



## Monument Valley, Arizona | Processing Site

### AN UMTRCA TITLE I SITE

This fact sheet provides information about the **Monument Valley site**. Long-term stewardship responsibilities for this site are managed by the **U.S. Department of Energy Office of Legacy Management** under **Title I** of the **Uranium Mill Tailings Radiation Control Act of 1978**.



### Site Information and History

The Monument Valley processing site is located on the Navajo Nation in northeastern Arizona, approximately 15 miles south of Mexican Hat, Utah, on the west side of Cane Valley. A uranium ore processing mill operated at the site from 1955 to 1968 on property leased from the Navajo Nation. The mill closed in 1968, and control of the site reverted to the Navajo Nation. Most of the mill buildings were removed shortly thereafter.

Uranium was first discovered in 1942 approximately 0.5 mile west of the site. From 1955 until 1964, ore at the site was processed by mechanical milling using an upgrader, which crushed the ore and separated it by grain size. The finer-grained material, which was higher in uranium content, was shipped to other mills for chemical processing. Coarser-grained material was stored on-site and later reprocessed at the site through a sulfuric acid batch leach process that was used at the mill from 1964 until 1968. The milling process also produced radioactive mill tailings, a predominantly sandy material.

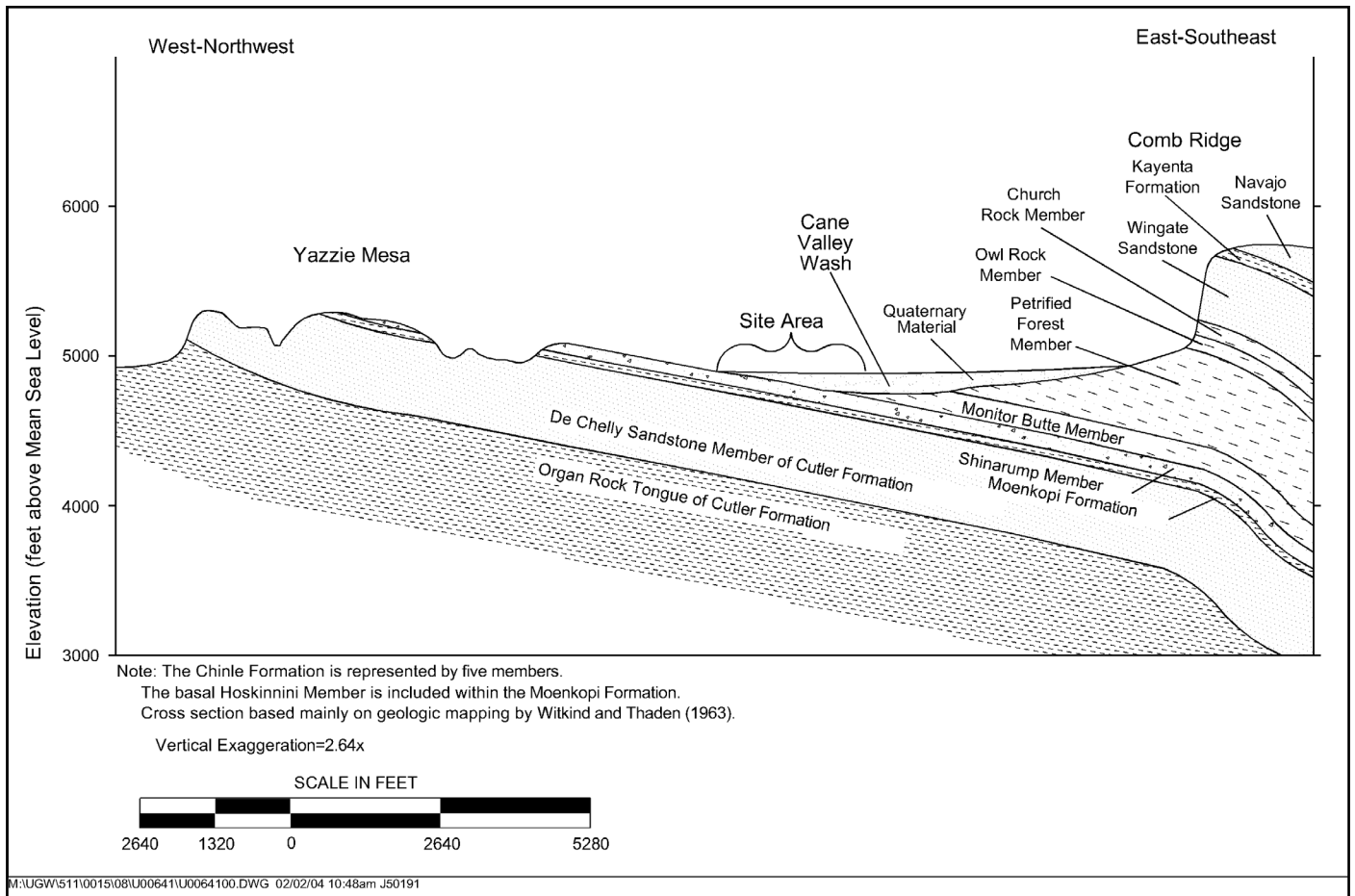
Source materials and other site-related contamination were removed during surface remediation at the site from 1992 through 1994. All contaminated materials from the Monument Valley processing site were transported north (approximately

