg/dL (ATSDR 1999). An estimated 890,000 U.S. children have blood lead levels equal to, or greater than, 10 µg/dL (CDC 1997).

To assess the potential for elevated blood lead levels in children, EPA has created the IEUBK model that estimates blood lead levels in children ages 1-7 years old based on a number of variables. The model uses standard age-weighted exposure parameters for consumption of food, drinking water, soil, and dust, and inhalation of air, matched with site-specific concentrations of lead in these media, to estimate exposure for the child (EPA 1994; See Appendix C). Using the maximum amount of lead found in the fish from Silver Creek (1.039 mg/kg), estimated blood lead levels for children ages six months to six years were less than 7 µg/dL. Therefore, adverse health effects from lead in the brown and cutthroat trout from Silver Creek are not likely. The amount of lead in the rainbow trout of Silver Creek could not be evaluated due to the limited sample size. It is unknown if lead in this species is at a level of concern.

Metal Concentration vs. Fish Location and Weight

Inorganic arsenic and lead concentrations appeared to be lowest at the LSC-3 site, above the town of Wanship. Five brown and one cutthroat trout were collected from this site and all had inorganic arsenic less than the detection limit. The greatest concentration of inorganic arsenic was found in a fish collected from site location LSC-5. Average lead concentrations also appeared to be greatest at site location LSC-5. This collection area was near Interstate 80 in the upper canyon, about ½ mile below the Pace Dairy at Atkinson. Table 1 includes a summary of all metals by site. A direct correlation did not appear to exist between metal concentration and fish weight.

Benefits of Fish Consumption

It is important to consider the benefits of eating fish as part of a balanced diet. Fish are an excellent source of protein and have been associated with reduced risk of coronary heart disease. The benefits of consuming fish also have been associated with low levels of unsaturated fats (e.g., omega-3 polyunsaturated fatty acids), which are essential nutrients. Fish also provide a good source of vitamins and minerals. The American Heart Association recommends two 6-ounce servings of fish per week as part of a healthy diet (AHA 2002).

Child's Health Considerations

ATSDR and EEP recognize the unique vulnerabilities of infants and children. Children are at greater risk than adults from some environmental hazards. Because children's bodies are still developing, children can sustain permanent damage if toxic exposures to some contaminants occur during critical growth stages. Based on available data, levels of inorganic arsenic in brown trout are not likely to cause adverse health effects. However, due to potentially unsafe levels of inorganic arsenic, infants, children, and pregnant women should limit their intake of cutthroat trout from Silver Creek to one 4-ounce meal per month.

Limitations and Conclusions

A recent analysis of fish from Silver Creek found concentrations of inorganic arsenic and lead at levels that required further evaluation for potential adverse health effects. Because only one rainbow trout was available for analysis, sufficient information does not exist to characterize contamination in this species.

One important limitation of this study was the detection limit for dry-weight inorganic arsenic analysis. Only five of the 19 fish collected and sampled had inorganic arsenic levels that exceeded the dry-weight detection limit of 0.07 mg/kg. When converted to wet-weight inorganic arsenic, the results fall between 0.015 mg/kg and 0.018 mg/kg, (depending on the percent of moisture in the fish), which is equal to or greater than the SV for children (0.015 mg/kg). Because EEP uses half the detection limit when results are reported as “less than” (<), it is assumed that 14 of the 19 fish collected contained inorganic arsenic at levels that are half the SV for children. Uncertainty in this assumption warrants further investigation of inorganic arsenic in all fish species, using a dry-weight detection limit less than 0.07 mg/kg.

It is also important to note that site visits to Silver Creek have not proven the creek to be a popular fishing spot. An exposed population has not been observed or confirmed in the area; this missing element in the exposure pathway may suggest that the risk for human exposure is low.

The concentrations of lead in the brown and cutthroat trout collected from Silver Creek are not expected to cause adverse health effects, nor are the estimated concentrations of inorganic arsenic in the brown trout. However, levels of inorganic arsenic in the cutthroat trout may be hazardous to public health if the fish are consumed at levels greater than the recommended consumption limits.

Fish consumption limits have been estimated to determine how many meals of fish from Silver Creek can safely be eaten per month. Adults and sport fishers may safely consume two 8-ounce meals of cutthroat trout from Silver Creek per month. Children and pregnant women are advised to consume no more than one 4-ounce meal of cutthroat trout from Silver Creek per month. Consumption limits for rainbow trout were not estimated due to the lack of sampling data.

Recommendations

Fish samples stored at the Trace Element Research Laboratory at Texas A & M University should be reanalyzed for inorganic arsenic using a method with a detection limit less than the screening value to determine the true value of inorganic arsenic in brown and cutthroat trout.

From a meeting with the majority of stakeholders, it was determined that, because of the difficulty many anglers have with distinguishing between the species of fish, the fish consumption advisory should not be species-specific. Therefore, a fish consumption advisory should be issued for all trout taken from Silver Creek. Adults should limit their consumption of Silver Creek trout to no more than two 8-ounce meals per month. Children and pregnant women should consume no more than one 4-ounce meal of Silver Creek trout per month.

