

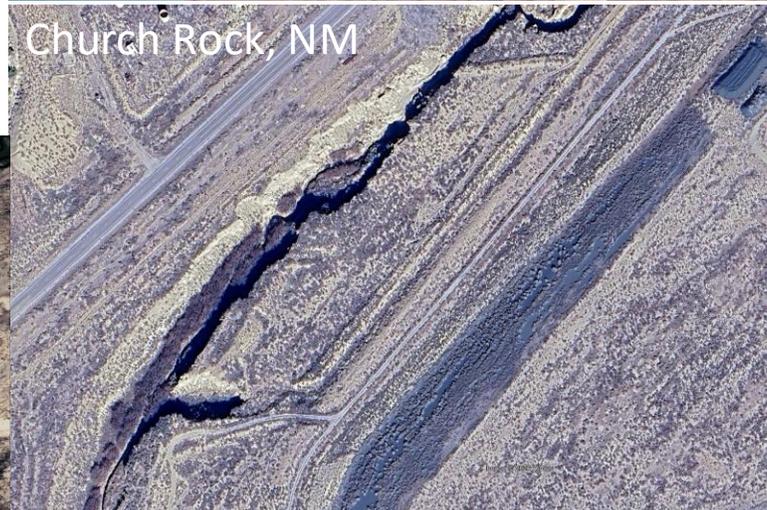
Environmental: Post-Closure: Uncertain, Unsettled and Underestimated

Evaluating Post-Closure Care
and Maintenance at Uranium
Mill Tailings Facilities in the
Western U.S.



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Abstract

Evaluating Post-Closure Care and Maintenance at Uranium Mill Tailings Facilities in the Western U.S. T. Braun; SRK Consulting (U.S.), Inc., Denver, CO Title II of the Uranium Mill Tailings Radiation Control Act of 1978 addressed siting, design, operations, decommissioning and long-term surveillance and control of tailings produced at conventional uranium milling operations licensed in 1978 or later. Appendix A to 10 CFR Part 40 defines technical, financial and long-term site surveillance criteria. Given the radiological hazard associated with uranium mill tailings, the criteria include reasonable assurance of effective engineering control for **1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years**. The U.S. Nuclear Regulatory Commission (NRC) has federal licensing authority for uranium tailings operations and closure. The NRC granted licensing authority to five Agreement States (Colorado, Texas, Utah, Washington and Wyoming). This presentation surveys post-closure care and maintenance activities at sites approaching or under long-term surveillance.

History



Atomic Energy Act of 1946
Atomic Energy Act of 1954



Energy Reorganization Act of 1974

**Uranium Mill Tailings Radiation
Control Act of 1978**

10 CFR Part 40, [Appendix A](#)

Uranium Mill Tailings Radiation Control Act of 1978

Title II of the Uranium Mill Tailings Radiation Control Act of 1978 **addressed siting, design, operations, decommissioning and long-term surveillance and control** of tailings produced at conventional uranium milling operations licensed in 1978 or later. Appendix A to 10 CFR Part 40 defines technical, financial and long-term site surveillance criteria. Given the radiological hazard associated with uranium mill tailings, the criteria include **reasonable assurance of effective engineering control for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years**. The U.S. Nuclear Regulatory Commission (NRC) has federal licensing authority for uranium tailings operations and closure. The NRC granted licensing authority to five Agreement States (Colorado, Texas, Utah, Washington and Wyoming). There are 20 Title II facilities in decommissioning, including 15 under the authority of Agreement States. Six additional Title II facilities are fully decommissioned and transferred to the U.S. Department of Energy for long-term monitoring.

APPENDIX A TO PART 40 – CRITERIA RELATING TO THE OPERATION OF URANIUM MILLS AND THE DISPOSITION OF TAILINGS OR WASTES PRODUCED BY THE EXTRACTION OR CONCENTRATION OF SOURCE MATERIAL FROM ORES PROCESSED PRIMARILY FOR THEIR SOURCE MATERIAL CONTENT

Criterion	
1	Siting that favors permanent isolation
2	Consolidation over proliferation of mine waste
3	Below grade placement if feasible
4	Upstream rainfall catchment areas minimized , embankment slopes no steeper than about 5H:1V , avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient; incorporate features which will promote deposition
5	Groundwater protection

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Criterion	
6	Place an earthen cover (or approved alternative) over tailings or wastes at the end of milling operations; provides reasonable assurance of control of radiological hazards to (i) be effective for 1,000 years , to the extent reasonably achievable, and, in any case, for at least 200 years
12	Final disposition of tailings, residual radioactive material, or wastes at milling sites should be such that ongoing active maintenance is not necessary to preserve isolation

25 UMTRCA Disposal Sites Under Long-Term Federal Management in the US

Site Name	State	Title	Site Name	State	Title
Tuba City	AZ	I	Cannonsburg	PA	I
Durango	CO	I	Falls City	TX	I
Gunnison	CO	I	Mexican Hat	UT	I
Rifle	CO	I	Green River	UT	I
Slick Rock	CO	I	Salt Lake City	UT	I
Grand Junction	CO	I	Spook	WY	I
Maybell	CO	I	Maybell West	CO	II
Naturita	CO	I	Bluewater	NM	II
Lowman	ID	I	L-Bar	NM	II
Shiprock	NM	I	Edgemont	SD	II
Ambrosia Lake	NM	I	Sherwood	WA	II
Lakeview	OR	I	Shirley Basin South	WY	II
Burrell	PA	I			

[Table A-1](#)

