Letter Health Consultation

Exposure to Uranium Contaminated Soil at Seep 6

MONTICELLO MILL TAILINGS SITE

MONTICELLO, SAN JUAN COUNTY, UTAH

CERCLIS NO: UT3890090035

Prepared by
Utah Department of Health

OCTOBER 24, 2016

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

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LETTER HEALTH CONSULTATION

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Utah Department of Health
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U.S. Department of Health and Human Services
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To: Jason Nguyen
Site Manager
U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Subject: Assessment of seep 6 soil exposures at the Monticello Mill Tailings Site

Dear Mr. Nguyen,

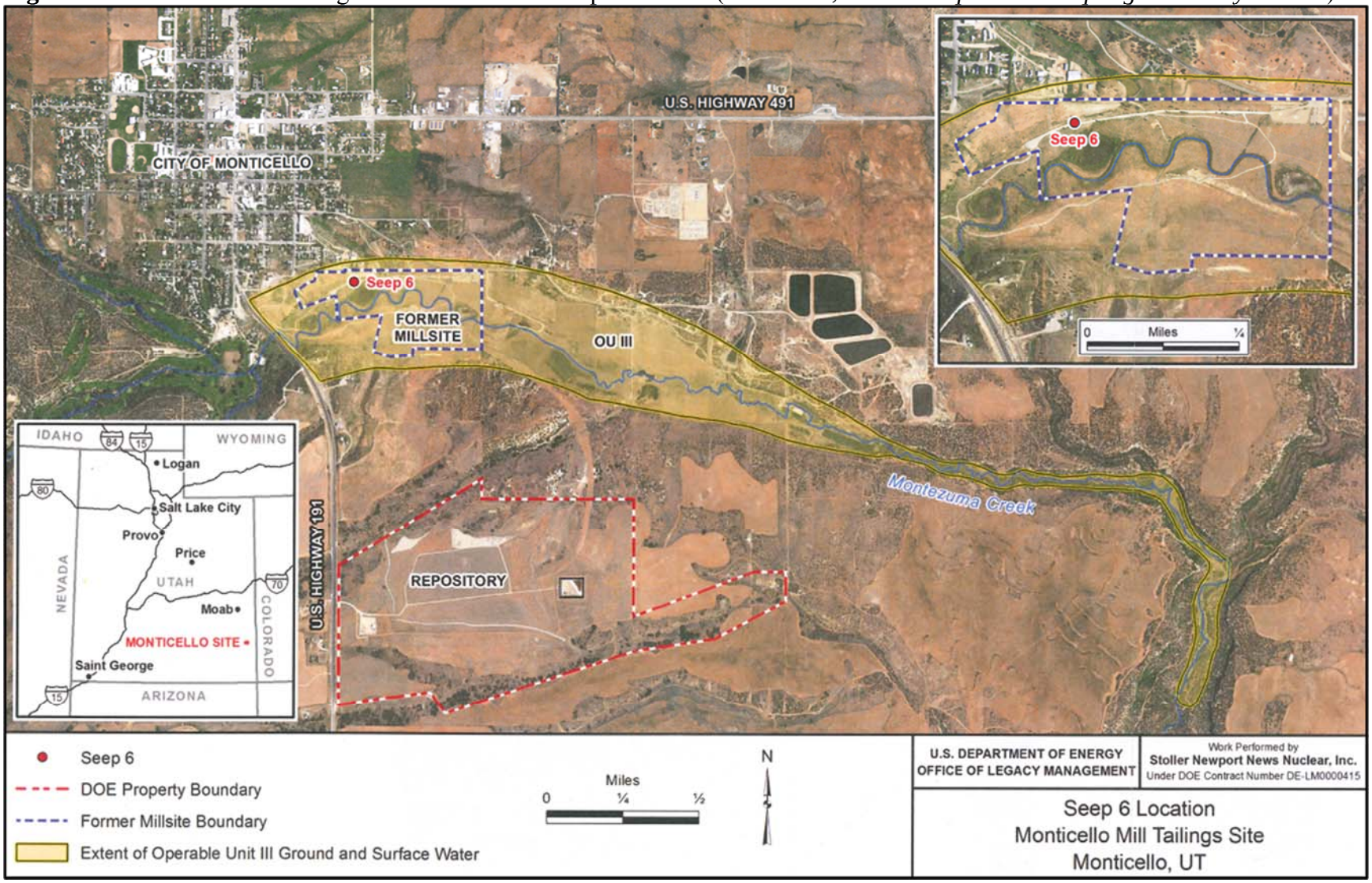
In a public health assessment (PHA) released in February 2014, the Utah Environmental Epidemiology Program (EEP) recommended that the U.S. Department of Energy (DOE) conduct soil sampling near a contaminated groundwater seep in the Monticello Mill Tailings Site (MMTS). The concern was that the soils near the seep could potentially accumulate uranium to harmful levels. Any exposures are likely to be recreational, as Seep 6 is within the former mill site, which is now used as a city park. DOE followed this recommendation, collecting soil samples on September 29, 2015 and transmitting the results to the EEP on December 17, 2015. This health consultation presents an assessment of these samples to determine if uranium-contaminated soil near Seep 6 poses a health hazard.