Levels of heavy metals in the fish from Silver Creek should continue to be monitored.

Public Health Action Plan

EEP will continue to work with UDEQ, USFWS, UDNR, USGS, the Summit County Health Department, and all other stakeholders and agencies involved to notify the public of the findings of this health consultation. Signs, pamphlets, and other educational materials will be prepared to provide the public with health-related information on the fish of Silver Creek.

EEP will also work with all stakeholders and agencies involved to perform additional research on metal concentration in the fish of Silver Creek and will review any new data from this area. EEP will adjust recommendations as new information becomes available.

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Figures and Tables

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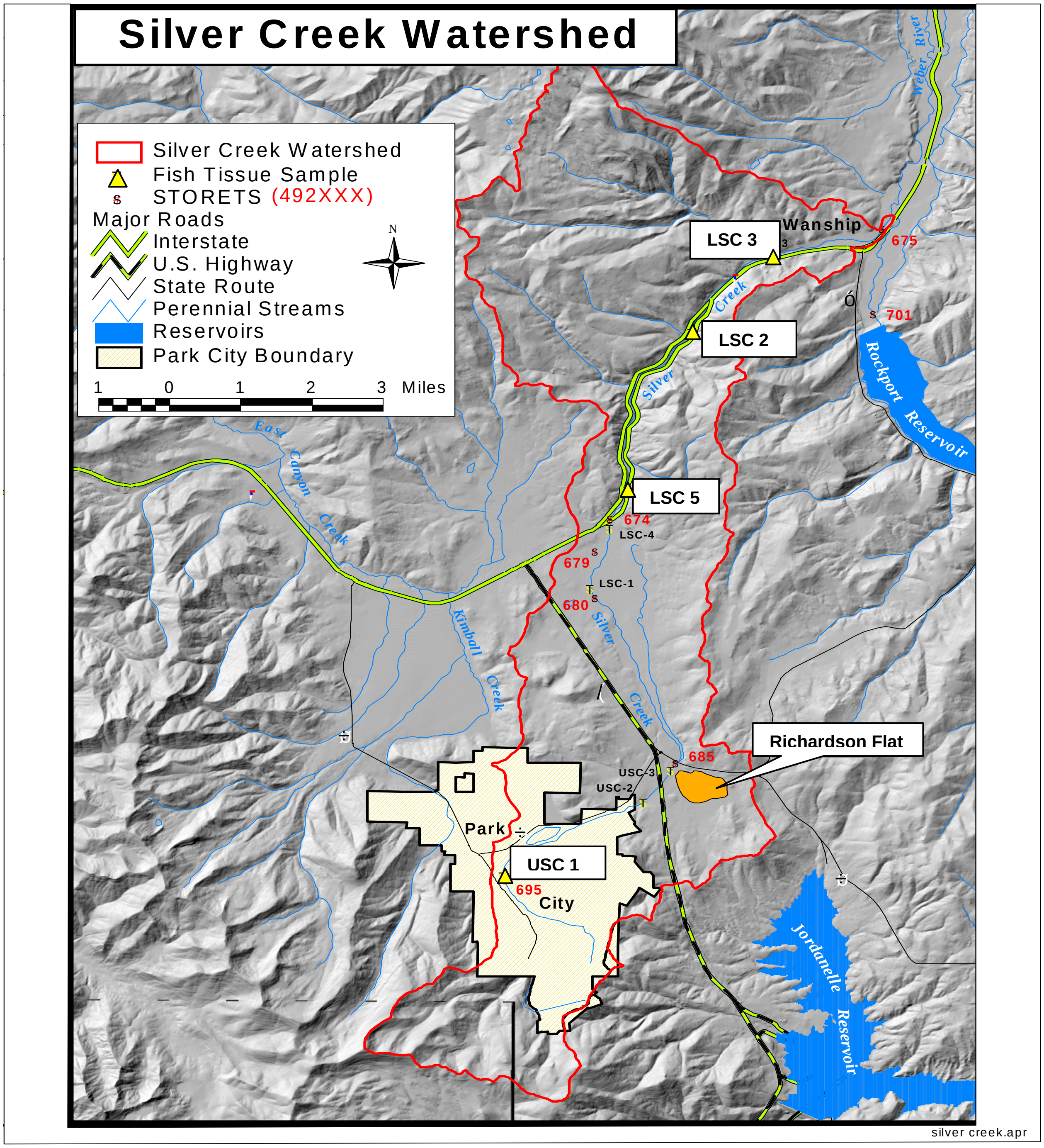
Figure 1. Silver Creek Watershed & Sampling Locations



Sample Locations:

- USC-1: Upper Silver Creek at Bonanza Road (near City Park) – 1 rainbow trout
- LSC-2: Lower Silver Creek, mid-canyon – 6 cutthroat trout
- LSC-3: Lower Silver Creek, lower canyon (below Alexander Canyon, above Wanship) – 1 cutthroat trout, 5 brown trout
- LSC-5: Upper canyon; about ½ mile below the Pace Diary at Atkinson - 6 cutthroat trout

Figure 2. Historical Union Pacific Rail Trail, Summit County, Utah.

