




**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105**

MEMORANDUM

DATE: August 29, 2018

SUBJECT: Request for Concurrence on Proposed Nationally Significant or Precedent-Setting Removal at the Cove Mesa II Mine Reclamation Erosion Site, Apache County, Arizona, Navajo Nation Indian Reservation

FROM: Enrique Manzanilla, Director
Superfund Division (SFD-1) 

TO: Reggie Cheatham, Director
Office of Emergency Management

The purpose of this memorandum is to request your concurrence on the proposed time-critical removal action at the Cove Mesa II Mine Reclamation Erosion Site, within the Navajo Nation Indian Reservation in Arizona. The Site is situated within the Navajo Nation Chapter known as Cove in Apache County, Arizona. Redelegation of Authority in R-14-2 gives the Director of the Office of Emergency Management the authority to concur on nationally significant or precedent-setting removals¹. This removal action is estimated to cost \$3,600,000 in direct extramural expenditures² and to take more than 12 months, due to the short construction season available on the Navajo Nation. As a result, contingent upon your concurrence, I will approve the Action Memorandum, an emergency exemption from the \$2 million limit on removal actions and an exemption from the 12-month limit,³ in order to avert the ongoing exposures to unsafe levels of uranium contamination that are occurring at the Site.

Region 9 staff for the Cove Mesa II Mine Reclamation Erosion Site have discussed this proposed removal with staff for the Office of Emergency Management's Preparedness and Response Operations Division (PROD). PROD has advised that this removal is considered nationally significant or precedent setting because it is a removal of radioactive mining waste from a site located in Indian country. As has been the case with all of Region 9's uranium waste removal actions on the Navajo Nation, Region 9 has conducted extensive government to government consultation with the Navajo Nation and community involvement activities with local residents regarding the Cove Mesa II Mine Reclamation Erosion Site and the proposed removal action.

¹ See September 2009 Superfund Removal Guidance on Preparing Actions Memoranda ("2009 Guidance"), removals in Indian Country generally require OEM concurrence (see p. 45).

² "Removal Action Ceiling Costs," as defined by EPA guidance OSWER 9360.0-42 (November 5, 2001), includes only direct extramural costs. As discussed in this memorandum, additional costs may be incurred and recoverable as "incurred response costs."

³ See Regional Delegation No. 1290.03A.

The proposed Cove Mesa II Mine Reclamation Erosion removal action would address stabilizing the erosion occurring at the reclamation cell at the Site. The uranium waste rock contamination at the Site, through its erosion into the Cove Wash, the receiving water body, poses an imminent and substantial endangerment to human health and the environment because it is resulting in ongoing exposures to levels of uranium contamination that pose an unacceptable increased risk of toxic effects, including cancer.⁴ The proposed action would secure the Site, prepare the access road for safe access to equipment, stabilize the reclamation cell erosion, and construct a water diversion channel at the Site. This action is part of the larger effort to address the Navajo Abandoned Uranium Mines and the waste rock associated with these mines in the areas where these wastes have come to be located. The action is expected to occur over two construction seasons.

The Cove Mesa II Mine Reclamation Erosion Action Memorandum is attached for your review. My approval awaits your concurrence.

Concur:

Reggie Cheatham, Director
Office of Emergency Management

Date

According to the redelegation, authority to non-concur remains with the Assistant Administrator. If you choose not to concur on this action, please forward this memorandum to the Assistant Administrator.

Non-Concur:

Barry N. Breen, Acting Assistant Administrator
Office of Land and Emergency Management

Date

Attachment

cc: Gilberto Irizarry, U.S. EPA, OEM, HQ
Brian Schlieger, U.S. EPA, OEM, HQ

⁴ See Radiation Risk Assessment at CERCLA Sites Q & A, May 2014, OWSER Directive 9200.4-40, EPA 540-R-012-13



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

MEMORANDUM

DATE:

SUBJECT: Request for a Time-Critical Removal Action and for Exemption from \$2 Million and 12-Month Statutory Limits at the Cove Mesa II Mine Reclamation Site, Arizona, Navajo Nation Indian Reservation

FROM: Kenneth B. Rhame, On-Scene Coordinator
Chip Poalinelli, Remedial Project Manager
Tribal Lands Cleanup Section (SFD6-2)

THROUGH: Will C. Duncan, III, Assistant Director (SFD-6)

TO: Enrique Manzanilla, Director
Superfund Division (SFD-1)

I. PURPOSE

The purpose of this memorandum is to request and document approval to spend up to \$3,600,000 in direct extramural costs and to request an exemption from the \$2 million statutory cost limit and 12-month statutory time limit to mitigate threats to human health and the environment posed by a release into the environment of hazardous substances at the Cove Mesa II Mine Reclamation Site (the Site). The Site is located within the Navajo Nation Indian Reservation and consists of a 2.2-acre uranium waste reclamation cell which is eroding into the Cove Wash, the receiving water body. This reclamation cell is situated in Mesa II of the Lukachukai Mountains in Cove Chapter in Apache County, Arizona. Contaminants contained in the uranium waste include uranium and its progeny, radium-226, which have resulted in gamma and alpha ionizing radiation.

During the summer and fall of 2016, EPA Region 9 and EPA's START contractors completed the Mine Category Assessment Protocol (MCAP) for the prioritization of Removal Site Evaluations within the Navajo Nation in Apache County Arizona. The Mesa II Site is identified as "Mesa II, Mine No. 1 & 2, P-21", and was the second highest scoring site in the MCAP. In addition to highly elevated gamma readings at the Site (15 times the comparison level of 8,000 counts per minute [cpm]), MCAP identified that the uranium waste at the Site was highly mobile and that the reclamation work performed at the Site had become highly eroded and compromised. In addition, surface water samples collected from directly downstream of the Site contained the highest levels of uranium in the Lukachukai Mountains at 2,000 micrograms per liter (ug/L), which is more than ten times the human health screening level for primary exposure (187 ug/L).

If approved, this action memorandum will serve to document Region 9's authorization of the expenditures required for U.S. EPA to take actions described herein to address the threat of further release of hazardous substances into the environment. Residents use the Cove Wash for a variety of activities, such as wading, livestock watering, and gathering plants. The proposed stabilization of hazardous substances eroding into the Cove Wash waters would be undertaken pursuant to Section 104(a)(1) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9604(a)(1), and Section 300.415 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR § 300.415. An exemption from the \$2 million statutory limit is justifiable under criteria of Section 104(c), 42 U.S.C. § 9604(c) and 40 C.F.R. § 300.415(b)(5)(i), which allows for an exemption from the statutory requirements when: there is an immediate risk to public health or welfare or the environment; continued response actions are immediately required to prevent, limit, or mitigate an emergency; and such assistance will not otherwise be provided on a timely basis.

Conditions at the Mesa II Site meet the criteria for the emergency exemption from statutory limits, and if not addressed by implementing the immediate response action documented in this memorandum, may lead to additional human exposure to gamma and alpha ionizing radiation, radium-226 and uranium contamination.

A 12-month exemption is required due to the anticipated short construction season for 2018. Work is not expected to begin until September of 2018. Although it is anticipated that all access and stabilization construction work will be completed within 3 months (9 - 10 weeks), it is possible that the project will run into monsoon season and need to be completed in spring of 2019. Monsoon season starts in August.

Likewise, the \$2 million exemption is required due to the cost of preparing the mountainous road for adequate, safe access of heavy equipment and large haul trucks to the remote site, and for the stabilization of the eroding reclamation cell. Stabilization materials such as large rocks will need to be hauled in to the site from four hours away, which also contributes to the cost of the action.

II. SITE CONDITIONS AND BACKGROUND

Site Status: Non-NPL
Category of Removal: Time-Critical
CERCLIS ID: NNN000900374
SITE ID: A9BH

A. Site Description

1. Physical Location

The Site is located within the Navajo Nation Indian Reservation in Arizona. The Site is situated within the Navajo Nation Indian Reservation in an area known as Cove Chapter. Site Location Maps are attached (Attachments II and III).

2. Site Characteristics

Portions of the Navajo Nation are located on geologic formations rich in radioactive uranium ores. Beginning in the 1940s, widespread mining and milling of uranium ore on Navajo Nation tribal lands for national defense and energy purposes led to a legacy of uranium mine (AUM) sites. The Mesa II Site was the most prolific mine of the 42 mines within the Cove Chapter.