Based on DOE soil sampling data, the EEP concludes that recreational exposures to uranium in Seep 6 soil are not expected to harm the health of children or adults. All exposure dose estimates were below the relevant minimal risk levels developed by the Agency for Toxic Substances and Disease Registry (ATSDR). However, the sampling data indicate that accumulation of uranium in the soil is occurring. Without long-term sampling of Seep 6 soil, it is not possible to know if uranium concentrations are remaining steady or if they are increasing. The EEP recommends that DOE conduct periodic sampling of Seep 6 soil, potentially as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mandated five-year review cycle. The EEP will continue to support DOE on interpreting sampling data and adverse health outcomes. The remainder of this document describes how the EEP arrived at these conclusions and recommendations.

BACKGROUND AND STATEMENT OF ISSUES

The city of Monticello is located at the base of the Abajo Mountains in southeastern Utah (**Figure 1**). The United States government, through the DOE, operated a 110-acre uranium and vanadium processing mill adjacent to Monticello between 1942 and 1960. After closure, the mill tailings were stabilized in 1961 and 1962 by grading and covering with dirt and rock. The mill building was demolished in 1964, and the entire mill site was dismantled by 1965. Some contaminated soils from the ore buying station were removed between 1974 and 1975, and a fence was constructed to restrict public access. The U.S. Environmental Protection Agency (EPA) placed the MMTS on the National Priorities List (NPL) in 1989. Cleanup occurred through a federal facilities agreement, with DOE as the lead federal agency. Remedial actions at the MMTS began in 1992 and continued through 1999. In 2000, the former mill site was