Signs and parking lots mark access to the trail (Trail Link 2004).

Figure 3. Silver Creek between the divided Interstate 80 (I-80)

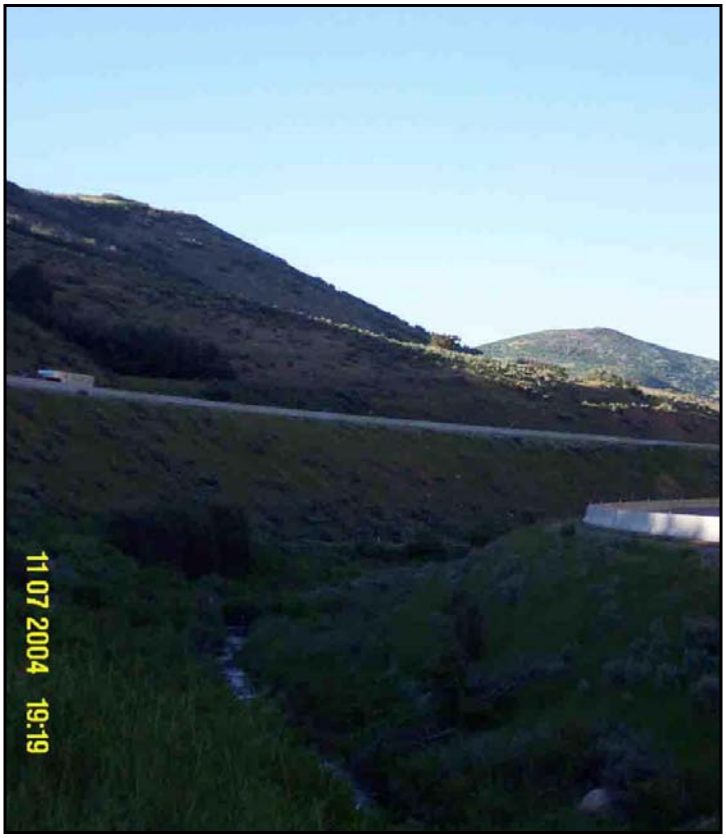


Figure 4. Photo of a Silver Creek trout collected for analysis

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Table 1. Summary of Metal Concentrations by Site in Fish Collected from Silver Creek

Metal	Site LSC-2			Site LSC-3			Site LSC-5			Screening Values		RfD
	High	Low	Average	High	Low	Average	High	Low	Average	Child	Sport Fisher	
	mg/kg			*mg/kg*			*mg/kg*			*mg/kg*		*mg/kg/day*
Aluminum	1.34	0.517	0.904	1.61	0.510	0.938	1.47	0.526	0.822	4,570	8,000	2
Arsenic (inorganic)	0.024	0.008	0.014	0.008	0.008	0.008	**0.027**	0.008	0.013	0.015	0.027	0.0003
Barium	0.201	0.040	0.111	0.131	0.048	0.090	0.241	0.042	0.117	160	280	0.07
Beryllium	0.012	0.010	0.011	0.012	0.010	0.011	0.012	0.011	0.011	4.57	8	0.002
Boron	0.249	0.206	0.219	0.233	0.204	0.218	0.234	0.211	0.226	22.9	40	0.01
Cadmium	0.118	0.012	0.054	0.094	0.028	0.049	0.098	0.025	0.060	2.29	4	0.001
Calcium	324	416	371	668	243	510	478	282	408	38,800	68,000	17
Chromium	0.124	0.103	0.110	0.188	0.104	0.123	0.254	0.105	0.139	6.86	12	0.003
Cobalt	0.124	0.103	0.110	0.116	0.102	0.109	0.117	0.105	0.113	0.91	1.6	0.0004
Copper	1.03	0.692	0.803	1.14	0.460	0.740	1.11	0.617	0.837	1.37	2.4	0.0006
Iron	9.72	7.16	8.70	7.55	4.86	6.08	9.88	6.23	7.82	320	560	0.14
Lead	0.326	0.105	0.206	0.232	0.100	0.169	1.039	0.186	0.520	n/a	n/a	n/a
Magnesium	269	233	245	275	227	250	258	224	239	9,140	16,000	4
Manganese	0.974	0.618	0.756	1.24	0.327	0.781	0.934	0.275	0.615	320	560	0.14
Mercury	0.077	0.060	0.067	0.094	0.035	0.062	0.105	0.046	0.080	0.69	1.2	0.0003*
Molybdenum	0.249	0.206	0.219	0.233	0.204	0.218	0.234	0.211	0.226	11.4	20	0.005

