LMS/BLU/S08595

Cover Performance Evaluation Proposal Bluewater, New Mexico, Disposal Site

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U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

ACL	Alternate concentration limit
ARCO	Atlantic Richfield Company
DOE	U.S. Department of Energy
LM	Office of Legacy Management
NMED	New Mexico Environment Department
NRC	U.S. Nuclear Regulatory Commission
POC	Point of compliance

1.0 Introduction

Several issues pertaining to the cover of the main tailings disposal cell have been observed at the Bluewater, New Mexico, disposal site. These issues include ponded water on the cover of the cell and concerns about the hydrologic performance of the cover based on the types and locations of vegetation that have established since the cell was completed in 1995. Experience and data obtained from other uranium mill tailings disposal cells also suggest that an evaluation of the Bluewater cell cover is warranted.

Another issue pertains to groundwater quality at the site. An alluvial aquifer, which is present under a portion of the disposal cell, was contaminated during milling operations. A point-of-compliance (POC) well downgradient of the disposal cell exhibited increasing uranium concentrations since the U.S. Department of Energy (DOE) began sampling in 1999, and has exceeded the U.S. Nuclear Regulatory Commission (NRC)-approved alternate concentration limit (ACL) since 2010. Samples from a new alluvial aquifer well installed near the site boundary in 2011 had uranium concentrations in excess of the drinking water standard. It is not known if the contamination represents legacy contamination from milling operations, leakage from the disposal cell, a combination of both sources, or other causes. An evaluation of the cell cover would be an important component in gaining an understanding of the source of contamination in the alluvial aquifer.

This proposal presents a detailed approach to acquire the necessary information to determine if the disposal cell cover is performing as designed. A four-phased investigation is proposed starting with a review of site records (Phase I). This information will be used to understand cover design parameters and functions (Phase II), and then to develop a scope of work to characterize and evaluate current cover performance and associated risks to human health and the environment (Phase III). Phase IV, if warranted, would apply the results of Phase III to design cover enhancements and to project the long-term performance of the cover.

2.0 Background

The Bluewater disposal site transitioned from the former licensee, Atlantic Richfield Company (ARCO), to the DOE Office of Legacy Management (LM) in 1997. The main tailings disposal cell at the site covers an area of approximately 354 acres, contains approximately 23 million tons of mill tailings and other contaminated materials, and has a rock cover that slopes to the north. The acid-leach mill that generated these tailings operated from 1957 to 1982 and processed uranium-bearing sandstone ore that was hauled to the site (no mines were present on the site). The rock surface of the cell protects an underlying low-permeability layer, or radon barrier, that is designed to attenuate radon emissions from the encapsulated tailings. Generally, disposal cell covers of this type are intended to shed precipitation and prevent infiltration of water into the tailings.

Five other disposal cells and landfills are present on the site, the largest being the 54-acre carbonate tailings disposal cell. This rock-covered cell contains approximately 1.3 million tons of mill tailings and contaminated materials generated by the original carbonate-leach mill from 1953 to 1959. This mill processed uranium-bearing limestone ore that was hauled to the site. The remaining four cells and landfills on the site are much smaller and contain radiologically

contaminated asbestos materials, polychlorinated biphenyls, mill building materials, and miscellaneous waste and byproduct materials. No issues have been observed with these cells; therefore, this proposal addresses only the main tailings disposal cell cover.

Annual inspections and other site visits are conducted in accordance with the Long-Term Surveillance Plan for the site. DOE conducted the first annual inspection of the site in April 1998. A small area of ponded water was present in a shallow depression at the north end of the main tailings disposal cell cover, and visual evidence suggested that ponded water had covered areas totaling approximately 4 to 5 acres. This was not considered a concern at the time because of the high evaporation rate in the region relative to the amount of precipitation; it was assumed that the ponded water evaporated instead of infiltrating the cover.

Subsequent site observations and a greater understanding in cover performance in general, however, have raised concerns about the performance of the cell cover. For several years, perennial vegetation was absent from the cell cover. However, annual weeds have become prolific and perennial plants, including deep-rooted shrubs and trees, have become established. Consequently, concerns about cover performance exist because of observations of water ponding in depressions on the cover, the types of vegetation growing on the cover, wind-deposited sediment in the rock armor, and results of cover permeability studies at similar sites.

2.1 Ponded Water

Shallow depressions and ponded water were noted on the cell cover during the first annual inspection in 1998. In 1999, seven depressions showing evidence of ponding (due to the presence of clay and evaporite deposits) were mapped using a global positioning system unit. Ponded water is ephemeral, but it has been observed at these locations on several occasions since that time.

The depressions are located on the north portion of the disposal cell cover (Figure 1). The south portion of the cover has an approximate 4 percent slope that decreases to a designed slope of about 0.5 percent on the north portion. Runoff from the cover was intended to drain off the north slope of the disposal cell; however, there has been no evidence that this has occurred. The grade may have been constructed too flat to drain the runoff.

The relatively flat area also covers the portion of the disposal cell that contained the wettest tailings (referred to as "slimes"). These tailings were then overlain with relocated contaminated materials. The depressions are suspected to be the result of differential settlement of the slimes. It appears that the depressions have increased in size and depth since they were first observed, but it is not known if they have stabilized. The essentially flat grade and the presence of depressions have served to inhibit runoff from draining from the cell cover as intended.

2.2 Cover Vegetation

The types of plants growing on the cover and along the toe slope of the cover provide clues to the hydrologic performance of the cover. The cover vegetation consists primarily of annual weeds (Russian thistle and kochia), but populations of perennial grasses, forbs, and deep-rooted woody plants are also establishing on the cover.