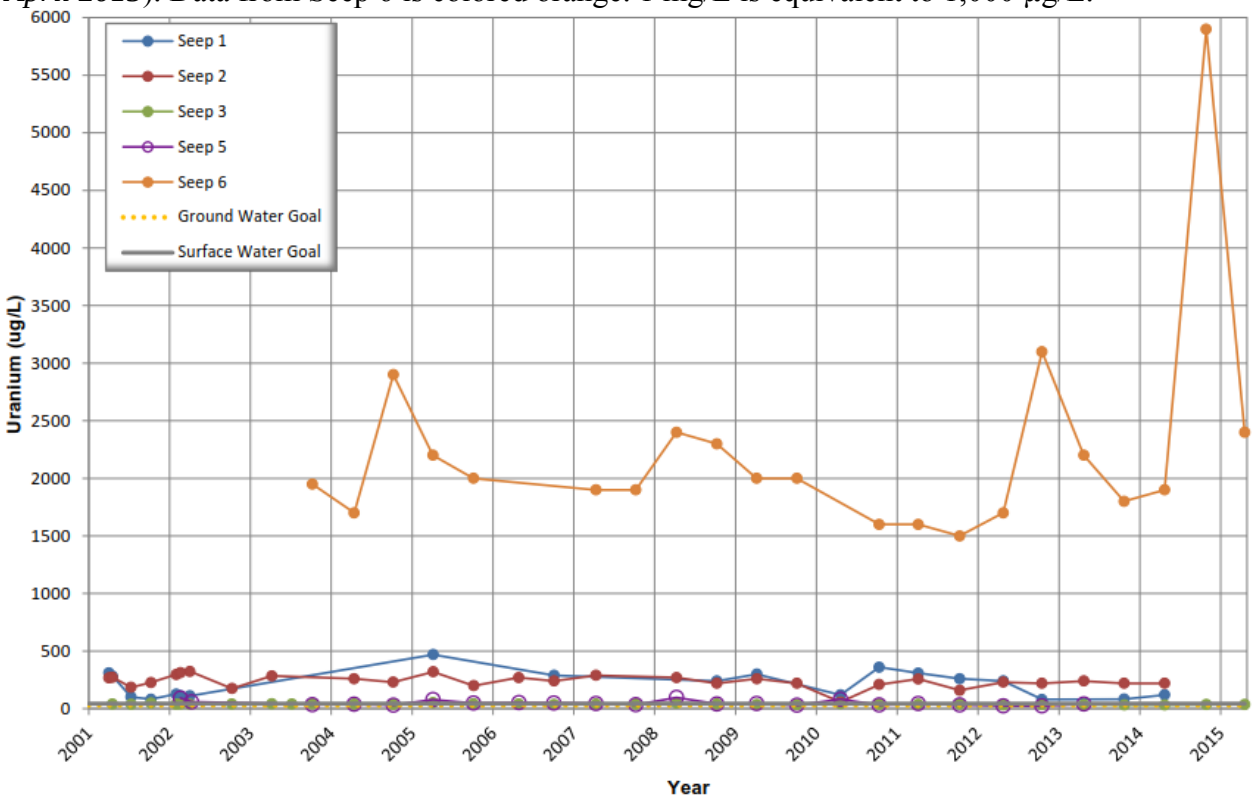
Figure 1: Monticello Mill Tailings Site overview and Seep 6 location (from *DOE, 2015a: Seep 6 Soil Sampling and Analysis Plan*).



transferred from DOE to the city of Monticello, where it now serves as a park. Portions of the MMTS were deleted from the NPL in 2003 (EEP, 2014).

Seep 6 is a small, intermittent water seep located on a steep south-facing hillside in the northwest portion of the former mill site (**Figure 1**). The DOE's Office of Legacy Management (DOE-LM) has tested water quality at Seep 6 since 1998, and it is part of the site's ongoing monitoring program. Historically, groundwater discharge at Seep 6 has shown elevated uranium concentrations of approximately two milligrams per liter (mg/L), although uranium levels were at 5.9 mg/L in 2014 (See **Figure 2**) (DOE, 2015c). The source of the contamination is thought to be mill tailings used as bedding material or backfill in the construction of a public utility corridor where city sewer and irrigation lines are buried. The water expressed from Seep 6 likely originates from a leak in these lines in the hillside above the seep (EEP, 2014). Due to the depth of these lines (upwards of 20 feet in places), the area was not remediated by DOE as part of the MMTS remedial actions. Instead, it was designated as a supplemental standards area, allowing buried contamination in the utility trench to remain in place. It is planned that this remaining contaminated material will be remediated and managed at a future time when city activities require maintenance or removal of the utility lines (DOE, 2015a).

Figure 2: Uranium concentrations over time at selected seep locations (from *DOE, 2015c: Monticello Mill Tailings Site Operable Unit III Annual Groundwater Report May 2014 through April 2015*). Data from Seep 6 is colored orange. 1 mg/L is equivalent to 1,000 µg/L.



Flow of water at Seep 6 is low, likely less than 250 milliliters (or roughly one cup) per minute. The water does not flow directly into Montezuma Creek, but instead drains into the soil immediately downslope of the seep. It generally flows year round (though intermittently) and

supports a small area of wetland, though significant wildlife habitat is not found, as the area is small (approximately 3,340 square feet) and the hillside is steep (EEP, 2014) (**Figures 3 & 4**). The wetland area extends roughly 100 feet to the east in an elongated shape where small quantities of water from the seep temporarily accumulate in a drainage ditch. This ditch runs along an unpaved access road for the city park and is drained by a culvert (**Figure 3**). In the past, there have been times when the ditch and culvert have been overwhelmed and water flowed into and across the road. An isolated, smaller (approximately 80 square feet) seep area is located roughly 140 feet to east northeast of the main seep; this is included in the Seep 6 area (**Figure 3**) (DOE, 2015a).