(Table 1 continued, Summary of Metal Concentrations by Site in Fish Collected from Silver Creek)

Metal	Site LSC-2			Site LSC-3			Site LSC-5			Screening Values		RfD
	High	Low	Average	High	Low	Average	High	Low	Average	Child	Sport Fisher	
	mg/kg			*mg/kg*			*mg/kg*			*mg/kg*		*mg/kg/day*
Nickel	0.241	0.103	0.133	0.116	0.102	0.109	0.329	0.105	0.148	45.7	80	0.02
Phosphorus	2,662	2,267	2,400	2,724	2,247	2,481	2,512	2,214	2,337	25,143	44,000	11
Potassium	4,114	3,545	3,747	4,131	3,640	3,831	3,763	3,337	3,546	57,100	114,400	28.6
Selenium	0.363	0.243	0.312	0.320	0.287	0.298	0.553	0.447	0.494	11.4	20	0.005
Sodium	900	664	780	759	639	703	743	631	700	16,000	28,000	7
Strontium	0.531	0.319	0.413	0.795	0.216	0.568	0.672	0.342	0.525	1,370	2,400	0.6
Titanium†	0.234	0.131	0.103	0.116	0.102	0.109	0.117	0.105	0.113	n/a	n/a	n/a
Vanadium	0.249	0.206	0.219	0.233	0.204	0.218	0.234	0.211	0.226	6.86	12	0.003
Zinc	26.0	16.3	19.8	20.9	12.3	17.7	30.1	15.7	24.0	686	1,200	0.3

Those in **bold** are contaminants of concern because the metal exceeds screening values or is a toxic metal with no screening value.
Results reported as "less than" (<) the dry-weight detection limits have been converted to wet weight using half the reported detection limit.
mg/kg = milligrams of metal per kilogram of wet-weight fish
mg/kg/day = milligrams of metal per kilogram of body weight per day
n/a = not available
RfD = Reference Dose; used to calculate screening value (See Appendix A)

Sample Locations:
- LSC-2: Lower Silver Creek, mid-canyon – 6 cutthroat trout
- LSC-3: Lower Silver Creek, lower canyon (below Alexander Canyon, above Wanship) – 1 cutthroat trout, 5 brown trout
- LSC-5: Upper canyon; about ½ mile below the Pace Diary at Atkinson - 6 cutthroat trout

* Minimal Risk Level (MRL) for methylmercury, the type of mercury most commonly found in fish.
† Titanium was not evaluated further because it is not considered a toxic metal.
Source: TERL 2004

Table 2. Screening Values vs. Contaminants of Concern in Fish of Silver Creek

Trout Species	Metal	Screening Values (SVs) (mg/kg)		Results of Fish Sampling (mg/kg)		
		Child	Sport Fisher	Average	High	Low
		mg/kg		*mg/kg*		
Brown	Arsenic (inorganic)	0.015	0.027	0.008*	0.008*	0.007*
	Lead†	n/a	n/a	0.183	0.232	0.154
Cutthroat	Arsenic (inorganic)	0.015	0.027	0.013	0.027	0.008*
	Lead†	n/a	n/a	0.343	1.039	0.100

mg/kg = milligrams of metal per kilogram of wet-weight fish
n/a = not available
*Wet-weight inorganic arsenic was calculated from dry-weight results. Some results were reported as "less than" (<) the detection limit; therefore wet-weight results have been calculated using half the reported detection limit.
† SVs have not been calculated for lead because there is no dose of lead that is considered safe. As a result, lead exposures should be avoided when possible.
Source: TERL 2004

Appendix A: Summary of Metals Analyzed

Metal	Analytical Method of Detection
Aluminum	ICP-O
Arsenic (total)	ICP-M
Arsenic (inorganic)	HGAA
Barium	ICP-O
Beryllium	ICP-O
Boron	ICP-O
Cadmium	ICP-M
Calcium	ICP-O
Cobalt	ICP-O
Chromium	ICP-M
Copper	ICP-O
Iron	ICP-O
Lead	ICP-M
Magnesium	ICP-O
Manganese	ICP-O
Mercury	CVAA
Molybdenum	ICP-O
Nickel	ICP-O
Phosphorous	ICP-O
Potassium	ICP-O
Selenium	HGAA
Sodium	ICP-O
Strontium	ICP-O
Titanium	ICP-O
Vanadium	ICP-O
Zinc	ICP-O

ICP-M = Inductively coupled plasma mass spectrophotometry
ICP-O = Inductively coupled plasma-optical emission spectroscopy
HGAA = Hydride generation atomic absorption spectrophotometry
GFAA = Graphite furnace atomic absorption spectrophotometry
CVAA = Cold vapor atomic absorption spectrophotometry

Appendix B: Calculations

Dry-weight Concentration to Wet-weight Concentration

$$WW = DW * (1 – (0.01 * PM))$$ (TERL 2004)

Where:

WW = Wet-weight concentration, in milligrams metal per kilogram of fish (mg/kg)
DW = Dry-weight concentration, in milligrams metal per kilogram of fish (mg/kg)
PM = Percent moisture, %

Note: When dry weight is reported as “less than” (<) the detection limit, half the detection limit value is used to calculate wet weight.