24 UMTRCA Sites **Not Yet** Under Long-Term Federal Management in the US

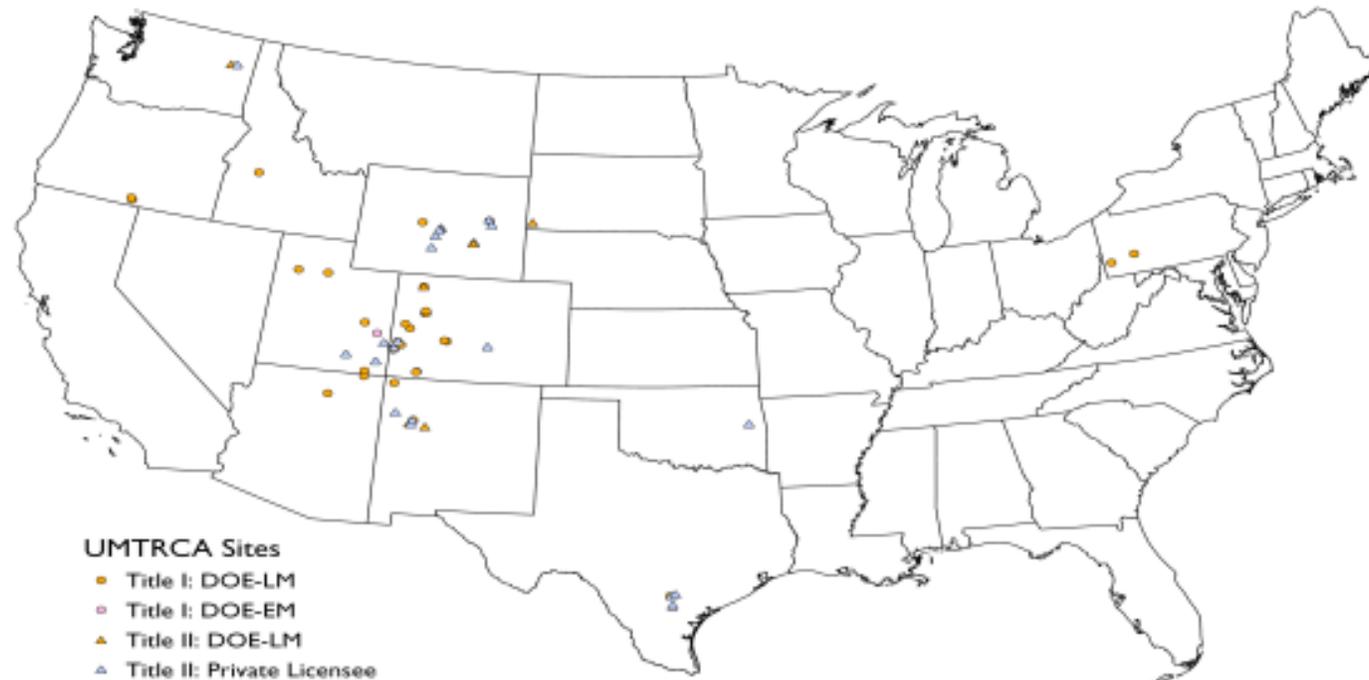
Site Name	State	Title	Site Name	State	Title
Ambrosia Lake-West	NM	II	Lisbon Valley	UT	II
Church Rock	NM	II	White Mesa	UT	II
Grants-Homestake	NM	II	Ford	WA	II
Sequoyah Fuels	OK	II	Bear Creek	WY	II
Gas Hills-West	WY	II	Lucky MC	WY	II
Uravan	CO	II	Gas Hills-East	WY	II
Durita	CO	II	Split Rock	WY	II
Canyon City	CO	II	Highland	WY	II
Panna Maria	TX	II	Shirley Basin (North)	WY	II
Ray Point	TX	II	Sweetwater	WY	II
Conquista	TX	II	Lisbon Valley	UT	II
Intercontinental Energy Corporation	TX	II	White Mesa	UT	II
Shootaring Canyon	UT	II			

[Table A-2](#)

Long-Term Surveillance Plans

- Post-closure inspections and reporting
- Contractors/Agency representatives
- Physical condition and groundwater conditions

Location of UMTRCA Sites



[Figure 3](#)