In the 2014 PHA, the EEP concluded that it is very unlikely that water at Seep 6 would be ingested by recreational users given the intermittent and very limited nature of the any standing water, and that skin contact with Seep 6 waters does not present a health hazard (EEP, 2014). However, soluble uranium compounds can accumulate in soils exposed to contaminated water at concentrations that are much higher than those in the water (ATSDR, 2013). The EEP recommended that DOE conduct soil sampling in the Seep 6 area to help determine if uranium accumulating in those soils could harm the health of people recreating on the former mill site (EEP, 2014). Given the heavy vegetation and persistent moisture at Seep 6, exposure to contaminated dust through inhalation is not expected at this site (**Figure 4**).

DISCUSSION

Uranium

Uranium is a naturally occurring, weakly radioactive element. It is found in nature as a mixture of three isotopes: ^{234}U, ^{235}U, and ^{238}U. The most common and least radioactive isotope is ^{238}U, which makes up over 99% of natural uranium by mass (ASTDR, 2013a). While natural uranium is weakly radioactive, the health effects of exposure are due to its chemical toxicity to the kidneys and not to radiation. Neither the National Toxicology Program, the International Agency for Research on Cancer, nor the EPA have classified uranium with respect to carcinogenicity. To date, no evidence linking oral or skin exposure to uranium with human cancer has been found (ATSDR, 2013).

Seep 6 Soil Sampling

On September 29, 2015, DOE-LM collected ten soil samples from the Seep 6 area (see **Figure 3** for sample locations). Each sample was assembled from a 0 to 3-inch depth interval and homogenized by mixing. No duplicate or split samples were taken. For the full sampling protocol, please refer to DOE, 2015a: Seep 6 Sampling and Analysis Plan, Monticello Mill Tailings Site. The samples were sent to ALS Environmental Laboratory in Fort Collins, CO for analysis using EPA method 6020A (DOE, 2015b).

Soil sampling test results are presented in **Table 1**. The EEP determines if a potential health risk exists by comparing environmental sampling results to comparison values (CVs) calculated by ATSDR or the U.S. Environmental Protection Agency (EPA). A CV is a concentration of a substance in air, water, food, or soil that is unlikely to cause harmful health effects in exposed people (ATSDR, 2005). It should be stressed, however, that comparison values are screening tools, not thresholds of toxicity. While levels at or below a CV may reasonably be considered to pose no risk, it does not necessarily follow that concentrations above a CV would be expected to

Figure 3: Seep 6 overview and soil sample locations (from *DOE, 2015b: Transmittal of Seep 6 Soil Sample Analytical Results*).