Screening Value Calculations

<u>For non-carcinogenic health effects:</u>

$$SV_n = (RfD * BW) /CR$$ (EPA 2000a and 2000b)

Where:

SV_n = Screening value for a non-carcinogen (mg/kg, milligrams of metal per kilogram of fish)
RfD = Oral reference dose (mg/kg/day, the dose in milligrams of metal per kilogram of human body weight per day that is unlikely to result in adverse health effects)

Examples of RfDs:

$RfD_{Cadmium}$ = 0.001 mg/kg/day
RfD_{Zinc} = 0.3 mg/kg/day
RfDs are found on EPA’s Integrated Risk Information System (IRIS) database. ATSDR’s minimal risk levels (MRL) can be used in place of an RfD.

BW = Mean body weight of the general population or sub-population of concern (kg).
BW_{child} = 16 kg
BW_{adult} = 70 kg

CR = Mean daily consumption rate of the species of interest by the general population or by the sub-population of concern averaged over a 70-yr lifetime (in kg/day).
CR_{child} = 0.007 kg/day
CR_{adult} = 0.0175 kg/day

Examples of SV calculations:

Mercury (Hg)
MRL = 0.0003 mg/kg/day (for methylmercury the type most commonly found in fish.)

Therefore, for mercury:

SV_{child} = [(0.0003 mg/kg/day) * (16kg)]/(0.007 kg/day) = 0.686 mg/kg
SV_{adult} = [(0.0003 mg/kg/day) * (70kg)]/(0.0175 kg/day) = 1.2 mg/kg

Cobalt (Co)

To calculate a SV_n for cobalt we first had to calculate a RfD, as none was available in the literature.

RfD = NOAEL or LOAEL/UF*MF (EPA 2000a)

Where:

NOAEL = No-Observed-Adverse-Effect level
LOAEL = Lowest-Observed-Adverse-Effect level
UF = Uncertainty factor
MF = Modifying factor (the default value is 1)

For cobalt there is a possible LOAEL of 0.04 mg cobalt/kg/day based on oral, human exposures (ATSDR 1992).

RfD = 0.04 mg/kg/day/UF*MF
UF for cobalt = 10 x 10 = 100 ((Variations in human sensitivity) x (extrapolate from a LOAEL to a NOAEL). No 10-fold factors for sub-chronic to chronic extrapolations were used because exposure to fish assumed to be seasonal, and therefore, sub-chronic).
MF = 1 (The modifying factor in this case is the default value of 1).

Therefore, for cobalt:

RfD = 0.04 mg/kg/day / 100 = 0.0004 mg/kg/day
SV_n = (0.0004 mg/kg/day * 70kg)/0.025 kg/day = 1.12 mg/kg

For carcinogenic health effects:

$SV_c = [(RL/SF) * BW]/CR$ (EPA 2000a and 2000b)

Where:

SV_c = Screening value for a carcinogen (in mg/kg or ppm)
RL = Maximum acceptable risk level (dimensionless)
SF = Oral slope factor $(mg/kg/d)^{-1}$
BW = Mean body weight of the general population or subpopulation of concern (kg).
CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

The arsenic SV_c was calculated based on the oral slope factor for inorganic arsenic, the most toxic form of arsenic.

For an adult or sport fisher, the calculation looks like this:

Where:

RL = 1/100,000
SF = 1.5 $(mg/kg/d)^{-1}$
BW = 70 kg
CR = 0.0175 kg/day

Therefore,

SV_c = 0.027 mg/kg

For a child:
Where:
RL = 1/100,000
SF = 1.5 $(mg/kg/d)^{-1}$
BW = 16 kg
CR = 0.007 kg/day
Therefore,
SV_c = 0.015 mg/kg

Consumption Rate Calculations

For non-carcinogenic health effects:

To calculate the maximum allowable fish consumption rate for a non-carcinogen:

$CR_{lim} = [(RfD)*(BW)] / C_m$ (EPA 2002a and 2002b)

Where:
CR_{lim} = maximum allowable fish consumption rate (kg/day)
BW = Mean body weight of the general population or sub-population of concern (kg).
C_m = measured concentration of chemical contaminant in a given species of fish (mg/kg).

$CR_{mm} = [(CR_{lim})*(T_{ap})] / MS$ (EPA 2002a and 2002b)

Where:
CR_{mm} = maximum allowable fish consumption rate (meals/month)
CR_{lim} = as calculated above
T_{ap} = time averaging period (365.25 d/12 mo = 30.44 days per month)
MS = meal size (0.227 kg fish/meal for adults, 0.113 kg fish/meal for children)

Assumptions used in calculating consumption rates are:
- An average adult weighs 70 kg and eats 227g (8 ounces) of fish per meal (EPA 2000a).
- A child (1 - 6 years of age) weighs 16 kg and eats 113 g (4 ounces) of fish per meal.