Spotlight

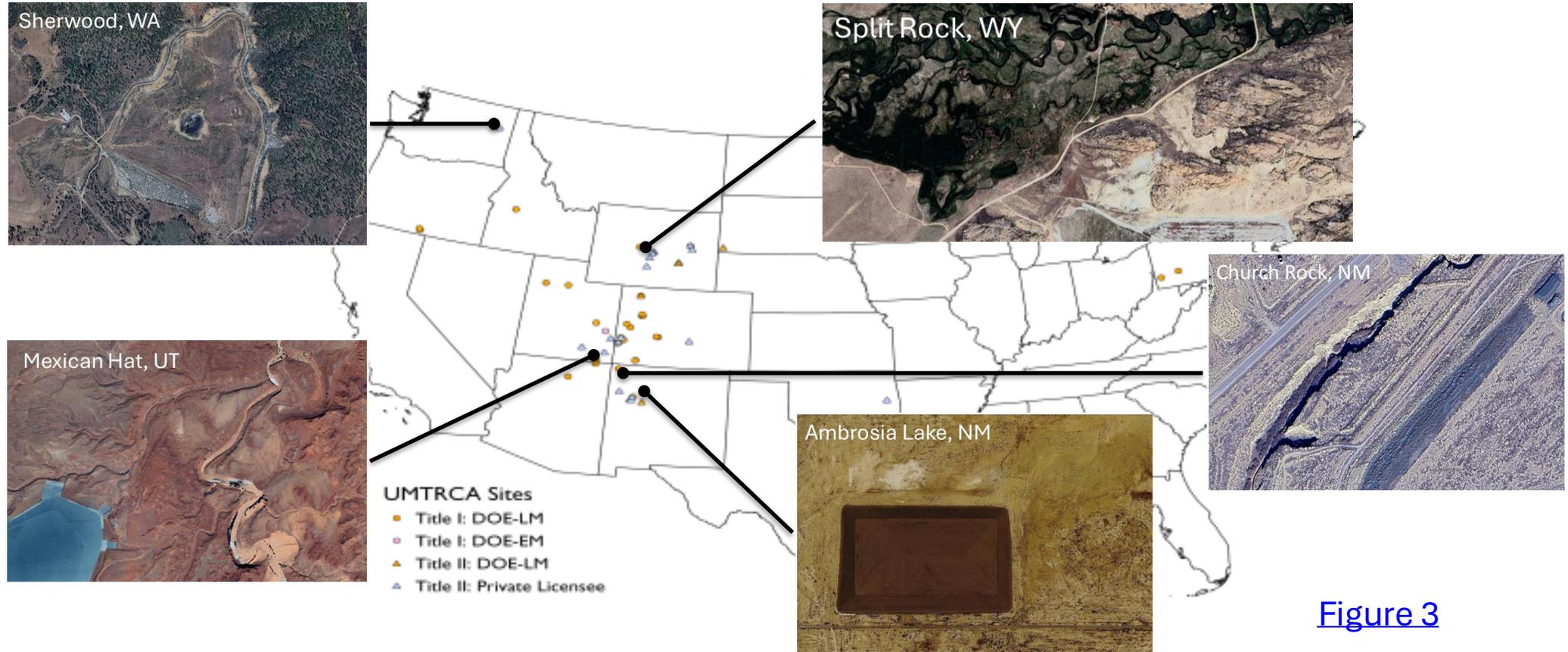
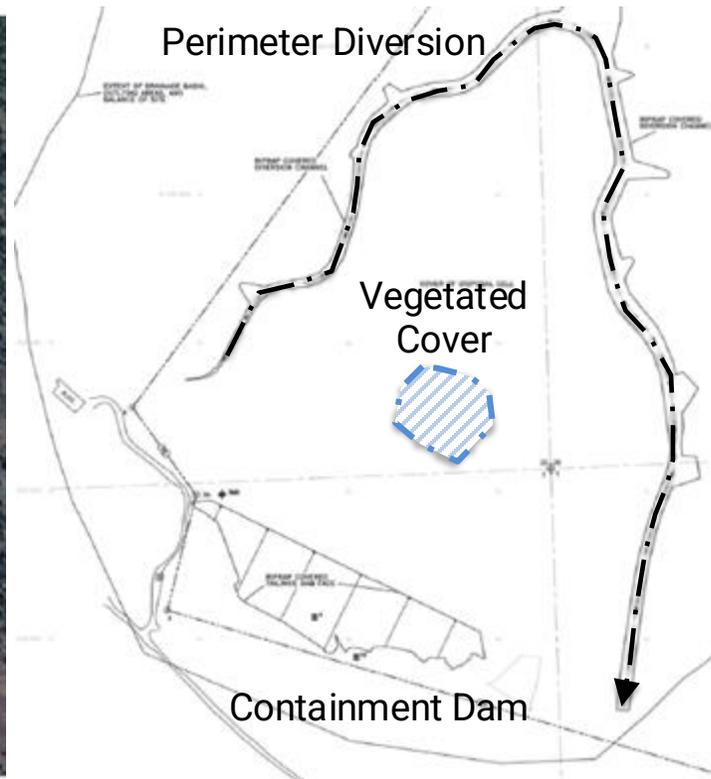


Figure 3

Spotlight

	Title	Cover Install	Comment
Sherwood, WA	II	1996 Interim	94 ac; 2.9Mt; 12 to 20 ft uncompacted
Mexican Hat, UT	I	1995	119 ac; 3.6Mt; 2 ft radon barrier; 0.5 ft bedding; 1 ft rock layer
Split Rock, WY	II	1998 Final	265 ac; 7.7Mt; 1 to 2 ft Interim Cover; 0.5 to 3.75 ft radon barrier, 0.6 to 1.25 feet borrow, 0.5 ft rock
Church Rock, NM	II	1996	110 ac; 3.5Mt; radon barrier, erosion cover
Ambrosia Lake, NM	I	1995	91 ac; 6.9Mt; 2.5 ft radon/infiltration barrier; 0.5 ft riprap on top; <5% slope on top; <20% slope on side

Sherwood, WA



- Synthetically lined (Hypalon)
- **5H:1V** embankment
- 6-inch thick 3-inch D_{50} rock riprap on embankment slope
- 730-acre watershed
- Perimeter drainage channel to convey PMP event
 - 3-inch to 18-inch riprap average diameter size

1996 to 2024 Sherwood, WA

Wildlife trails cross the diversion channel at numerous locations and have **displaced the diversion channel riprap in several places**

Sediment deposition is found in places on the west leg of the diversion channel but does not interfere with the diversion channel's design function. **Upslope areas** that have contributed to the sedimentation have **stabilized with vegetation**.

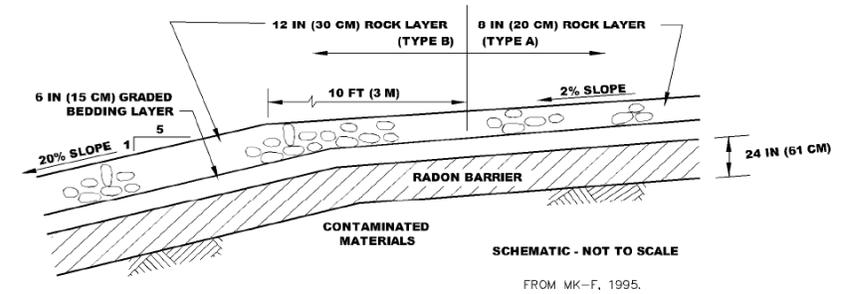
2023 indicated that a **maximum of 5.54 ft of settlement** has occurred near the pond

“The cover was designed to be **self-healing** with regard to impacts from **freezing** and **thawing, biointrusion,** and **settlement**”