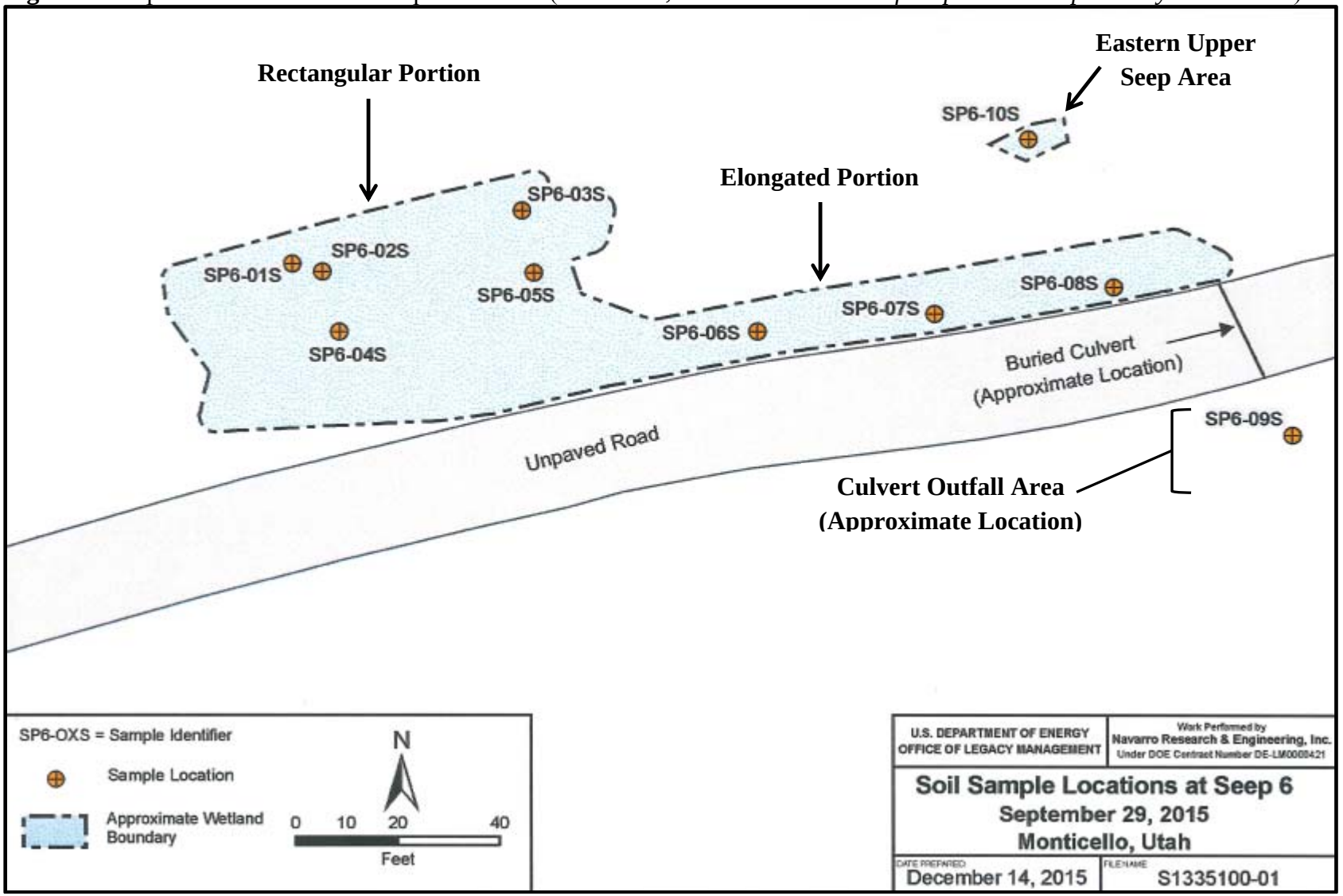


Figure 4: Photographs of the Seep 6 area. Panel A: rectangular portion. Panel B: elongated portion (from *DOE, 2015a: Seep 6 Soil Sampling and Analysis Plan*).

cause harmful health effects. Rather, levels above a CV indicate the need for further evaluation (ATSDR, 2005). The appropriate CVs for children and adults are also included in **Table 1**. No soil sample exceeded the adult CV, so no harmful health effects are expected in adults. However, nine of the ten samples exceeded the CV for exposure to uranium contaminated soil in children, so further analysis was required to evaluate the likelihood of possible harmful effects.

Table 1: Seep 6 soil sampling results (see **Figure 3** for sample locations).

Sample ID	Uranium Concentration (ppm)	Child Intermediate CV* (ppm)	Adult Intermediate CV* (ppm)
SP6-01S	36	10	140
SP6-02S	67		
SP6-03S	62		
SP6-04S	89		
SP6-05S	59		
SP6-06S	32		
SP6-07S	9.8		
SP6-08S	15		
SP6-09S	13		
SP6-10S	35		
Average	41.78		
95% UCL	57.13		

***** ATSDR environmental media evaluation guide (EMEG) for uranium soluble salts. Intermediate time periods are 15 days to one year.

CV: comparison value **ppm:** parts per million **UCL:** upper confidence limit

Exposure Dose Estimates

To determine if exposure to Seep 6 soil poses a health hazard to children, the EEP estimated potential exposure doses using standard ATSDR equations for soil ingestion and skin contact. Due to the uncertainty associated with estimating the true average concentration with limited sampling data, the 95 percent upper confidence limit (95% UCL) of the average was used (see **Appendix B** for term definitions). The 95% UCL provides reasonable assurance that the true average concentration at a site will not be underestimated and its use is in accordance with EPA's risk assessment guidance for Superfund sites (EPA, 1992; EPA, 2015). Recreational exposures for this site are estimated at 80 days/year, at the request of Monticello residents (EEP, 2014). Exposures in children under two years of age were not assessed as they are unlikely to have unmonitored access to the area. The ATSDR toxicological profile for uranium lists the absorption of water soluble uranium compounds for oral and skin exposures as 6% and 0.4%, respectively (ATSDR, 2013); the exposure dose estimates used these values. Lower absorption would be expected of less soluble uranium compounds. Equations and sample calculations for estimating potential exposure doses can be found in **Appendix A**.