Example of consumption rate calculations, using the greatest amount of mercury, 0.105 mg/kg:
For adults: CR_{lim} = [(0.0001mg/kg/day)*(70kg)]/0.105 mg/kg = 0.067 kg/day
For children: CR_{lim} = [(0.0001 mg/kg/day)*(16kg)]/0.105 mg/kg = 0.015 kg/day

Then, to calculate the number of meals of fish containing 0.105 mg/kg of mercury that can be safely eaten per month:
For adults: CR_{mm} = [(0.067 kg/day)*(30.44 d/mo)]/(0.227 kg fish/meal) = 9 meals/month
For children: CR_{mm} = [(0.015 kg/day)*(30.44 d/mo)]/(0.113 kg fish/meal) = 4 meals/month

For carcinogenic health effects:

CR_{lim} = [(ARL)*(BW)]/[(CSF)*(C_m)] (EPA 2002a and 2002b)

Where:

CR_{lim} = maximum allowable fish consumption rate (kg/day)
ARL = max acceptable risk level (dimensionless) = 1/100,000
BW = mean body weight of the general population or sub-population of concern (kg)
C_m = measured concentration of chemical contaminant in a given species of fish (mg/kg)
CSF = Oral slope factor (mg/kg/day)

CR_{mm} = [(CR_{lim})(T_{ap})]/MS (EPA 2002a and 2002b)

Where:

CR_{mm} = maximum allowable fish consumption rate (meals/month)
CR_{lim} = as calculated above
T_{ap} = time averaging period (365.25 days/12 months = 30.44 days/month)
MS = meal size (0.227 kg fish/meal for adults, 0.113 kg fish/meal for children)

Assumptions used in calculating consumption rates are:

- An average adult weighs 70 kg and eats 227g (8 ounces) of fish per meal.
- A child (1-6 years of age) weighs 16 kg and eats 113 g (4 ounces) of fish per meal.
- Oral slope factor for Arsenic = 1.5

Example of consumption rate calculations, using the greatest amount of inorganic arsenic, 0.027 mg/kg:

For adults: CR_{lim} = [(1/100,000)*(70kg)]/[(1.5)*(0.027 mg/kg)] = 0.017 kg/day
For children: CR_{lim} = [(1/100,000)*(16kg)]/[(1.5)*(0.027 mg/kg)] = 0.004 kg/day

Then, to calculate the number of meals of fish containing 0.027 mg/kg of inorganic arsenic that can be safely eaten per month:

For adults: CR_{mm} = [(0.017 kg/day)*(30.44 days/month)]/(0.227 kg/meal) = 2 meals/month
For children: CR_{mm} [(0.004 kg/day)*(30.44 days/month)]/(0.113 kg/meal) = 1 meals/month

Appendix C: Integrated Exposure Uptake Biokinetic (IEUBK) parameters

EPA has developed an integrated exposure, uptake, and biokinetic (IEUBK) model to estimate the risks of lead (Pb) exposure for children ages 1-7 years old based on a number of variables. This model requires 1) input of point estimates of the average concentration of lead in various environmental media, and 2) the average amount of those media contacted by a child at the site.

The parameters used to evaluate the lead risk for children consuming fish from Silver Creek are as follows:

<u>Air</u>

Default Air Pb concentration: 30 % of outdoor air
Other air parameters:

Age (years)	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Concentration (µg Pb/m^3)
0.5 – 1	1.0	2.0	32.0	0.1
1 – 2	2.0	3.0	32.0	0.1
2 – 3	3.0	5.0	32.0	0.1
3 – 4	4.0	5.0	32.0	0.1
4 – 5	4.0	5.0	32.0	0.1
5 – 6	4.0	7.0	32.0	0.1
6 - 7	4.0	7.0	32.0	0.1

<u>Diet</u>

20% of the child's meat consumption is fish from Silver Creek
The maximum amount of lead found in the Silver Creek fish, 1.040 µg/g

<u>Drinking water</u>

Default drinking water concentration: 4.0 µg Pb/L
Multiple source analysis used.
Water consumption parameters:

Age (years)	Water (L/day)
0.5 – 1	0.20
1 – 2	0.50
2 – 3	0.52
3 – 4	0.53
4 – 5	0.55
5 – 6	0.59
6 - 7	0.59

<u>Soil and Dust</u>

Multiple source analysis used.
Default average multiple source concentration: 150 µg/g
Mass fraction of outdoor soil to indoor dust conversion factor: 0.7
Outdoor airborne lead to indoor household dust lead concentration: 100.0