15 miles) and stabilized in the Mexican Hat disposal cell. However, analyses of subpile soil samples (samples collected beneath the “footprint” of the former tailings piles) at the site indicate contaminants in these soils may be a continuing source of groundwater contamination. Ammonium in the subpile soil can degrade to contribute to nitrate contamination in groundwater.

### Regulatory Setting

U.S. Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) in 1978 (Public Law 95-604), and the U.S. Department of Energy (DOE) remediated 22 inactive uranium ore processing sites under the Uranium Mill Tailings Remedial Action Project in accordance with standards set by the U.S. Environmental Protection Agency in Title 40 *Code of Federal Regulations* (CFR), Part 192 (40 CFR 192). Subpart B of 40 CFR 192 regulated cleanup of contaminated groundwater at the processing sites. The radioactive materials were encapsulated in U.S. Nuclear Regulatory Commission (NRC)-approved disposal cells. NRC general license for UMTRCA Title I sites is established in 10 CFR 40.27.

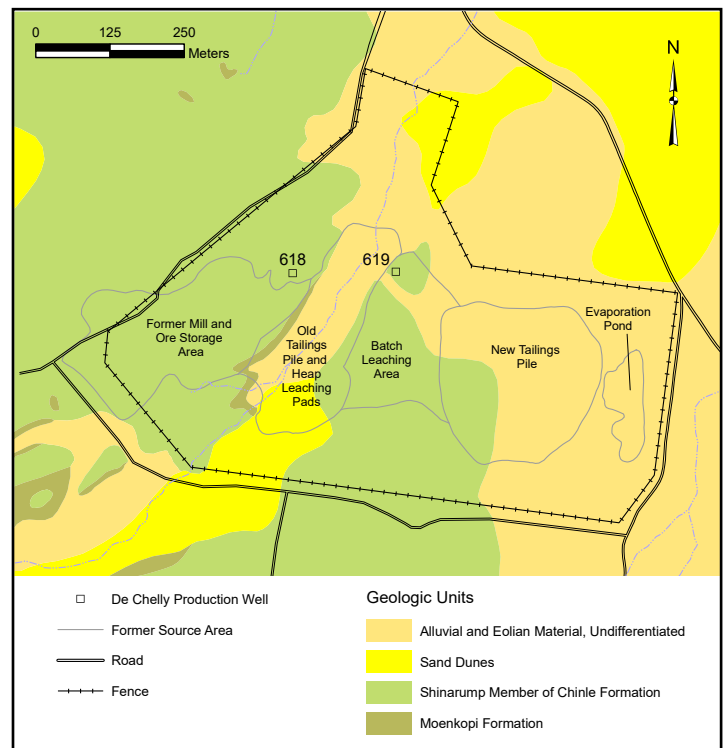
The Mexican Hat disposal site was included under the general license in 1997 and transferred to DOE at that time.



Geologic features in the Monument Valley area.