The Site consists of a 2.2-acre reclamation cell located between two mesas (Mesa I-1/2 and Mesa II) in the Chuska Mountains. The reclamation cell was constructed in 2001 by Navajo Nation Abandoned Mine Lands program (NNAML) to aggregate and bury waste rock resulting from uranium mining during the 1940's to 1960's. The Site also contains 6 mine adits or portals, all of which were sealed off by NNAML at the time of the reclamation effort. The rock and soil waste was capped with 1.5 feet of clean fill (Class A material), which has been steadily eroding to the point that an approximately 15-foot deep by 8-foot wide by 150-foot long erosion channel is now running through the northern end of the reclamation cell. A flow channel had been built into the eastern edge of the reclamation cell and had been meant to collect runoff and direct it to the side of the reclamation cell and straight into Cove Wash. However, water has eroded a channel outside of the designed erosion channel. The Cove Wash lies directly below the damaged reclamation cell and receives water and sediments directly from the eroding cell.

3. Removal Site Evaluation

In 2016, EPA conducted the Mine Category Assessment Protocol (MCAP), which included fieldwork at the Mesa II reclamation cell in April. The purpose of MCAP was to establish a systematic method for assessing and surveying abandoned uranium mine sites and other potential contributions of uranium material areas to determine and evaluate factors impacting future site work, and to develop ranking system for prioritizing forthcoming Removal Site Evaluations. The Mesa II Site is identified as "Mesa II, Mine No. 1 & 2, P-21", which is the second highest scoring site in the MCAP, based on the following:

- Mesa II Mines 1 & 2 P-21 was the most productive mine in the Lukachukai Mountains, producing nearly five times the volume of the second largest operation
- Large quantities of fine grained and highly mobile contaminated material are found throughout the area
- Reclamation performed at the site has become highly eroded and compromised; and
- Water and sediment samples collected from a spring originating within the waste area were found to contain the highest levels of contamination in the Lukachukai Mountains.

In order to document the radiological measurements throughout the MCAP deployment, and to delineate the extent of the contaminated areas, the field teams used Ludlum 22-41 gamma rate meters with 2" x 2" sodium-iodide scintillation detectors, linked to a Trimble GeoXTs. The gamma radiation measurements for the Mesa II erosion channel are displayed in Figure 2. The highest readings were at the bottom of the erosion channel and were highest at 121,650 counts per minute (cpm), or 15 times the Comparison Level of 8,000 cpm. It should be noted that these readings were taken at the surface of the erosion channel, and might have been even higher had they been taken at depths within the erosion channel.

From April of 2016 to April of 2017, U.S. EPA, in partnership with the Navajo Nation Environmental Protection Agency (NNEPA), investigated the extent of the Cove Wash waters and sediments. As part of the investigation, waters and sediments directly downstream of the erosion channel were sampled on three different occasions (one low-flow event in June and two Spring runoff events in April/May). On each occasion, samples were collected and sent for laboratory analysis of metals (including uranium) and radium-226/228.

Of the more than 50 sample locations within the study area, the two sample points (CW65 and CW66) directly below the eroding reclamation cell (the Site) had the highest levels of total uranium in the water, with each of the ten samples taken ranging from a low of 950 ug/L to a high of 2,000 ug/L. Total uranium concentrations of water samples upgradient of uranium mining in the area ranged from 1.5 to 180 ug/L. The human health screening level for primary exposure is 187 ug/L. The levels detected directly downstream of the eroding cell are up to more than ten times the screening level and pose a direct threat to humans who are recreating in the wash or wading through the wash as they walk their livestock up and down the mesas. See memorandum titled "Surface Water Action Level for Uranium" dated April 18, 2018, attached, for the derivation of the 187 ug/L risk number.

4. Release or threatened release into the environment of a hazardous substance, or pollutant or contaminant

Uranium Waste

Uranium mining at the Site resulted in releases of uranium and progeny, such as radium and thorium, to the environment. Uranium, radium and thorium are CERCLA hazardous substances, listed in the National Contingency Plan at Appendix B to 40 C.F.R. Section 302.4 (Radionuclides). Based on field observations and the assessment data collected, it is evident that mining waste containing hazardous substances is present at the Site and is migrating offsite. As noted above, the dissolved uranium migrating offsite is present downstream at levels more than ten times the human health screening value of 187ug/L. It is known that people in the Cove Community and their livestock frequent the Cove Wash, and that livestock drink from the Cove Wash.

5. NPL status

The Mesa II reclamation cell is not on the National Priorities List (NPL), nor is it proposed to be on the NPL. Current conditions at the Site pose an imminent and substantial endangerment (see Sections III and IV) to the surrounding community, including community members that may walk around the reclamation cell and/or use the Cove Wash for recreational or cultural purposes. The proposed Removal Action will not complete all work at the Mesa II mine waste and reclamation cell area, but is intended as an interim action that will minimize the risk of exposure until a final action is selected and implemented.

B. Other Actions to Date

No other response actions have occurred at the Site to date, since the reclamation activities performed by NNAML in 2001. In 2001, NNAML got rid of physical hazards at the site by burying waste rock under a clean fill cover, which is now eroding.

C. State and Other Authorities' Role

1. State and local actions to date

No State or Tribal actions have taken place at the Site, other than the 2001 reclamation activities performed by NNAML. Formal consultations with the Navajo Nation for a broad range of AUM-related issues have been ongoing for several years, and formal consultations for this removal action began in early 2017. NNEPA and NAML were closely involved in the planning of this removal action and will also be involved in implementation. This collaboration is part of ongoing consultation with the Navajo Nation regarding EPA's efforts to address approximately 523 uranium mine claim areas on the Navajo Nation.¹

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

Current Site conditions include ongoing releases into the environment and the threat of future releases of hazardous substances, namely: uranium and its progeny (i.e., radium-226) and ionizing gamma and alpha radiation associated with that progeny. The likelihood of direct human exposure, via ingestion and/or close proximity to the hazardous substances, and the threat of future releases and migration of those substances, pose an imminent and substantial endangerment to public health or welfare or the environment based on the factors set forth in the NCP, 40 CFR § 300.415(b)(2). These factors include:

1. Actual or potential exposure to hazardous substances or pollutants or contaminants by nearby populations or the food chain

As described in Section II.A.3, elevated levels of ionizing gamma radiation of 121,650 cpm, or 15 times the Comparison Level of 8,000 cpm, have been detected near the erosion channel, and it is known that people from the Cove community frequent the Mesa II area while herding their livestock, gathering plants, or generally engaging in recreational activities. Additionally, levels of uranium in the Cove Wash waters downstream from Mesa II (at 2,000 ug/L), also used by the community, are elevated by up to ten times reference levels (187 ug/L). These exposures pose an unacceptable excess cancer risk (see Attachment VI).

Persons exposed to excess levels of external gamma radiation in outdoor soils may also face excess cancer risk. Furthermore, elevated levels of gamma radiation in external soils, resulting from uranium mine waste contamination, are indicative of the presence of radium which poses additional health risks related to alpha ionizing radiation exposures.

Uranium is found in small amounts in most rocks and soil. It slowly breaks down to its

¹ EPA Policy on consultation and coordination with Indian Tribes, May 4, 2011. See <http://www.epa.gov/tp/pdf/cons-and-coord-with-indian-tribes-policy.pdf>

progeny including radium and radon. Radon is also a listed CERCLA hazardous substance. See Appendix B to 40 C.F.R. Section 302.4. Radium and radon enter the environment from the soil, and from uranium mines and sometimes other types of mines. Uranium occurring in a subsurface vein is brought to the surface during mining activities. Thorium is also often present in uranium ore.

One of the radioactive properties of uranium is its half-life, or the time it takes for half of the isotope to give off its radiation and change into another substance. The half-life of uranium is very long (between 200,000 years and 5 billion years). This is why uranium still exists in nature and has not all decayed away.

Radium is formed when uranium and thorium break down in the environment. Two of the main radium isotopes found in the environment are radium-226 and radium-228. During the decay process, alpha, beta, and gamma radiation are released. Radium may be found in air and water. Radium in the soil may be absorbed by plants.

Acute inhalation exposure to high levels of radium can cause adverse effects to the blood (anemia) and eyes (cataracts). It also has been shown to affect the teeth, causing an increase in broken teeth and cavities. Exposure to high levels of radium results in an increased incidence of bone, liver, and breast cancer. The BEIR V report has also stated that radium is a known human carcinogen (ATSDR, 1999). Inhalation of radium contaminated particulates is of particular concern. Radium emits alpha radiation, which, when inhaled, becomes a source of ionizing radiation in the lung and throat, possibly leading to toxic effects.