Appendix D: Fish Tissue Data

ID Number	Trout Species	Weight (grams)	Percent Moisture (%)	Aluminum	Total Arsenic	Inorganic Arsenic	Barium	Beryllium	Boron	Calcium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead
				mg/kg												
03L3BRT2	Brown	140.06	77.8%	1.228	0.172	0.008*	0.098	0.005*	0.109*	639.36	0.094	0.055*	0.055*	0.826	5.506	0.174
03L3BRT1	Brown	149.21	77.2%	1.208	0.183	0.008*	0.109	0.006*	0.116*	668.04	0.053	0.058*	0.058*	1.147	6.065	0.187
03L3BRT4	Brown	159.17	77.3%	1.614	0.208	0.008*	0.131	0.006*	0.112*	651.49	0.028	0.056*	0.056*	0.579	4.858	0.232
03L3BRT5	Brown	161.84	78.4%	0.510*	0.150	0.008*	0.098	0.005*	0.102*	386.64	0.041	0.051*	0.188*	0.648	6.674	0.154
03L3BRT3	Brown	200.67	78.5%	0.519*	0.160	0.008*	0.058	0.005*	0.104*	470.85	0.037	0.052*	0.052*	0.460	5.805	0.166
03L5CTT3	Cutthroat	44.874	76.5%	1.466	0.123	0.009*	0.063	0.006*	0.117*	387.75	0.098	0.058*	0.058*	1.112	8.813	0.186
03L5CTT5	Cutthroat	63.15	76.3%	1.249	0.059*	0.027	0.063	0.006*	0.117*	459.78	0.088	0.059*	0.254*	0.950	9.883	0.236
03L5CTT4	Cutthroat	97.46	78.3%	0.563*	0.056*	0.008*	0.097	0.006*	0.113*	414.47	0.025	0.056*	0.056*	0.647	6.228	0.503
03L2CTT6	Cutthroat	104.68	79.2%	1.294	0.052*	0.024	0.073	0.005*	0.104*	345.28	0.052	0.052*	0.052*	0.718	8.632	0.158
03L2CTT4	Cutthroat	124.13	77.6%	1.340	0.126	0.008*	0.162	0.006*	0.112*	416.64	0.077	0.056*	0.056*	0.820	9.722	0.231
03L5CTT6	Cutthroat	132.94	78.5%	0.551*	0.055*	0.008*	0.042	0.006*	0.111*	281.65	0.051	0.055*	0.055*	0.617	7.375	0.295
03L2CTT3	Cutthroat	132.99	78.9%	1.104	0.053*	0.016	0.114	0.005*	0.106*	377.69	0.039	0.053*	0.053*	0.692	9.157	0.236
03L5CTT2	Cutthroat	152.54	77.0%	0.574*	0.057*	0.008*	0.195	0.006*	0.115*	478.40	0.025	0.057*	0.069*	0.789	6.831	0.858
03L5CTT1	Cutthroat	165.47	78.3%	0.526*	0.180	0.017	0.241	0.005*	0.105*	427.49	0.076	0.053*	0.053*	0.905	7.769	1.039
03L2CTT1	Cutthroat	174.87	79.6%	0.517*	0.148	0.020	0.077	0.005*	0.103*	365.16	0.118	0.052*	0.052*	1.030	9.078	0.181
03L2CTT2	Cutthroat	182.63	75.8%	0.621*	0.062*	0.009*	0.040	0.006*	0.125*	324.28	0.026	0.062*	0.062*	0.840	7.163	0.105
03L2CTT5	Cutthroat	206.53	77.5%	0.547*	0.055*	0.008*	0.201	0.005*	0.109*	402.75	0.012	0.055*	0.111*	0.720	8.415	0.326
03L3CTT1	Cutthroat	209.24	78.8%	0.546*	0.055*	0.008*	0.048	0.005*	0.109*	243.80	0.043	0.055*	0.055*	0.776	7.547	0.100
03U1RBT1	Rainbow	61.48	80.5%	2.945	0.411	0.007*	1.260	0.024*	0.094*	6920.00	0.017	0.047*	0.047*	0.298	58.900	0.057
	Average	140.21	78.0%	0.996	0.124	0.011	0.167	0.006	0.110	771.659	0.052	0.055	0.076	0.767	10.233	0.286
	Minimum	44.87	75.8%	0.510	0.052	0.007	0.040	0.005	0.094	243.800	0.012	0.047	0.047	0.298	4.858	0.057
	Maximum	209.24	80.5%	2.945	0.411	0.027	1.260	0.024	0.125	6920.00	0.118	0.062	0.254	1.147	58.900	1.039

*Samples calculated using half the detection limit
mg/kg = milligrams of metal per kilogram of wet weight fish

(Appendix D continued, Fish Tissue Data)