The **containment dam face** is **thickly vegetated**. No maintenance needs were identified...areas of **sand** deposition have been described that indicate that materials have **washed out from underneath the dam rock cover**



Mexican Hat, UT



- **5H:1V** embankment
- 8-inch thick 1.7-inch minimum mean diameter rock riprap on cover
- 12-inch thick 4.4-inch minimum mean diameter rock on embankment slope
- 730-acre watershed
- West diversion channel North Arroyo
- Southeast diversion channel to South Arroyo

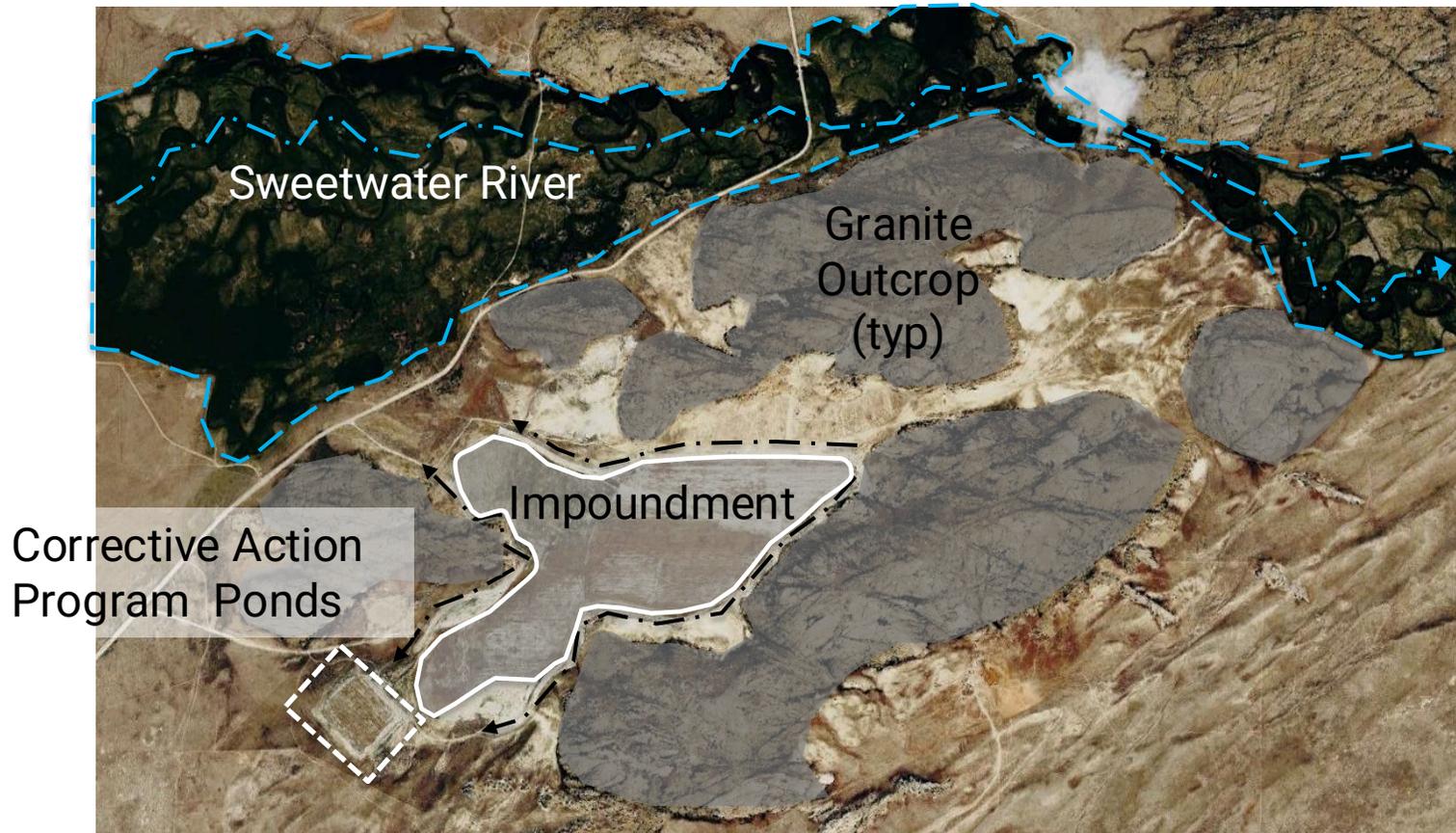
1995 to 2024 Mexican Hat, UT

“...observed **voids, piping, and incisions**, including their locations towards the lower portions of the north and northeast side slopes, and the **lack of fines** in the bedding/filter material in these areas ... it can be reasonably assumed that these features are the result of **precipitation-induced erosion**. No evidence of subsidence.

(2024 UMTRCA Title I Annual Report)