Exposure dose estimates for children and adults are presented in **Table 2**. Children between two and six years of age had the highest dose estimates and were used to represent all children. To determine if these estimated doses could be harmful, they were compared with ATSDR minimal

risk levels (MRLs) for uranium exposure. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse, non-cancer health effects over a specific duration of exposure (ATSDR, 2015). As ATSDR has not derived a chronic duration (greater than one year) MRL for uranium exposure, the intermediate duration (two weeks to one year) MRL was used. As the exposure doses are substantially lower than the MRL, recreational exposures to Seep 6 soil are not expected to harm the health of children or adults.

Table 2: Potential recreational (80 days/year) exposure doses to uranium from Seep 6 soil.

Uranium 95% UCL (ppm)	Intermediate MRL (mg/kg/day)	Exposure Route	Potential Child [a] Exposure Dose (mg/kg/day)	Potential Adult Exposure Dose (mg/kg/day)
57.13	2.00×10^{-4}	Ingestion	1.44×10^{-4}	1.56×10^{-5}
		Skin Contact [b]	3.73×10^{-6}	6.60×10^{-7}
		Total	1.48×10^{-4}	1.63×10^{-5}

[a] Between two and six years of age.
[b] Hands, forearms, hands, lower legs, and (in children) feet.

mg/kg/day: milligrams of uranium per kilogram of body weight per day
MRL: minimal risk level
ppm: parts per million
UCL: upper confidence limit

CONCLUSIONS

Based on DOE soil sampling data, the EEP concludes that recreational oral and skin exposures to uranium in Seep 6 soil are not expected to harm the health of children or adults. While uranium concentrations in Seep 6 soil exceeded the ATSDR comparison value for children, all exposure dose estimates were well below the intermediate MRL. However, conclusions cannot be made on the trajectory of uranium concentrations in Seep 6 soil without additional data points. If levels of uranium increase sufficiently, potential future exposures could present increased risks of adverse health outcomes.

RECOMMENDATIONS

The concentration of uranium in Seep 6 soil is considerably higher than the concentration in the water, suggesting that uranium may possibly be accumulating in the soil. Without long-term sampling of Seep 6 soil, it is not possible to know if uranium concentrations are at a steady state or if they are increasing (potentially to the point of health concern). Therefore, the EEP recommends that:

- DOE periodically sample Seep 6 soil, possibly during their CERCLA five-year reviews.

The EEP will continue to support DOE on interpreting sampling data and adverse health outcomes, and will remain available to the community to address public health questions or concerns on this issue.

Please do not hesitate to contact us if you have any questions regarding this health consultation.

Best regards,

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REPORT PREPARATION

This Letter Health Consultation for soil exposures near Seep 6 in the Monticello Mill Tailings Site was prepared by the Environmental Epidemiology Program at the Utah Department of Health under a cooperative agreement with ATSDR. It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database, and the approving agency partners are listed below.

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APPENDIX A
EXPOSURE DOSE CALCULATIONS

Exposure dose (ED) equation for soil ingestion (ATSDR, 2005)

ED = (C x IR x EF x BF x CF) / BW

Where:
ED = Exposure dose (mg/kg/day)

C = Contaminant concentration (mg/kg)

IR = Intake rate of contaminated soil
- Children (1 to 21 years) = 200 mg/day
- Adult (over 21 years) = 100 mg/day

EF = Exposure factor (unitless)
- 1.0 = daily exposure for 365 days a year

BF = Bioavailability (unitless)
- 1.0 is the default value

CF = Conversion factor
- 1.0×10^{-6} kg/mg

BW = Body weight (kg)
- Children (2 to 6 years) = 17.4 kg
- Adults (over 21 years) = 80 kg

Example from **Table 2**. Calculating the potential child exposure dose of uranium from incidental ingestion of Seep 6 soil.