ID Number	Species	Manganese	Magnesium	Mercury	Molybdenum	Nickel	Phosphorous	Potassium	Selenium	Sodium	Strontium	Titanium	Vanadium	Zinc
		mg/kg												
03L3BRT2	Brown	1.241	248.640	0.053	0.109*	0.055*	2464.200	3640.800	0.320	752.580	0.710	0.055*	0.109*	20.935
03L3BRT1	Brown	0.746	273.600	0.069	0.116*	0.058*	2667.600	3944.400	0.292	715.920	0.784	0.058*	0.116*	17.077
03L3BRT4	Brown	1.142	274.670	0.059	0.112*	0.056*	2724.000	4131.400	0.313	687.810	0.795	0.056*	0.112*	19.431
03L3BRT5	Brown	0.737	239.760	0.035	0.102*	0.051*	2397.600	3801.600	0.287	639.360	0.391	0.051*	0.102*	20.002
03L3BRT3	Brown	0.495	236.500	0.062	0.104*	0.052*	2386.500	3719.500	0.288	662.200	0.514	0.052*	0.104*	16.620
03L5CTT3	Cutthroat	0.752	231.005	0.060	0.117*	0.058*	2213.700	3337.000	0.447	712.050	0.437	0.058*	0.117*	25.380
03L5CTT5	Cutthroat	0.649	258.330	0.046	0.117*	0.329	2512.200	3602.400	0.448	720.480	0.498	0.059*	0.117*	30.099
03L5CTT4	Cutthroat	0.297	232.190	0.105	0.113*	0.056*	2278.500	3558.800	0.503	672.700	0.540	0.056*	0.113*	19.530
03L2CTT6	Cutthroat	0.668	237.120	0.060	0.104*	0.113	2267.200	3640.000	0.289	786.240	0.360	0.052*	0.104*	21.216
03L2CTT4	Cutthroat	0.930	250.880	0.063	0.112*	0.056*	2441.600	3673.600	0.363	804.160	0.488	0.056*	0.112*	25.984
03L5CTT6	Cutthroat	0.275	247.250	0.092	0.111*	0.055*	2322.000	3762.500	0.488	722.400	0.342	0.055*	0.111*	15.738
03L2CTT3	Cutthroat	0.618	238.430	0.063	0.106*	0.053*	2299.900	3544.800	0.243	749.050	0.373	0.234	0.106*	17.450
03L5CTT2	Cutthroat	0.934	243.800	0.083	0.115*	0.057*	2438.000	3611.000	0.522	742.900	0.672	0.057*	0.115*	29.670
03L5CTT1	Cutthroat	0.781	223.510	0.094	0.105*	0.053*	2256.800	3406.900	0.553	631.470	0.662	0.053*	0.105*	23.002
03L2CTT1	Cutthroat	0.620	232.560	0.075	0.103*	0.052*	2325.600	3794.400	0.333	899.640	0.408	0.052*	0.103*	20.604
03L2CTT2	Cutthroat	0.728	268.620	0.077	0.125*	0.062*	2662.000	4114.000	0.324	779.240	0.319	0.062*	0.125*	17.109
03L2CTT5	Cutthroat	0.974	243.000	0.075	0.109*	0.241	2407.500	3712.500	0.320	663.750	0.531	0.055*	0.109*	16.268
03L3CTT1	Cutthroat	0.326	226.840	0.094	0.109*	0.055*	2247.200	3752.400	0.288	758.960	0.216	0.055*	0.109*	12.338
03U1RBT1	Rainbow	2.730	1370.000	0.027	0.094*	0.191	15300.000	21600.000	1.440	3860.000	7.780	0.095	0.094*	16.000
	Average	0.823	304.037	0.068	0.110	0.090	3084.847	4649.895	0.424	892.679	0.885	0.067	0.110	20.234
	Minimum	0.275	223.510	0.027	0.094	0.051	2213.700	3337.000	0.243	631.470	0.216	0.051	0.094	12.338
	Maximum	2.730	1370.000	0.105	0.125	0.329	15300.000	21600.000	1.440	3860.000	7.780	0.234	0.125	30.099

*Samples calculated using half the detection limit
mg/kg = milligrams of metal per kilogram of wet weight fish

Appendix E: Contact Information

For more information on health issues:	Tamra Jones Utah Department of Health (801) 538-6191 tamraj@utah.gov Scott Everett Utah Department of Environmental Quality (801) 536-4117 severett@utah.gov
For more information on water quality:	John Whitehead Utah Department of Environmental Quality (801) 538-6053 jwhitehead@utah.gov
For more information of fishery issues:	Chris Cline U.S. Fish and Wildlife Service (801) 975-3330 chris_cline@fws.gov
For more information about mining waste and clean-up efforts in the Silver Creek area:	Ann Tillia Utah Department of Environmental Quality (801) 536-4235 atillia@utah.gov

Certification

This Health Consultation, Fish Sampling in Silver Creek: Analysis of Metals and Potential Health Impacts, Summit County, Utah, was prepared by the Utah Department of Health, Environmental Epidemiology Program under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health consultation was begun.

for Charisse Walcott, Technical Project Officer
Division of Health Assessment and Consultation
ATSDR

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

Roberta Erlwein, Cooperative Agreement Team Leader
Division of Health Assessment and Consultation
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