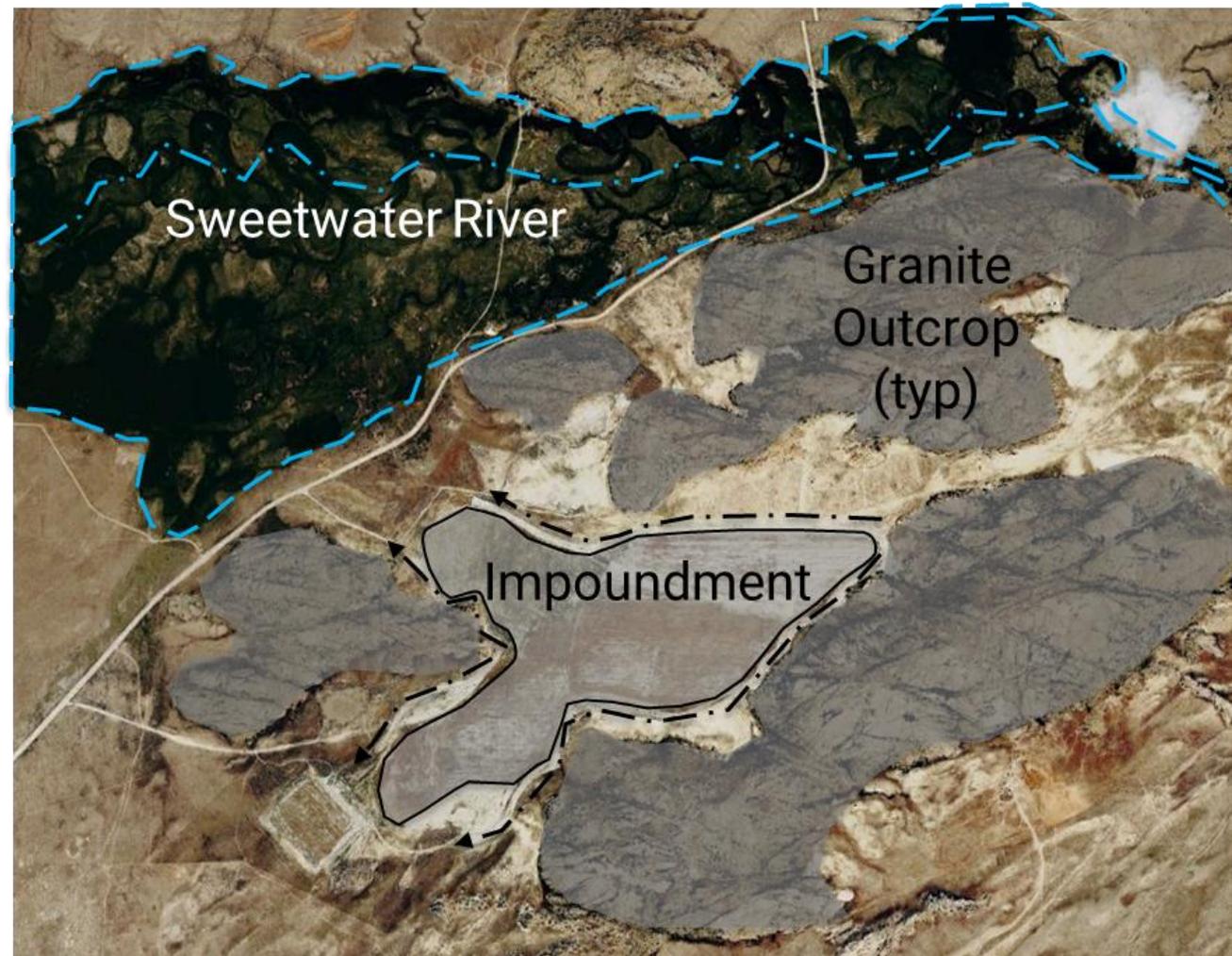
Split Rock Mill, WY



- Vertical band drains to accelerate settlement and dewatering. Primary settlement completed in 1996
- North, North Central, South and South Central Perimeter drainage channels to convey PMP event
 - One or two filter layers
 - D50 from 3 to 18 inches and riprap thickness varies from 6 to 27.5 inches

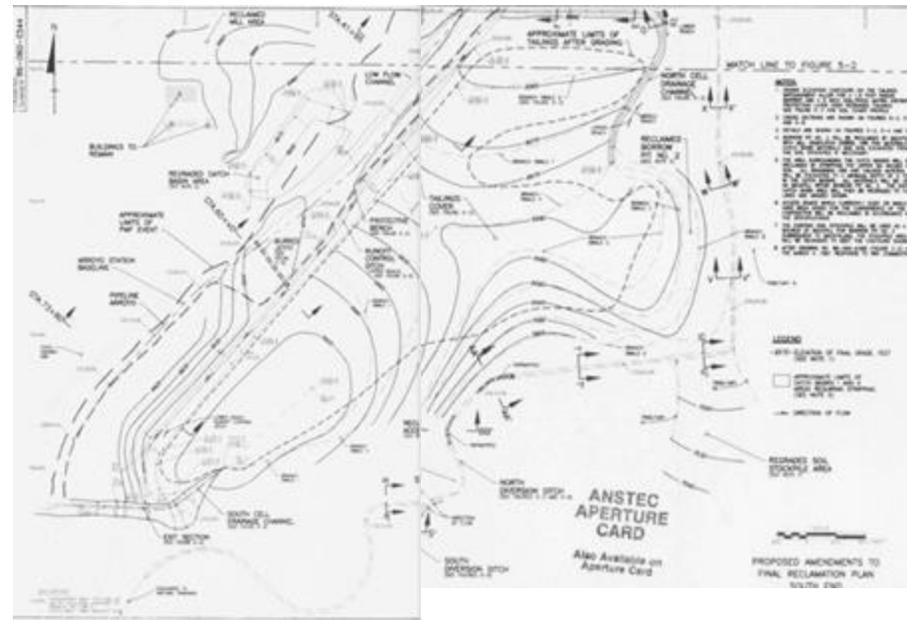
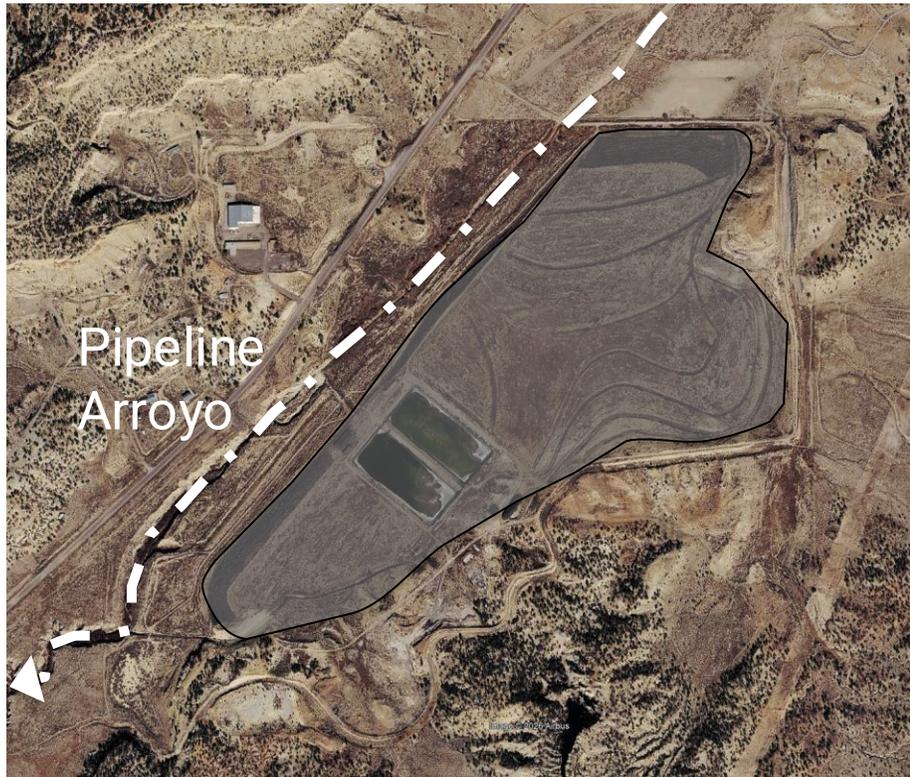
1998 to 2024 Split Rock, WY