C = 57.13 ppm or 57.13 mg/kg

IR = 200 mg/day

EF = 80 days/year = 80/365 = 0.219

BF = 1.0

CF = 1.0×10^{-6} kg/mg = 0.000001 kg/mg

BW = 17.4 kg

ED = (C x IR x EF x BF x CF) / BW

ED = (57.13 mg/kg x 200 mg/day x 0.219 x 1.0 x 0.000001 kg/mg) / 17.4 kg

ED = 0.000144 mg/kg/day = 1.44×10^{-4} mg/kg/day

Exposure dose (ED) calculation for skin contact with soil (ATSDR, 2005):

$ED = (C \times SA \times AF \times ABS_d \times EF \times CF) / BW$

Where:

ED = exposure dose (mg/kg/day)

C = Contaminant concentration (mg/kg)

SA = Surface area (50^{th} percentile default values)

Child (2 to <6 years)
- Head = 585 cm^2
- Forearms = 457 cm^2
- Hands = 300 cm^2
- Lower legs = 739 cm^2
- Feet = 463 cm^2

Adult (≥21 years)
- Head = 1,250 cm^2
- Forearms = 1,240 cm^2
- Hands = 980 cm^2
- Legs = 2,560 cm^2

* Feet are not included in the default adult dermal exposure scenario

AF = Adherence factor (mg/cm^2)
- 0.2 (default value, based on children playing in wet soil)

ABS_d = Dermal absorption factor (unitless)
- 0.01 (default for inorganic compounds)

EF = Exposure factor (unitless)
- 1.0 = daily exposure for 365 days a year

CF = Conversion factor
- 1.0×10^{-6} kg/mg

BW = Body weight (kg)
- 17.4 kg for a child (2 to <6 years).
- 80 kg for an adult ((≥21 years)

Example from **Table 2.** Calculating the potential child exposure dose of uranium from skin contact with Seep 6 soil.

C = 57.13 ppm = 57.13 mg/kg

SA = 2,591 cm^2

AF = 0.2

ABS_d = 0.01

EF = 80 days/year = 80/365 = 0.219

CF = 1.0×10^{-6} kg/mg = 0.000001 kg/mg

BW = 17.4 kg

$ED = (C \times SA \times AF \times ABS_d \times EF \times CF) / BW$

ED = (57.13 mg/kg x 2,591 cm^2 x 0.2 x 0.01 x 0.219 x 0.000001 kg/mg) / 17.4 kg

ED = 0.00000373 mg/kg/day = 3.73×10^{-6} mg/kg/day

APPENDIX B
ACRONYMS AND DEFINITIONS

ATSDR Agency for Toxic Substances and Disease Registry.

CV Comparison value. A concentration calculated by ATSDR or EPA of a substance in air, water, food, or soil that is unlikely to cause harmful health effects in exposed people.

DOE U.S. Department of Energy.

EEP Environmental Epidemiology Program, within UDOH.

EMEG Environmental media evaluation guide, based on ATSDR's MRL. A concentration of a substance in water, soil, and air to which humans may be exposed during a specified period of time (acute, intermediate, or chronic) without experiencing adverse, non-cancer health effects. Acute is 14 days or less, intermediate is 15 days to one year, and chronic is over one year.

EPA U.S. Environmental Protection Agency.

kg Kilogram. One thousand grams.

mg Milligram. One thousandth of a gram.

MMTS Monticello Mill Tailings Site.

MRL Minimal risk level. 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, non-cancerous effects. MRLs are calculated for a route of exposure over a specified time period. Acute is 14 days or less, intermediate is 15 days to one year, and chronic is over one year.

ppm Parts per million.

UCL Upper confidence limit of the mean. These are often used to represent the concentration of an environmental contaminant, and are associated with a confidence level (95% in this report). They are commonly used in environmental decision making, and are considered to be more protective of human health than simply using average concentrations. Example: we can be 95% confident that the 95% UCL is higher than the true average concentration.

UDEQ Utah Department of Environmental Quality.

UDOH Utah Department of Health.