The contaminated erosion channel and resulting runoff into the Cove Wash are likely to result in human exposure via ingestion or proximal exposure to various radioactive contaminants related to uranium and its decay such as radium-226. Contamination is readily accessible to visitors onsite and to the Cove Wash. Persons occupying or traversing the Site may be exposed to contaminated dust by inhalation or ingestion of contamination sorbed to particulate matter. Uranium and radium-226 may be entrained in naturally generated dust and/or transported on shoes and clothing of residents passing over contaminated areas. Gathering of plants in the contaminated areas may also result in exposure to contamination.

Children may ingest contaminants during play activities in the Cove Wash.

2. High levels of hazardous substances in soils at or near the surface that may migrate

Uranium metal contamination from the erosion channel is migrating directly into the Cove Wash at levels up to 2,000 ug/L in the water, which then winds its way down to the Cove community. Additionally, there are high wind events in the Cove mesas, including at Mesa II where the erosion channel is, which may pick up the contaminated dust and disperse it all the way down to the community. If people are onsite during a high wind event, they may breathe in the contaminated dust and be exposed to alpha radiation as well.

3. Weather conditions that may cause hazardous substances to migrate or be

released

Rainfall events, including extreme weather such as monsoons, lead to transport of the contamination from erosion channel into the Cove Wash. In addition, contaminants may migrate during high wind events due to the propensity for contaminants to adhere to windborne dust particles.

4. Availability of other appropriate federal or state response mechanisms to respond to the release

NNEPA and NNAML have informed U.S. EPA that the Navajo Nation does not have the resources to address the Site.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of pollutants and contaminants from this site, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, or welfare, or the environment.

V. EXEMPTION FROM STATUTORY LIMITS

Based on estimating the cost of doing this removal action, EPA Region 9 is requesting authorization to incur \$3,600,000 in direct extramural cleanup costs, which is above the \$2 million statutory limit. Subject to exceptions, 42 U.S.C. § 9604(c)(1) provides that removal actions should not continue after \$2 million has been obligated for response actions or 12 months has elapsed from the date of initial on-site response. Pursuant to EPA delegations 14-2 and R9 1290.03A, the Assistant Director to the Superfund Division is authorized to determine whether an exception from these statutory limitations is warranted.

An exemption from the \$2 million statutory limit is justifiable under criteria of Section 104(c), 42 U.S.C. § 9604(c) and 40 C.F.R. § 300.415(b)(5)(i), which allows for an exemption from the statutory requirements when: there is an immediate risk to public health or welfare or the environment; continued response actions are immediately required to prevent, limit, or mitigate an emergency; and such assistance will not otherwise be provided on a timely basis.

Conditions at the Mesa II Site meet the criteria for the exemption from statutory limits, and if not addressed by implementing the immediate response action documented in this memorandum, may lead to additional human exposure to gamma and alpha ionizing radiation, radium-226 and uranium contamination.

1. There is an immediate risk to public health or welfare or the environment

Mining waste present at the Mesa II reclamation cell at levels emitting gamma radiation of up to 121,650 cpm continues to erode into the Cove Wash. Persons traversing the site or the Cove Wash water below the Site, as well as livestock traversing the Site and

drinking from the wash, are at risk of exposure to ionizing radiation. Exposure to ionizing radiation poses an increased risk of toxic effects including cancer. See Section III.1 for more information and other health risks related to exposures to these hazardous substances.

2. Continued response actions are immediately required to prevent, limit or mitigate an emergency

Based on the results of the MCAP and Cove Wash sampling, an interim time-critical action of stabilizing the erosion channel and diverting water away from the contaminated waste material in the reclamation cell will minimize exposure risks to the nearby community until a permanent action is selected and implemented. Currently, people using the Cove Wash are being exposed to ten times the reference limit for uranium.

3. Assistance will not otherwise be provided on a timely basis

NNEPA and NNAML do not have the capabilities or resources to carry out this effort in a timely manner. If U.S. EPA does not begin the proposed removal action immediately, the residents' risk of exposure to radiological contamination will continue unabated.

VI. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions

1. Proposed action description

On September 28, 2017, U.S. EPA and NNAML walked the site to assess the condition of the erosion as well as to discuss the best approach for performing an interim action at the site to fix the erosion problem.

U.S. EPA proposes to mitigate the imminent and substantial threats to human health, welfare, or the environment by taking steps to prevent the release of uranium and external gamma radiation. The removal action will include the following objectives to reduce direct human contact with external alpha and gamma radiation as well as uranium and its progeny at the Site and in the Cove Wash:

- Secure Site with fencing, signage and security as necessary;
- Develop Site Safety Plan;
- Stabilize repository containing elevated uranium waste rock, located at the Mesa II Site;
- Prepare road for adequate, safe access of heavy equipment and large haul trucks;
- Construct a water diversion channel to reduce the amount of water impacting and damaging the repository cap;
- Provide survey and as-builts;
- Put in place erosion control measures to reduce damage to roads and to reduce contaminated material from leaving the Site;
- Implement dust suppression and/or encapsulation to prevent off-site migration of dust during site activities;
- Conduct air monitoring/sampling to ensure that the dust suppression methods

and mitigation efforts are effective.

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Stabilization of the eroding reclamation cell will prevent direct exposure at the Site to ionizing radiation, and reduce the amount of contaminated material migrating into the Cove Wash. This action is a stabilization only until a permanent removal action is implemented under a non-time critical removal.

EPA anticipates a short construction season for 2018. Work is not expected to begin until September of 2018. Although it is anticipated that all access and stabilization construction work will be completed within 2.5 months (9 weeks), it is possible that the project will run into winter weather and need to be completed in spring of 2019. This would exceed the 12-month statutory limit.

The cost of preparing the mountainous road for adequate, safe access of heavy equipment and large haul trucks to the remote site, and for the stabilization of the eroding reclamation cell, will exceed \$2 million. Stabilization materials such as large rocks will also need to be hauled in to the site from four hours away.

2. Contribution to remedial performance

This removal action is being conducted in concert with future removal plans. The OSC is coordinating the work being done at this Site with the remedial project manager assigned to the Mesa II Mine Site in an effort to maximize the chance that the action will compliment future actions to address the contamination at the Site.

It is expected that this removal action will minimize exposure to the release or threat of release of hazardous substances and the public health risk associated with the activities that take place at the Site and in the Cove Wash. As discussed below, U.S. EPA expects to conduct subsequent assessments of other mine waste sites and AUMs located throughout the Navajo Nation, including in the Cove Chapter, to determine what additional response actions may be necessary.

Sources of the contamination may require long-term cleanup. In future actions, these sources may include individual Navajo AUM site cleanups. U.S. EPA will continue to coordinate with NNEPA to evaluate the risk of human health effects based on mine wastes exposure pathways that may be present at these other AUM sites.

The stabilization of the reclamation cell erosion channel will act as an interim action to reduce the risk of exposure and should reduce the threats described in Section III.

3. Applicable or relevant and appropriate requirements (ARARs)

Section 300.415(j) of the NCP provides that removal actions must attain ARARs to the extent practicable, considering the exigencies of the situation.

Section 300.5 of the NCP defines applicable requirements as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility

citing laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at a CERCLA site.

Section 300.5 of the NCP defines relevant and appropriate requirements as cleanup standards, standards of control and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility citing laws that, while not "applicable" to a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems- or situations sufficiently similar to those encountered at the CERCLA site and are well-suited to the particular site.

Because CERCLA on-site response actions do not require permitting, only substantive requirements are considered as possible ARARs. Administrative requirements such as approval of, or consultation with administrative bodies, issuance of permits, documentation, reporting, record keeping and enforcement are not ARARs for CERCLA actions confined to the site.

To date, the Navajo Nation has not identified additional ARARs.

Federal ARARs determined to be practicable for the Site are:

- U.S. Department of Transportation of Hazardous Materials Regulations 49 CFR Part 171, 172 and 173.
- Uranium Mill Tailings Radiation Control Act (40 CFR Part 192.12 subparts Band C) requirements for residential cleanup levels of tailings sands.
- Native American Graves Protection and Repatriation Act, 25 USC Section 3001 et seq. and its implementing regulations, 43 CFR Part 10.
- National Historic Preservation Act, 16 USC Section 470 et seq. and its implementing regulations, 36 CFR Part 800.
- Archeological Resources Protection Act of 1979, 16 USC Section 47000 et seq. and its implementing regulations, 43 CFR Part 7
- American Indian Religious Freedom Act, 42 USC Section 1996 et seq.