“NRC staff also examined the finished surface of the CAP pond for the presence of **minimal erosion protection**...The licensee indicated that a **contractor had brought additional erosion protection material on-site to rework the thin spots**. NRC staff did not identify the presence of any thin spots of erosion protection during the inspection.”
(ML082321568, 2008)



Church Rock, NM

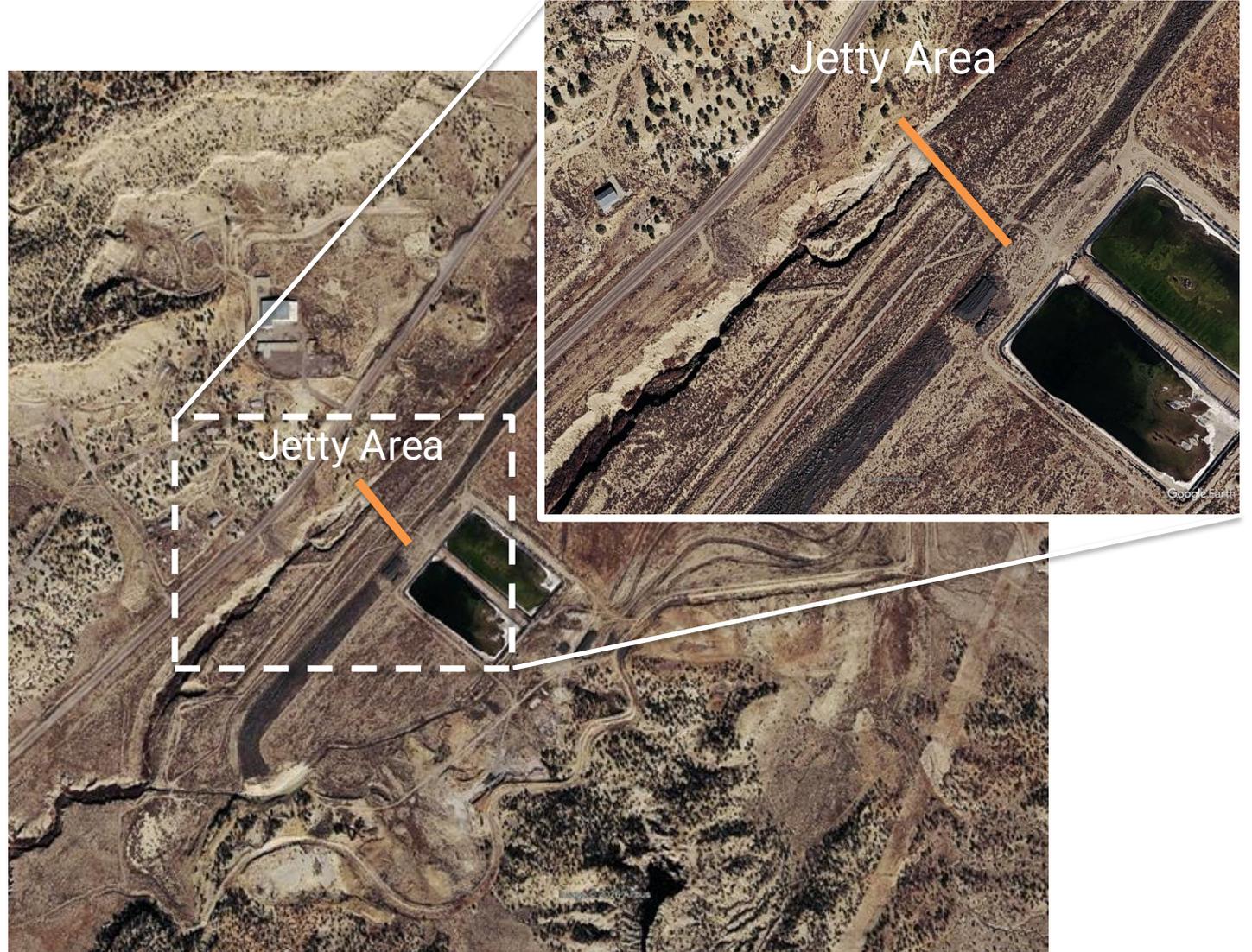
...placing a final radon attenuation soil cover and an erosion protection cover on the tailings area; (iii) constructing surface water control channels, diversion ditches, drainage swales, Pipeline Arroyo low-flow channel, and the buried rock jetty...0.15-m [0.5-ft] soil/rock matrix layer to protect against water and wind erosion” (EIS, 2020)