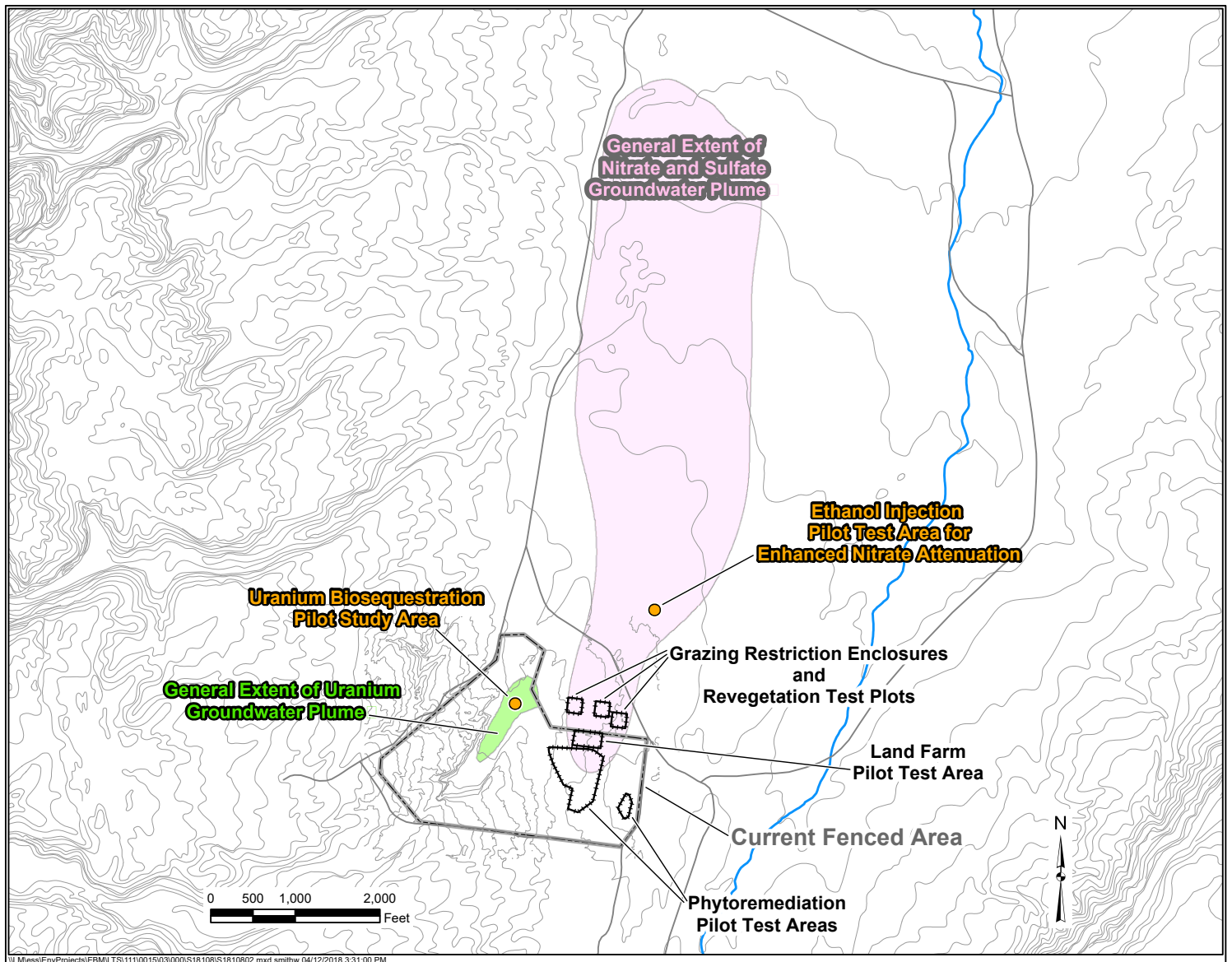
## Processing Site

Groundwater at the former processing site is present in three geological units: the unconsolidated alluvial sand (uppermost aquifer), the underlying Shinarump Member of the Chinle Formation, and the De Chelly Sandstone Member of the Cutler Formation, the deepest of the three aquifers. Only the alluvial and De Chelly aquifers show evidence of milling-related contamination. Although a distinct plume is not present, contamination in the De Chelly aquifer is limited to a small, isolated area where uranium concentrations in samples collected from a few monitoring wells have intermittently exceeded the groundwater standard in 40 CFR 192; however, an exceedance has not been observed since 2015. Historically, the De Chelly aquifer was used to supply production water for the milling operation. Supporting information indicates that pumping from this source can draw down uranium contamination from the overlying alluvium into the De Chelly aquifer. Uranium in the alluvial aquifer is also generally limited to this same isolated area where the former production wells are located.



Locations of former Monument Valley mill and ore storage area, tailings piles, heap-leach pads, and evaporation pond with surface geology.