Additional Federal policy and guidance to be considered:

- U.S. EPA Directive on Protective Cleanup Levels for Radioactive Contamination at CERCLA sites. OSWER Directive 9200.4-18, December 1997.
- Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination, Aug. 22 1997, at pages 13-14. See <http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/radguide.pdf>

4. Project schedule

It is estimated that it will take approximately 90 working days to complete the temporary road improvements to provide access to the site and an additional 60 working days to stabilize the erosion channel. Permanent disposal will not be included in this action memorandum's scope of work.

B. Estimated Extramural Costs

Tronox Settlement Costs

Cleanup Contractor	\$2,450,000
RAES	\$200,000

NNEPA	\$150,000
NNAML	\$200,000

<u>Extramural Subtotal</u>	<u>\$3,000,000</u>
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Extramural Costs Contingency (20% of \$3,000,000 Subtotal)	\$600,000
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TOTAL Removal Action Extramural Direct Cost Project Ceiling **\$3,600,000**

VII. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Given the Site conditions, the nature of the hazardous substances documented on-site, and the potential exposure pathways to nearby populations described in Sections III and IV above, actual or threatened releases of hazardous substances into the environment from the Site, if not addressed by implementing the response actions selected in this Action Memorandum, may present an imminent and substantial endangerment to public health or welfare or the environment.

VIII. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues with respect to the Site that have been identified at this time.

IX. ENFORCEMENT

This removal action is being funded with Tronox settlement special account funding.

Estimated EPA costs for this Removal Action

U.S. EPA Direct Costs ²	\$3,800,000
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² Direct costs include direct extramural costs and direct intramural costs. Indirect costs are calculated based on an estimated indirect cost rate expressed as a percentage of site-specific direct costs, consistent with the full cost accounting methodology effective October 2, 2000. These estimates do not include pre-judgment interest, do not take into account other enforcement costs, including Department of Justice costs, and may be adjusted during the course of a removal action. The estimates are for illustrative purposes only and their use is not intended to create any rights for responsible parties. Neither the lack of a total cost estimate nor deviation of actual costs from this estimate will affect the United States' right to cost recovery.

(Direct Extramural [\$3,600,000] + Direct Intramural [\$200,000])

U.S. EPA Indirect Costs \$2,149,200
(59.7% of Spending: \$3,600,000)

TOTAL \$5,949,200

The total U.S. EPA extramural and intramural costs for this removal action, based on full-cost accounting practices that would otherwise be eligible for cost recovery are estimated to be \$5,949,200; however, this amount has already been recovered in the Tronox bankruptcy litigation and funds from the resulting special accounts will be used.

X. U.S. EPA RECOMMENDATION

This decision document represents the selected removal action for the Cove Mesa II Mine Reclamation Site, Cove Chapter, Apache County, Arizona, developed in accordance with CERCLA and not inconsistent with the NCP. This decision is based on the Administrative Record for the Site.

Because conditions at the Site meet the NCP Section 300.415(b) criteria for a removal and the CERCLA Section 104(c) emergency exemption from the \$2 million and 12-month statutory limitations, EPA enforcement staff recommends the approval of the removal action proposed in this Action Memorandum. The total project ceiling if approved will be \$3,600,000, which will come from the Tronox special account, SSID A9BH. Approval may be indicated by signing below.

Approve:

Enrique Mazanilla, Director
Superfund Division

Date

Disapprove:

Enrique Mazanilla, Director
Superfund Division

Date

Attachments:

- I. Index to the Administrative Record
- II. Site Location Map 1 – Cove Watershed and Mesa II Mine
- III. Site Location Map 2 – Cove Mesa II Erosion Features
- IV. MCAP Report Mesa II Priority Ranking
- V. Cove Wash Watershed Assessment Uranium Map
- VI. Surface Water Action Level Memorandum
- VII. ATSDR Radium Factsheet

cc: Stephanie Wenning, U.S. EPA, OEM, HQ
Dr. Donald Benn, Navajo Nation Environmental Protection Agency
Harrison Karr, Navajo Nation Department of Justice
Steven Spencer, U.S. Department of Interior
Ron Maldonado, Navajo Nation Historic Preservation Department

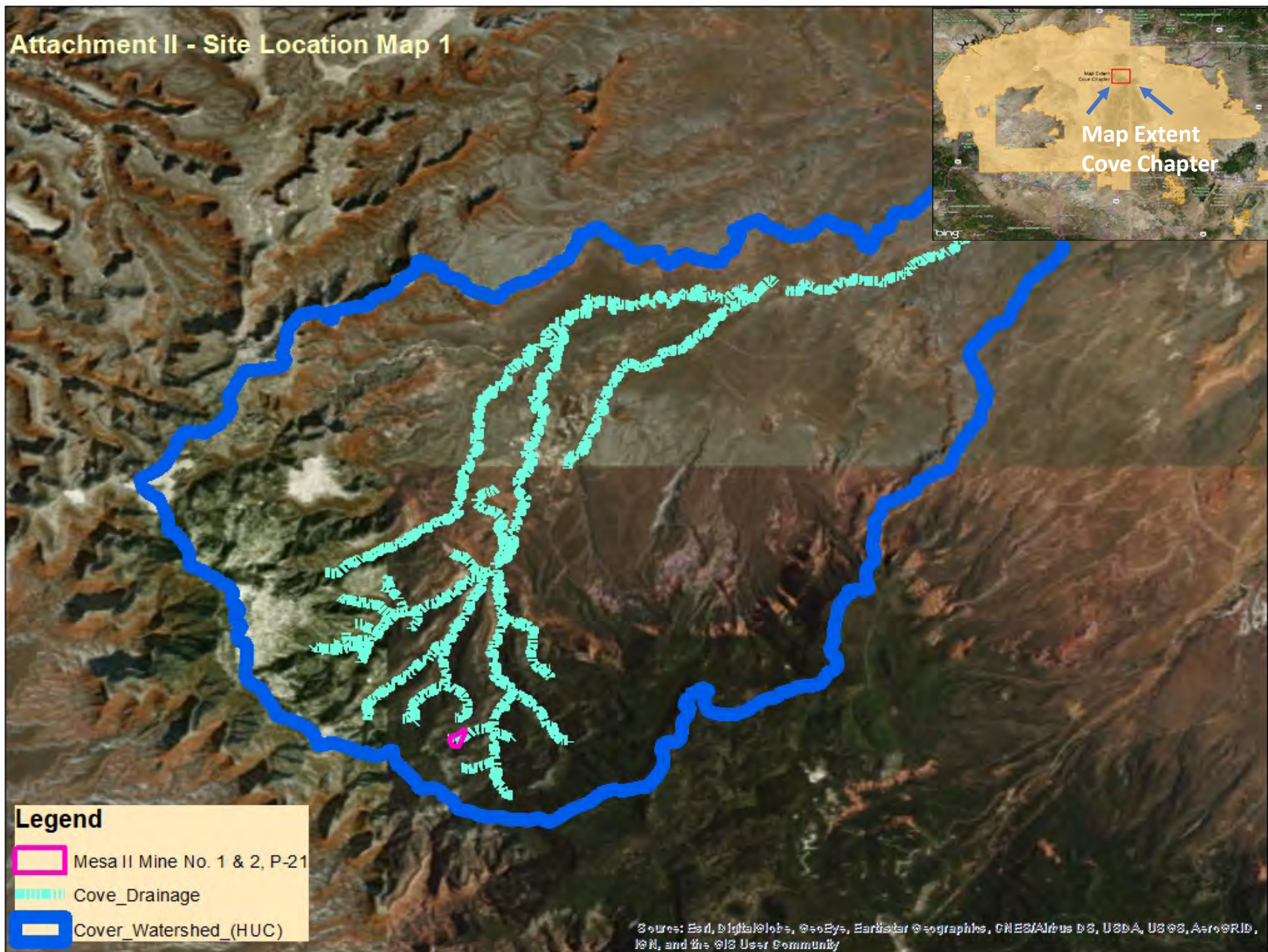
bcc: H. Allen, SFD-9-2
W. Duncan, SFD-6-2
L. Williams, ORC-3
G. Glickfield, SFD-6-2
C. Temple, SFD-9-2 Site File