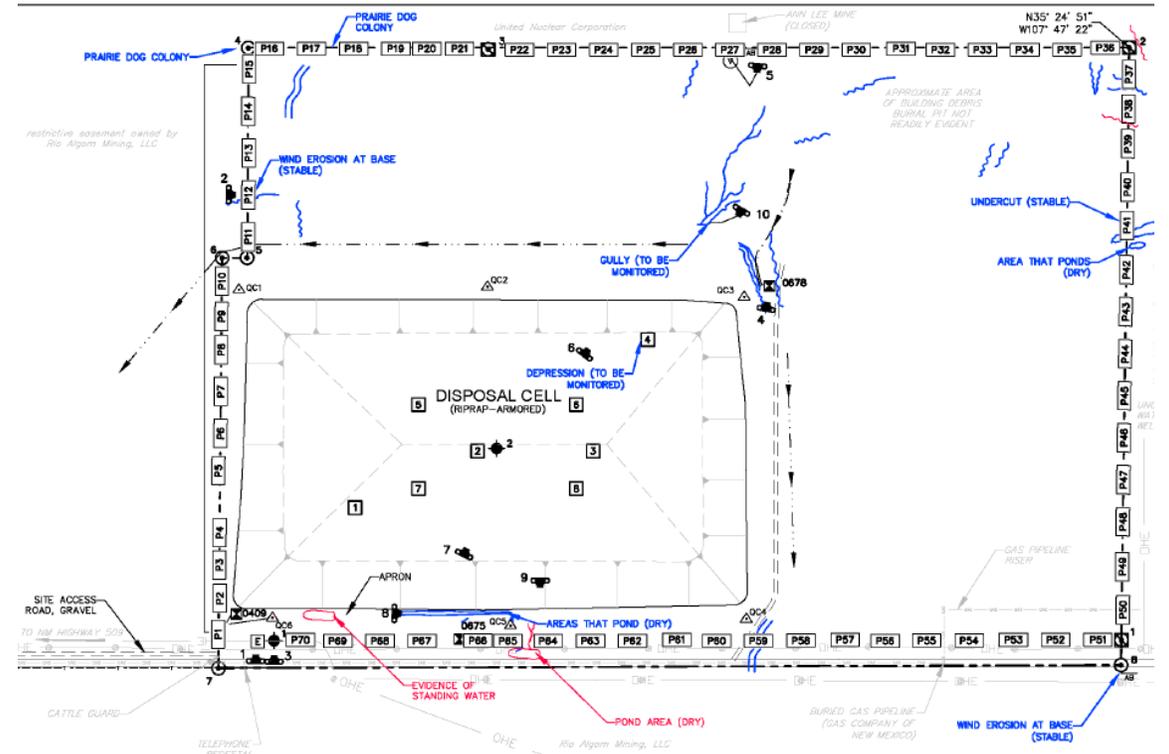
(M20117D549, 1996)

1996 to 2024 Church Rock, NM

“...re-configured portion of the Pipeline Arroyo in the Jetty Area would be to protect the existing tailing impoundment and added proposed mine waste disposal site from scouring and to safely convey flow from probable maximum precipitation events and all smaller storms downstream.” (EIS, 2020)