*Alluvial groundwater contaminant plumes and pilot study areas at the Monument Valley, Arizona, Processing Site.*

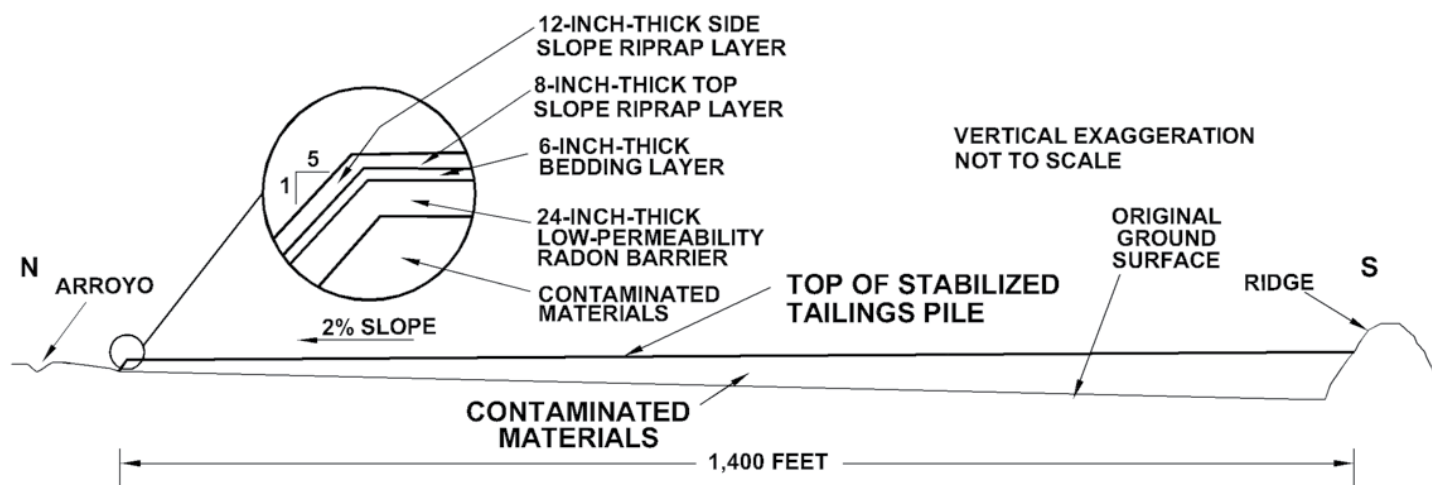
Approximately 600 million gallons of water are contaminated in the alluvial aquifer. Nitrate, sulfate, and uranium are the contaminants of concern in groundwater at the site. Nitrate and sulfate contamination in alluvial groundwater has migrated more than 6,000 feet north of the former mill site.

## Compliance Strategies

In late 2011, the DOE Office of Legacy Management (LM) completed a suite of pilot studies designed to evaluate, on a landscape scale, proposed passive and active remedies for nitrate and sulfate in the alluvial aquifer and in source area soils at the Monument Valley site. The pilot studies were carried out to evaluate remedies for three components of the alluvial aquifer: subpile soils, shallow alluvial aquifer, and deep alluvial aquifer. Natural and enhanced phytoremediation

(using native desert plants and natural and enhanced microbial nitrification and denitrification) were evaluated. For the subpile soils, irrigated plantings enhanced evapotranspiration and denitrification, cutting off and reducing the plume source. For the shallow portions of the alluvial aquifer, natural and enhanced phytoremediation and denitrification were evaluated as potential passive remedies. For deeper portions of the alluvial aquifer, land-farm phytoremediation (pumping high-nitrate groundwater for irrigation) was evaluated as an active option to supplement natural and enhanced attenuation processes.

Enhanced attenuation involves starting or boosting natural and sustainable attenuation processes. The goal is to increase the level of attenuation beyond the process that



Typical north-south cross section of the Mexican Hat disposal cell.

happens naturally. Bioremediation relies on bacteria to change or break down contaminants into less harmful substances (i.e., microbial denitrification) to reduce concentrations of nitrate in the source area and plume.

Planting and irrigating the source area has removed nitrate from the soil by microbial denitrification, and the pilot studies have shown that natural attenuation is occurring in the plume. In addition, as part of the pilot studies, injecting ethanol increases denitrifying bacteria activity and greatly increases the rate of denitrification, shortening the cleanup time.

Data associated with an additional pilot study performed to evaluate biosequestration of uranium at the Monument Valley site is under review. This study involves the injection of ethanol to determine its effectiveness as a treatment option for uranium-contaminated groundwater. Based on these test results, LM may supplement its previous pilot study conclusions.

LM is required to follow a groundwater compliance selection framework summarized in the [Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project](#) (PEIS), when selecting the appropriate compliance strategy to clean up the groundwater aquifers affected by former processing activities at the Monument Valley site.