ATTACHMENT I
INDEX TO THE ADMINISTRATIVE RECORD

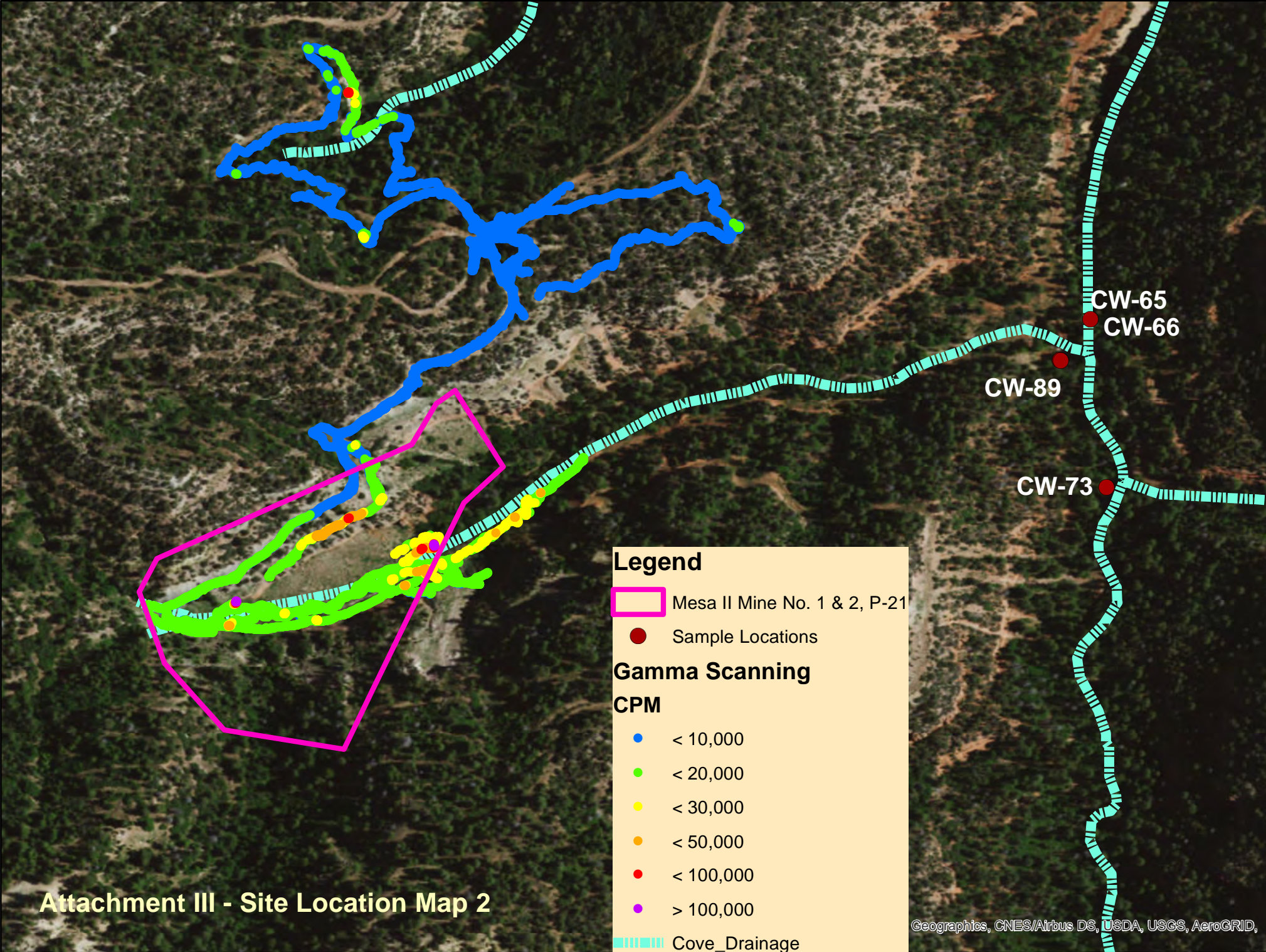
1. Site Location Map 1 – Cove Watershed and Mesa II Mine (Attachment II)
2. Site Location Map 2 – Cove Mesa II Erosion Features (Attachment III)
3. MCAP Report Mesa II Priority Ranking (Attachment IV)
4. Cove Wash Watershed Assessment Report Uranium Map (Attachment V)
5. Serda, Sophia. “Memorandum to Gaelle Glickfield Subject: Surface Water Action Level for Uranium.” April 2018. (Attachment VI)
6. Agency for Toxic Substances and Disease Registry (ATSDR) ToxFAQs, Radium CAS#7440-14-4. ATSDR. July 1999. <https://www.atsdr.cdc.gov/toxfaqs/tfacts144.pdf> (Attachment VII)

ATTACHMENT II – Site Location Map 1

Attachment II - Site Location Map 1



ATTACHMENT III – Site Location Map 2



ATTACHMENT IV – MCAP Report Mesa II Priority Ranking

While each of the target sites was assigned individual priority ranking score values, it may be appropriate for future Removal Site Evaluations to encompass multiple target sites geographically clustered in close proximity. The targets determined in need of further evaluation have been grouped into 17 “Removal Site Evaluation Priority Groups”, as shown on **Figures 7 and 8**. The RSE groups were ranked into four categories, based on the highest individual target site value within each group. Evaluation recommendations are based on the RSE groups, rather than individual Target Sites. The RSE groups and associated target sites are listed on **Table 5**, and shown on the figures indexed on **Table 5**.

Priority Removal Site Evaluation Groups

Five of the 17 Assessment Areas were determined to achieve the maximum priority ranking, these areas include the following:

M5 South – **Figures 19A, 19B and 19C** show the proposed M5 South RSE Group

- An un-reclaimed open adit was observed at AUM 103, which poses a potential and significant physical hazard. More than a mile of underground mine workings were once operational at the site, and it is current extent of the underground chambers is unknown. Cattle were observed entering the portal, so it appears the underground tunnel networks is still at least partially intact
- Waste below the adit, as well as throughout other Mesa V area AUMs, was characterized by fine grain soils, which are likely to be highly mobile.
- Observed contamination has been documented in the surface water pathway drainages downstream from Mesa V