Ambrosia Lake, NM

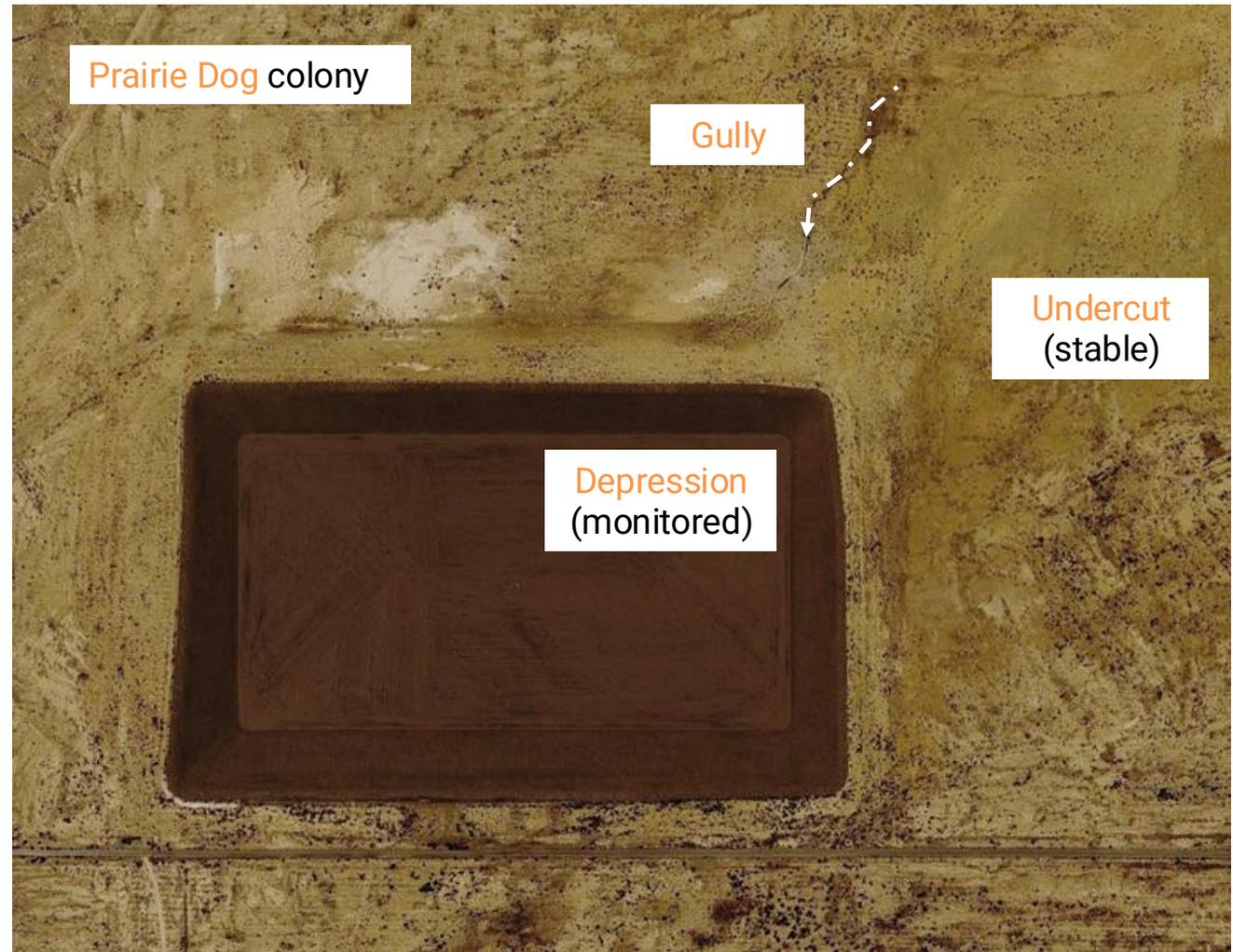


(2023 UMTRCA Title I Annual Report, Figure 1-1)

1995 to 2023 Ambrosia Lake, NM

“...visually observed for **erosion, changes in land use, or other phenomena** that might affect the long-term integrity of the site. No such impacts were identified. **Rills and gullies** continue to be observed east of perimeter sign P41. These **erosional features do not threaten the long-term integrity** of the site because **headward erosion is progressing away** from the site.”

(2023 UMRCA Title I Annual Report, Figure 1-1)



Cover Performance Factors

Impoundment Area

- Settlement increasing potential net percolation
- Synthetic components excluded from long-term performance (Sherwood)
- Prairie Dogs

Exterior Side-slopes

- Washout of bedding layers below rip rap
 - Off-spec materials
 - Piping

General Performance Factors

- Landscape evolution encroachment by adjacent drainages (e.g., Church Rock)
- Sedimentation (and vegetation) of **diversion systems** resulting in decreased capacity
- 5H:1V embankment
- **Groundwater** system corrective actions
- Requirement for active maintenance and long-term monitoring (30 out of 200 years so far)

Takeaways

- UMTRCA requires closure design performance criteria for >200 years
- Most projects are in long-term surveillance
- 30 year track record
- Lessons in performance uncertainty
 - Erosional stability
 - Mass stability
 - Diversion systems
 - Groundwater

Thank you

Terry Braun, P.E., RM-SME
Principal Consultant
SRK Consulting

Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). Under Title I of the UMTRCA, the U.S. Department of Energy (DOE) or the pertinent State is responsible for cleanup and remediation, as well as long-term care and maintenance of Title I disposal and processing sites, under a general license from the U.S. Nuclear Regulatory Commission (NRC). The NRC, in turn, is required to evaluate the design and implementation established by DOE or the pertinent State and, following remediation, to concur that the site meets the standards established by the U.S. Environmental Protection Agency (EPA). Title 10, Section 40.27, of the Code of Federal Regulations (10 CFR 40.27), "General License for Custody and Long-Term Care of Residual Radioactive Material Disposal Sites," is the governing regulation for these abandoned disposal sites.

[Locations of Uranium Recovery Sites Undergoing Decommissioning | Nuclear Regulatory Commission](#)

Title II of the UMTRCA addresses uranium recovery operations, some of which have substantial quantities of tailings, at sites that are licensed by the NRC or its Agreement States. Title II amended the definition of byproduct material to include mill tailings, and added specific authorities for the NRC to regulate this new category of byproduct material at licensed sites, which include conventional uranium mills and in situ recovery (ISR) facilities. The NRC's Office of Nuclear Material Safety and Safeguards (NMSS) provides project management and technical review for decommissioning and reclamation of these Title II facilities, which are regulated under Appendix A to 10 CFR Part 40.

- Sites under UMTRCA Title I were associated with former privately operated uranium ore-processing locations. The remediation of these sites created disposal cells that encapsulate uranium mill tailings and associated materials.
- UMTRCA Title II sites were commercially owned and regulated under a U.S. Nuclear Regulatory Commission (NRC) license, and the owner must conduct an NRC-approved cleanup and provide funding to offset some costs of site transition to LM.

Under UMTRCA law, the U.S. Department of Energy (DOE) Office of Legacy Management (LM) is currently responsible for long-term surveillance and maintenance at 28 UMTRCA disposal and former mill sites in the United States. Of those, 21 inactive uranium-processing sites were remediated by DOE under Title I of the law. These sites were already abandoned when the 1978 law was passed. In response, 19 engineered disposal cells were built to contain the tailings and other contaminated material.

Title II of UMTRCA applies to sites where uranium ore was being processed under an active license when UMTRCA was passed, and the site licensee is responsible for remediation. LM is currently the long-term custodian of seven remediated UMTRCA Title II disposal sites, and this number will increase as additional ongoing remediation is completed. Ultimately, LM will manage 22 Title I sites and up to 30 Title II sites.

LM manages each site with oversight from the U.S. Nuclear Regulatory Commission (NRC). LM fulfills NRC's general license requirements for long-term inspection, monitoring, maintenance, notifications, and record keeping by implementing a site-specific Long-Term Surveillance Plan (LTSP) as well as a Groundwater Compliance Action Plan (GCAP) if there is contaminated groundwater associated with the site.

[LM Sites | Department of Energy](#)

[Program Update Q4 2025](#)