Based on PEIS guidance, LM has determined that the no-remediation strategy is appropriate for the Shinarump Member aquifer because groundwater in this aquifer has not been contaminated from site-related activities. The no-remediation strategy is also anticipated for the De Chelly Sandstone aquifer, due to the presence of minor, isolated occurrences of contamination in this unit. Long-term annual

groundwater monitoring will continue with a focus on a set of existing monitoring wells.

Recent groundwater data collected at the site demonstrate that additional site characterization is needed to make informed decisions regarding aquifer restoration and viable compliance strategies for the alluvial aquifer. LM is in the process of collecting additional data and using the results of the pilot studies to develop a Groundwater Compliance Action Plan (GCAP) for the site that identifies the strategy for complying with groundwater standards in 40 CFR 192.

## Institutional Controls

Institutional controls at the site include fencing around the phytoremediation areas to prevent grazing by livestock and wildlife and to maximize plant growth. DOE is working with the Navajo Nation to restrict access to contaminated groundwater during the remediation period. A domestic water supply system was completed in 2003 to provide potable water to all Cane Valley residents. The project was jointly funded through an interagency agreement between the Indian Health Service and DOE. The project also consisted of the installation of individual septic systems and electricity distribution to approximately 33 households in Cane Valley. The Navajo Tribal Utility Authority retains responsibility for operation, monitoring, and maintenance of the water supply system.

## Mexican Hat, Utah, Disposal Site

Approximately 1.3 million dry tons of tailings and associated waste were hauled from the Monument Valley processing site and placed with tailings from the Mexican Hat processing site in the Mexican Hat disposal cell.

The cell contains 4.4 million dry tons (approximately 3.6 million cubic yards) of contaminated material with a total activity of 1,800 curies of radium-226. Information about the Mexican Hat disposal site is available at [www.energy.gov/lm/mexican-hat-utah-disposal-site](http://www.energy.gov/lm/mexican-hat-utah-disposal-site).

## Disposal Cell Design

The cell occupies an area of 68 acres on the 119-acre site. It lies along a rock outcrop on its south and rises 50 feet above the surrounding terrain to the north, east, and west. A posted, barbed wire perimeter fence surrounds the cell. The cover of the disposal cell system is designed with multiple components to encapsulate and protect the contaminated materials. The cover is composed of (1) a low-permeability radon barrier (first layer placed over compacted tailings) that does not allow substances to flow through easily, (2) a bedding layer of sand and gravel placed as a capillary break, and (3) a rock (riprap) layer to prevent erosion. The cell design promotes rapid runoff of precipitation so that it has less of a chance to seep through the protective layers. Runoff water flows down the 20% side slopes into the surrounding rock apron.

The site location and disposal cell design were selected to minimize the potential for erosion from on-site runoff or stormwater flow. All surrounding remediated areas were regraded and reseeded with native plants. Existing gullies around the cell were protected with riprap that was keyed into competent rock to minimize erosion. Riprap-protected diversion ditches were installed to direct surface runoff water away from the cell.

## Legacy Management Activities

LM is responsible for fulfilling DOE's post-closure responsibilities with the number one goal of protecting human health and the environment. LM will continue to review data associated with the Monument Valley pilot studies, including the results of ongoing groundwater characterization data collection efforts, to support the development of the draft GCAP and determine the appropriate groundwater compliance strategies. Groundwater monitoring and maintaining and developing the appropriate institutional controls at the Monument Valley site will continue until contaminant concentrations have decreased to acceptable levels.

LM manages the Mexican Hat disposal site according to a site-specific Long-Term Surveillance Plan to ensure that the disposal cell systems continue to prevent release of contaminants to the environment. Under provisions of this plan, LM conducts annual site inspections to evaluate the condition of surface features, and performs site maintenance, as necessary, to ensure the continued integrity of the disposal cell.

In accordance with Title 40 CFR 192.02(a), the disposal cell is designed to be effective for 1,000 years to the extent reasonably achievable, and, in any case, for at least 200 years. However, the general license has no expiration date, and LM's responsibility for the safety and integrity of the Mexican Hat disposal cell will last indefinitely.

## Contact Information

**In case of an emergency at the site, contact 911.**

LM toll-free emergency hotline: (877) 695-5322

Site-specific documents related to the **Monument Valley, Arizona, Processing Site** are available on the LM website at [www.energy.gov/lm/monument-valley-arizona-processing-site](http://www.energy.gov/lm/monument-valley-arizona-processing-site).

For more information about LM activities at the **Monument Valley, Arizona, Processing Site**, contact:

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 [www.energy.gov/lm/monument-valley-arizona-processing-site](http://www.energy.gov/lm/monument-valley-arizona-processing-site)

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