M2 South – **Figures 13A, 13B and 13C** show the proposed M2 South RSE Group

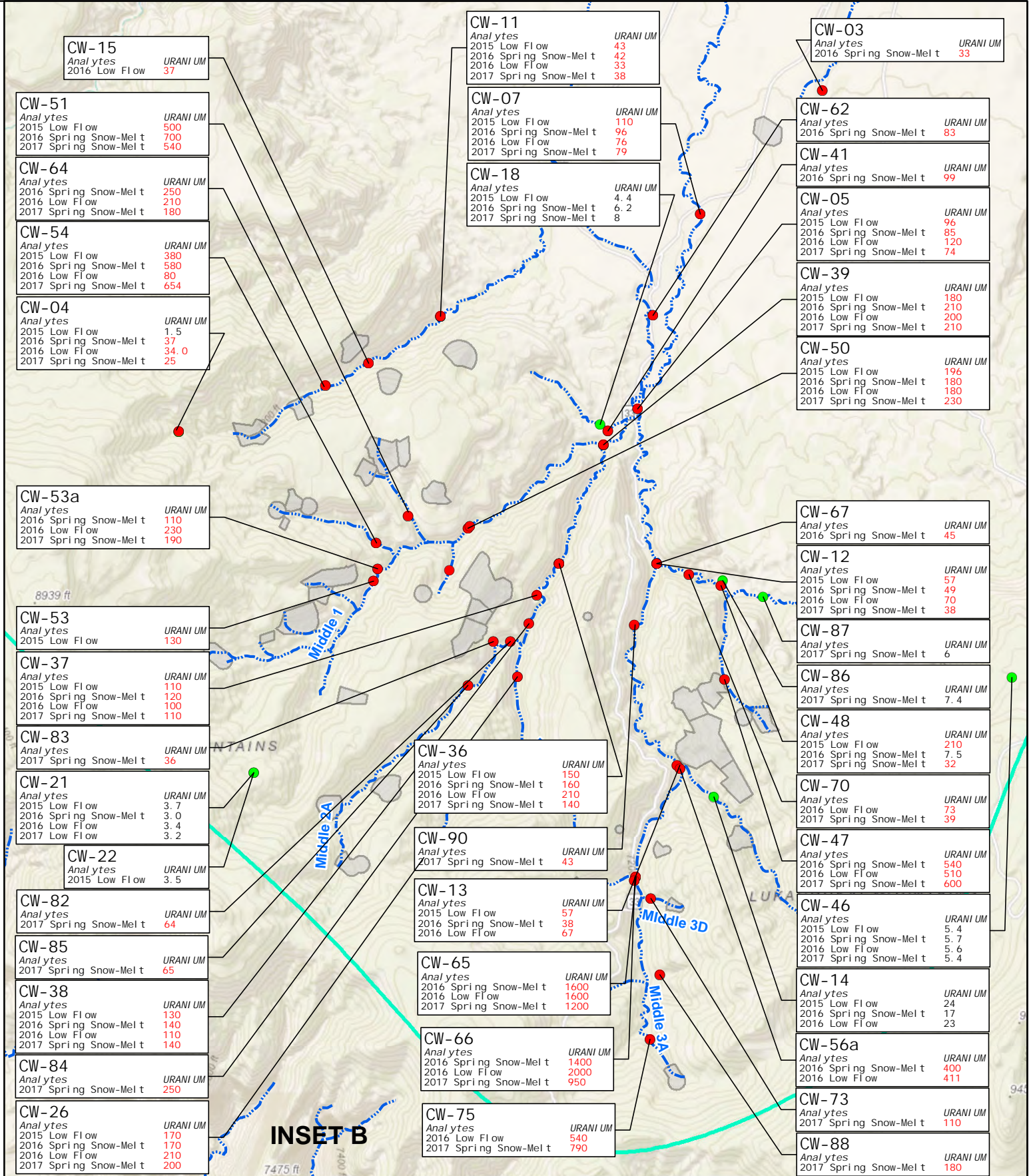
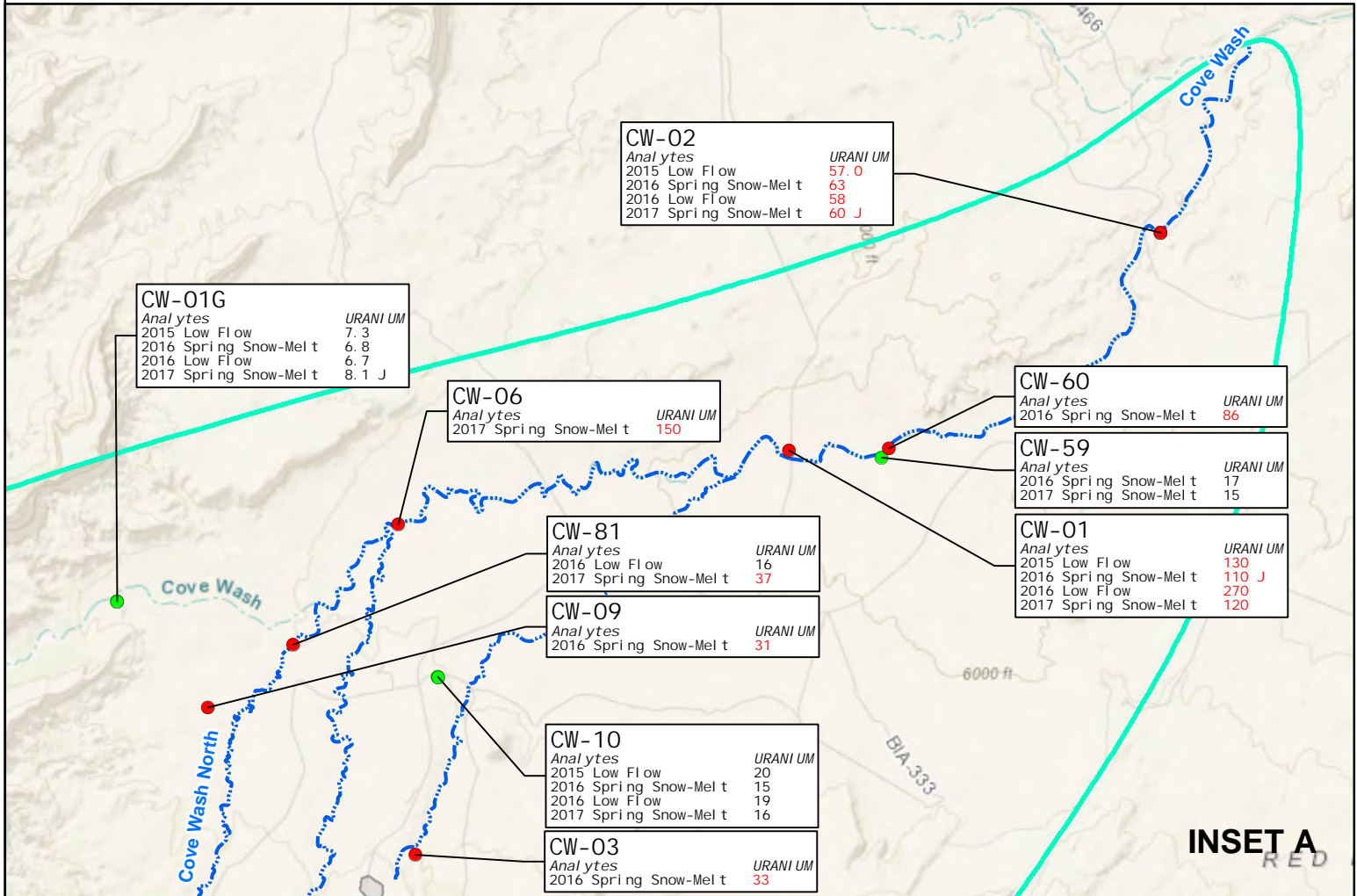
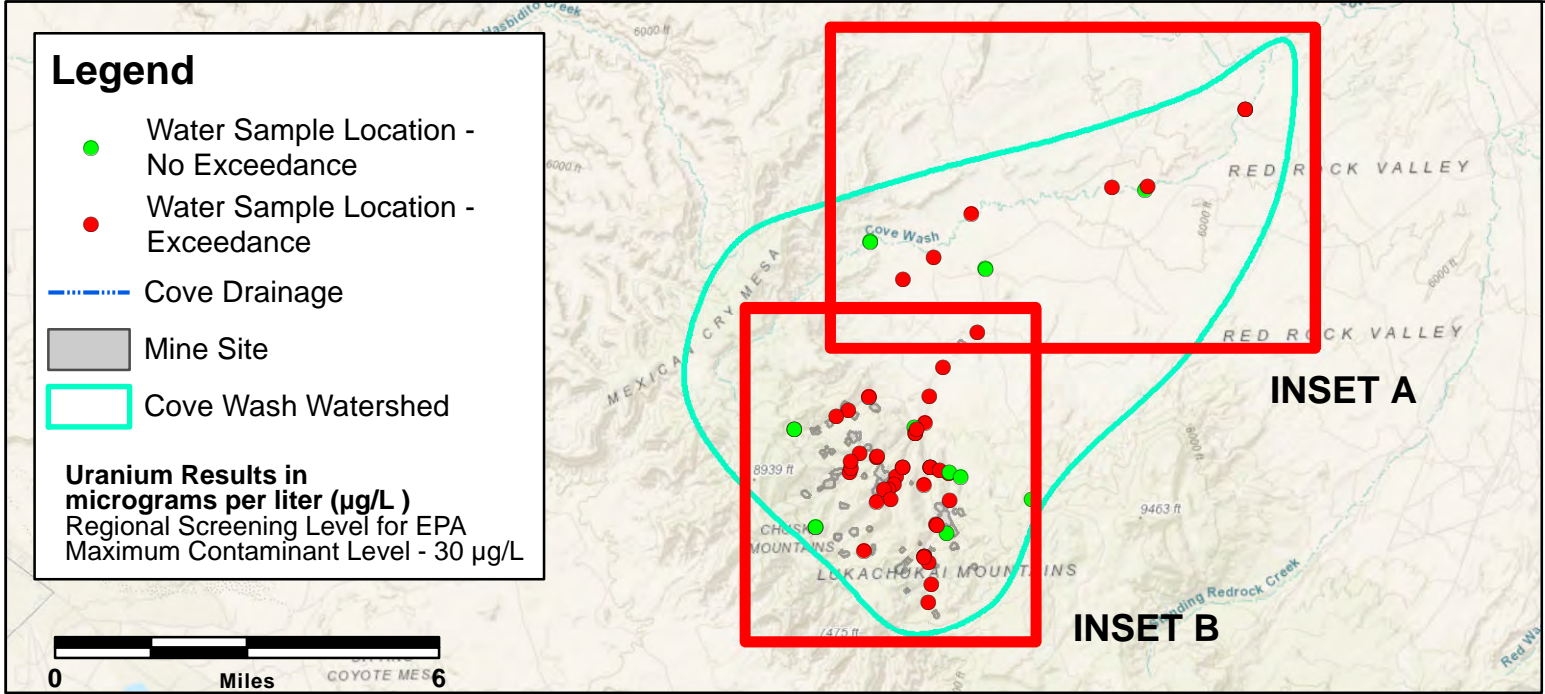
- Mesa II Mines 1 & 2 P-21 was the most productive mine in the Lukachukai Mountains, producing nearly five times the volume of the second largest operation
- Large quantities of fine grained and highly mobile contaminated material is found throughout the area
- Reclamation performed at the site has become highly eroded and compromised
- Water and sediment samples collected from a spring originating within the waste area were found to contain the highest levels of contamination in the Lukachukai Mountains.



Table 4. MCAP Target Site Priority Ranking

Target Site	Site ID	AUM/Non-AUM	Tronox Status	Range	Removal Site Evaluation Group	Physical Hazard		Impacted Area		Material Characteristics		Migration to Surface Water		Residential Exposure		Public Exposure		Accessibilty		Reclamation Status		Total Score
						Rationale	Score	Acres	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	
Mesa V Mine	103	AUM	Tronox	Lukachukai	M5 South	Open Adit	10	3.43	10	Fine (~1.3 acres) to Large	10	Elevated in Drainage	8	None	0	Pinon gathering	10	Jeep Road	8	Additional Reclamation Needed	8	64
Mesa II, Mine No. 1 & 2, P-21	601	AUM	Tronox	Lukachukai	M2 South	Major Erosion Channel	10	4.54	10	Fine (~1.7 acres) to Large	10	Seep/Spring in Waste Area	10	Unoccupied < 1 mi	2	Accessible, visitation rare	5	Offroad Trail	6	Additional Reclamation Needed	8	61
Mesa V Adit	609	AUM	Tronox	Lukachukai	M5 South	None	0	6.95	10	Fine (~3 acres) to Large	10	Elevated in Drainage	8	None	0	Pinon gathering	10	Jeep Road	8	Additional Reclamation Needed	8	54
Mesa I Mine 12	655	AUM	Tronox	Lukachukai	M1 North	None	0	15.84	10	Fine (~1.3 acres) to Large	10	Elevated in Stream	8	None	0	Near frequented road	8	Jeep Road	8	Additional Reclamation Needed	8	52
BR-01	N/A	Non-AUM	Attributable to Other Tronox	NW Carrizo	Brodie	None	0	1.86	8	Medium to Large	4	Drainage > 0.25 mi	2	Occupied < 0.25 mi	10	Near occupied residence	10	Paved Road	10	Unrelaimed Non-AUM	6	50
Mesa II 1/2, Mine 4	604	AUM	Tronox	Lukachukai	M3	None	0	1.92	8	Fine (~0.2 acres) to Large	6	Elevated in Drainage	8	Unoccupied < 0.25 mi	6	Sheep camp	8	Offroad Trail	6	Additional Reclamation Needed	8	50
CT-02	N/A	Non-AUM	Within 1/4 Mile	Lukachukai	Cove	None	0	0.02	4	Medium to Large	4	Drainage < 0.25 mi	4	Occupied < 0.25 mi	10	Within Cove	10	Paved Road	10	Unrelaimed Non-AUM	6	48
Mesa III Mine	605	AUM	Tronox	Lukachukai	M3	None	0	0.56	6	Medium to Large	4	Seep at Adit	10	Unoccupied < 0.25 mi	6	Sheep camp	8	Offroad Trail	6	Additional Reclamation Needed	8	48
Mesa III, Northwest Mine	424	AUM	Within 1/4 Mile	Lukachukai	M3	None	0	0.55	6	Medium to Large	4	Drainage < 200 ft	6	Unoccupied < 0.25 mi	6	Sheep camp	8	Jeep Road	8	Unreclaimed	10	48
Mesa III, West Mine	417	AUM	Within 1/4 Mile	Lukachukai	M3	None	0	0.78	6	Medium to Large	4	Drainage < 200 ft	6	Unoccupied < 0.25 mi	6	Sheep camp	8	Jeep Road	8	Unreclaimed	10	48
Frank Jr. Mine	421	AUM	Tronox	Lukachukai	M5 North	None	0	4.89	10	Medium to Large	4	Elevated in Drainage	8	Unoccupied < 1 mi	2	Pinon gathering	10	Offroad Trail	6	Additional Reclamation Needed	8	48
South Portal, Frank No. 1 Mine	106	AUM	Within 1/2 Mile	Lukachukai	M4 West	None	0	13.51	10	Fine (~0.8 acres) to Large	6	Elevated in Drainage	8	Unoccupied < 1 mi	2	Accessible, visitation rare	5	Jeep Road	8	Additional Reclamation Needed	8	47
Mesa I Mine 11	93	AUM	Tronox	Lukachukai	M1 North	None	0	4.42	10	Medium to Large	4	Elevated in Drainage	8	None	0	Near frequented road	8	Jeep Road	8	Additional Reclamation Needed	8	46
Mesa I Mine 13	94	AUM	Tronox	Lukachukai	M1 North	None	0	4.55	10	Medium to Large	4	Elevated in Drainage	8	None	0	Near frequented road	8	Jeep Road	8	Additional Reclamation Needed	8	46
Mesa I Mine 14	656	AUM	Tronox	Lukachukai	M1 North	None	0	9.89	10	Medium to Large	4	Elevated in Drainage	8	None	0	Near frequented road	8	Jeep Road	8	Additional Reclamation Needed	8	46
Mesa I Mine 15	657	AUM	Tronox	Lukachukai	M1 North	None	0	7.71	10	Medium to Large	4	Elevated in Drainage	8	None	0	Near frequented road	8	Jeep Road	8	Additional Reclamation Needed	8	46
Cato No. 1 Pit	426	AUM	Within 1/4 Mile	Lukachukai	M5 North	None	0	3.66	10	Medium to Large	4	Drainage < 0.25 mi	4	Unoccupied < 1 mi	2	Pinon gathering	10	Jeep Road	8	Additional Reclamation Needed	8	46
Mesa IV, Mine No. 2	607	AUM	Tronox	Lukachukai	M4 North	None	0	11.37	10	Fine (~0.2 acres) to Large	6	Elevated in Drainage	8	None	0	Accessible, visitation rare	5	Jeep Road	8	Additional Reclamation Needed	8	45
BR-02	N/A	Non-AUM	Attributable to Other Tronox	NW Carrizo	Brodie	None	0	0.13	4	Medium to Large	4	Drainage < 0.25 mi	4	Occupied < 0.5 mi	8	Near occupied residence	10	Offroad Trail	6	Additional Reclamation Needed	8	44
Mesa V Incline	610	AUM	Tronox	Lukachukai	M5 South	None	0	1.08	8	Medium to Large	4	Drainage < 200 ft	6	None	0	Pinon gathering	10	Jeep Road	8	Additional Reclamation Needed	8	44
NA-0318	99	AUM	Within 1/4 Mile	Lukachukai	M5 South	None	0	4.09	10	Medium to Large	4	Drainage < 0.25 mi	4	None	0	Pinon gathering	10	Jeep Road	8	Additional Reclamation Needed	8	44

ATTACHMENT V – Cove Wash Watershed Assessment Report Uranium Map



ATTACHMENT VI – Surface Water Action Level Memo



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, CA 94105

April 18, 2018

MEMORANDUM

SUBJECT: Surface Water Action Level for Uranium

FROM: Sophia M. Serda, PhD
Toxicologist
USEPA, Region 9

TO: Gaelle Glickfield
Cove Remedial Project Manager
USEPA, Region 9

This memo is in response to your request for documentation of a surface water action level for uranium using the new uranium noncancer chemical toxicity information supported by EPA's Office of Land and Emergency Management (OLEM) December 21, 2016 memo, and the Arizona surface water quality standard methodology (2008).

A surface water action level for uranium was determined to be 187 ug/L.

Below is a summary of the action level calculations and the assumptions used in the derivation.

Please feel free to contact me at 415.972.3057 or serda.sophia@epa.gov if I can be of further assistance.

Surface Water Action Level for Uranium

The mission of the US EPA Superfund program is to protect human health, and the environment consistent with the Comprehensive Environmental Response Compensation and Liability Act (CERLA). OLEM has issued guidance to select toxicity values for risk assessment (U.S.EPA 2003). OLEM has issued guidance supporting the use of the ATSDR Minimal Risk Level (MRL) for soluble uranium compounds in lieu of the IRIS Reference Dose (RfD) (U.S.EPA 2016) and recently incorporated the ATSDR MRL into the Regional Screening levels.

Background

EPA's existing IRIS evaluation of uranium dates from 1989 and includes an oral RfD of 0.003 mg U/kg-day based on kidney toxicity and body weight loss. A considerable amount of literature on uranium toxicology has since been published. ATSDR developed a comprehensive toxicological profile for uranium (2013) which provides an oral MRL of 0.0002 mg U/kg-day. The ATSDR value is also based on kidney toxicity.

Timeline of Events:

- 1989: US EPA's IRIS publishes a chronic RfD for soluble salts of uranium; (Maynard and Hodge 1949 critical study) Toxicity value 0.003 mg U/kg-day
- 2000: U.S.EPA's Office of water (OW) issues a Maximum Contaminant Level (MCL) for uranium; (Gilman et al 1998 critical study) Toxicity value 0.0006 mg U/kg-day
- 2002: U.S. EPA's NCEA which manages IRIS, conducts a literature review for uranium and acknowledges that new data from Gilman et al (1998) would impact the uranium RfD
- 2013: ATSDR publishes a MRL for uranium; (Gilman et al 1998 critical study) Toxicity value 0.0002 mg U/kg-day
- 2016: U.S EPA's OLEM supports the use of the ATSDR MRL in lieu of the IRIS RfD
- 2017: U.S. EPA incorporates the ATSDR MRL into the Regional screening levels

This memo derives a surface water action level for uranium chemical toxicity. This site-specific action level for uranium uses 1) the best science available - the ATSDR Intermediate MRL toxicity value of 0.0002 mg Uranium/kg-day and 2) the Arizona surface water quality standard methodology.

Uranium Surface Water Action Level Calculation

Arizona Administrative Register / Secretary of State Notices of Final Rulemaking

Pollutant	Existing FBC Criterion (µg/L)	Adopted FBC Criterion (µg/L)	Reason for Change
Styrene	280,000	186,667	The standard was calculated using FBC method for non-carcinogens (Rfd = 2.00E-01), revised FBC water ingestion rate of 15 ml/day, and RSC = 20%.
Uranium	NNS	2,800	The standard was calculated using FBC method for non-carcinogens (Rfd = 3.00E-03), revised FBC water ingestion rate of 15 ml/day, and RSC = 20%.

Methodologies for Deriving Criteria for the Partial Body Contact Designated Use

The Department derived numeric water quality criteria for the partial body contact (PBC) designated use using the following equation:

$$\frac{\text{Rfd} * \text{RSC} * 70 \text{ kg}}{15 \text{ ml/day}}$$

In this equation, RfD is the reference dose, RSC is the relative source contribution factor, 70 kg is the average weight of a human in kilograms and the 15 ml is the incidental water ingestion rate. Note the equation is the same equation used to derive numeric criteria for noncancer chemical toxicity for the full body contact designated use.

The Cove action level for uranium chemical toxicity in surface water is estimated by using the ATSDR Minimal Risk Level for Uranium, as supported by OLEM 2016 and, methodology used by the State of Arizona to develop surface water standards (RSC=20%).

1st Step: Methodology (RfD * RSC * 70 kg / 0.015 L/day)

2nd Step: Calculation (0.0002 mg U/kg-day * 0.20*70kg/ 0.015 L/day) * 1000 ug/mg

References

Arizona Administrative Register Final Rulemaking 2008. *Chapter 11 Department of Environmental Quality Water Quality Standards Volume 14 Issue 52*. December 26.

U.S. Environmental Protection Agency. 2000. National Primary Drinking Water Regulations; Radionuclides; Final

U.S. Environmental Protection Agency. 2002. Screening-Level Literature Review for Uranium, Soluble Salts. National Center for Environmental Assessment, Washington, D.C. September. EPA (literature search for soluble uranium)

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U.S. Environmental Protection Agency. 2016. *Considering a Noncancer Oral Reference dose for uranium for Superfund Human Health Risk*; OSWER Directive SEMS Doc ID 11-196808. Memorandum from Dana Stalcup. Office of Superfund Remediation and Technology Innovation, Office of Solid Waste and Emergency Response, Washington, DC. December 21.

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Maynard, E.A. and H.C. Hodge. 1949. Studies of the toxicity of various uranium compounds when fed to experimental animals. In: *The Pharmacology and Toxicology of Uranium Compounds*. Nations Nuclear Energy Service. Division VJ, Vol.1, C. Voegtlin, and H.C. Hodge, Eds. McGraw Hill, New York, NY. p. 309-376.

ATTACHMENT VII – Radium ToxFAQs

This fact sheet answers the most frequently asked health questions (FAQs) about radium. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Radium is a radioactive substance formed from the breakdown of uranium and thorium. Exposure to high levels results in an increased risk of bone, liver, and breast cancer. This chemical has been found in at least 18 of the 1,177 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is radium?

(Pronounced rā'dē-əm)

Radium is a naturally occurring silvery-white radioactive metal that can exist in several forms called isotopes. Radium is formed when uranium and thorium break down in the environment. Uranium and thorium are found in small amounts in most rocks and soil. Two of the main radium isotopes found in the environment are radium-226 and radium-228.

Radium undergoes radioactive decay. It divides into two parts—one part is called radiation and the other part is called a daughter. The daughter, like radium, is not stable, and it also divides into radiation and another daughter. The dividing of daughters continues until a stable, nonradioactive daughter is formed. During the decay process, alpha, beta, and gamma radiation are released. Alpha particles can travel only a short distance and cannot travel through your skin. Beta particles can penetrate through your skin, but they cannot go all the way through your body. Gamma radiation can go all the way through your body.

Radium has been used as a radiation source for treating cancer, in radiography of metals, and combined with other

metals as a neutron source for research and radiation instrument calibration. Until the 1960s, radium was a component of the luminous paints used for watch and clock dials, instrument panels in airplanes, military instruments, and compasses.

What happens to radium when it enters the environment?

- ☐ Radium is constantly being produced by the radioactive decay of uranium and thorium.
- ☐ Radium is present at very low levels in rocks and soil and may strongly attach to those materials.
- ☐ Radium may also be found in air.
- ☐ High concentrations are found in water in some areas of the country.
- ☐ Uranium mining results in higher levels of radium in water near uranium mines.
- ☐ Radium in the soil may be absorbed by plants.
- ☐ It may concentrate in fish and other aquatic organisms.

How might I be exposed to radium?

- ☐ Everyone is exposed to low levels of radium in the air, water, and food.

ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>

- ☐ Higher levels may be found in the air near industries that burn coal or other fuels.
- ☐ It may be found at higher levels in drinking water from wells.
- ☐ Miners, particularly miners of uranium and hard rock, are exposed to higher levels of radium.
- ☐ It may also be found at radioactive waste disposal sites.

How can radium affect my health?

Radium has been shown to cause effects on the blood (anemia) and eyes (cataracts). It also has been shown to affect the teeth, causing an increase in broken teeth and cavities. Patients who were injected with radium in Germany, from 1946 to 1950, for the treatment of certain diseases including tuberculosis were significantly shorter as adults than people who were not treated.

How likely is radium to cause cancer?

Exposure to high levels of radium results in an increased incidence of bone, liver, and breast cancer. The EPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation, has stated that radium is a known human carcinogen.

Is there a medical test to show whether I've been exposed to radium?

Urine tests can determine if you have been exposed to radium. Another test measures the amount of radon (a breakdown product of radium) in exhaled air. Both types of tests require special equipment and cannot be done in a doctor's office. These tests cannot tell how much radium you were exposed to, nor can they be used to predict whether you will develop harmful health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a drinking water limit of 5 picocuries per liter (5 pCi/L) for radium-226 and radium-228 (combined).

The EPA has set a soil concentration limit for radium-226 in uranium and thorium mill tailings of 5 picocuries per gram (5 pCi/g) in the first 15 centimeters of soil and 15 pCi/g in deeper soil.

The federal recommendations have been updated as of July 1999.

Glossary

Anemia: A decreased ability of the blood to transport oxygen.

Carcinogen: A substance that can cause cancer.

CAS: Chemical Abstracts Service.

National Priorities List: A list of the nation's worst hazardous waste sites.

Picocurie (pCi): A unit used to measure the quantity of radioactive material.

rem: A unit used to measure radiation dose.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological profile for radium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html> ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