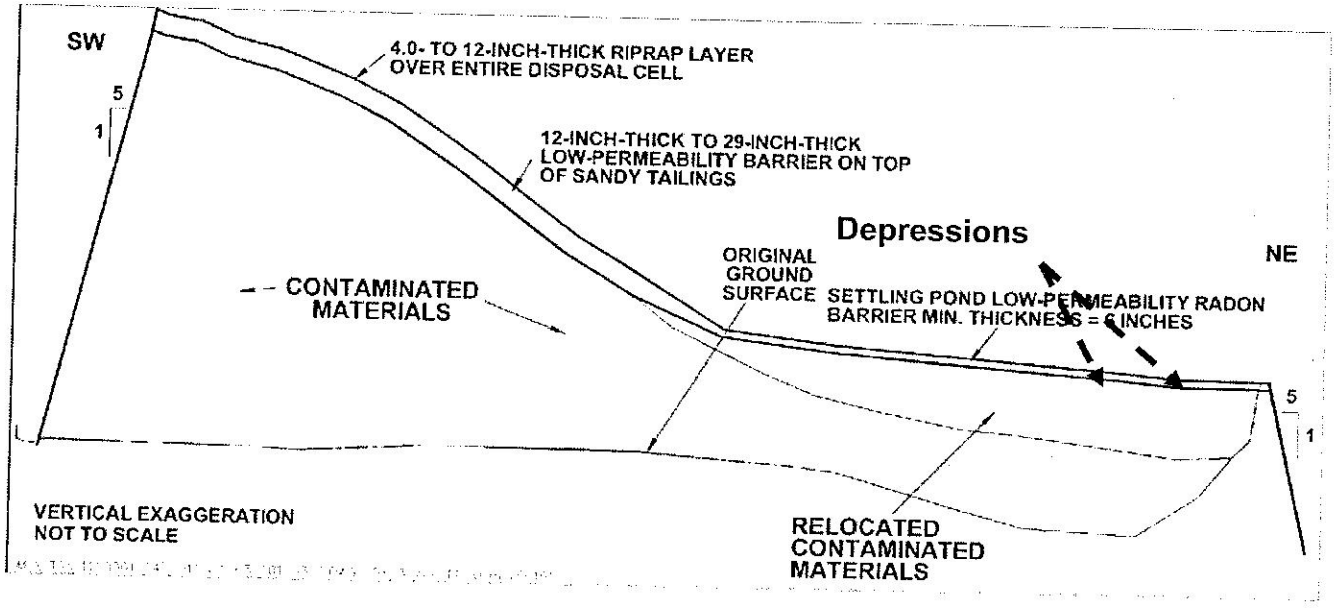

Figure 1. Southwest-Northeast Cross Section of the Main Tailings Disposal Cell at the Bluewater Disposal Site (from LM Fact Sheet) and Areas with Depressions

Two deep-rooted woody species, fourwing saltbush and Siberian elm, are currently only sparsely distributed but occur over much of the disposal cell cover. Fourwing saltbush is a native shrub and a major component of rangeland vegetation in the vicinity of the disposal cell. It can send down roots 30 feet in sandy soil and is known to be a facultative phreatophyte in Southwestern deserts, which is a class of plant that often sends down roots to saturated soil to survive. The saltbush shrubs growing on the cell cover appear to be larger than normal and may be indicative of relatively moist tailings and relocated materials. Currently, the saltbush shrubs are not being controlled.

Siberian elm, an exotic invasive tree, is an indicator of moist soils in the semiarid Southwest. In New Mexico it is commonly found along irrigation canals and streambanks in association with native cottonwoods, willows, and other invasive trees such as tamarisk and Russian olive. Siberian elms are being controlled on the disposal cell cover by cutting the saplings and applying herbicide to the stumps.

If the cell is shedding runoff, then more abundant plant growth would be expected along the north toe of the disposal cell where runoff would occur. However, vegetation in that area appears to be no more abundant than in surrounding areas, and no moist areas have been observed during site inspections or other visits.

2.3 Sediment in Rock Armor

The rock placed on the cell apparently was free of soil and fine particles at the time of construction. However, windblown sand and silt have been accumulating in the open spaces between the rocks. The fine particles have a much lower saturated conductivity than the original rock layer. This condition tends to reduce surface drainage by storing runoff and enhances conditions for establishment of vegetation.

2.4 Cover Permeability Studies

DOE observations and evaluations at other LM sites, plus several independent studies, have shown that cell covers similar to the Bluewater cell often fall short of their designed low-permeability targets. Also, NRC has documented how engineering properties of materials used in covers change over time and concluded that changes in hydraulic properties occurred in all cover soils due to the formation of soil structure, regardless of climate, cover design, or service life.

2.5 Groundwater Contamination

Fluvial sediments of the ancestral Rio San Jose, which were covered by about 100 feet of basalt lava flows (the river canyon was completely filled with basalt), are present under a portion of the main tailings disposal cell and are partially to fully saturated at the site. Tailings fluids leaked through the highly jointed basalt and into the buried sediments during milling operations. The concerns about the performance of the disposal cell cover have arisen in part because of increasing uranium concentrations in this alluvial aquifer.

Uranium concentrations in alluvium POC well T(M) increased from 0.0962 milligram per liter (mg/L) in November 1999 to a peak of 0.557 mg/L in November 2010, when the ACL of 0.44 mg/L was first exceeded. The uranium concentration was 0.531 mg/L at the time of the November 2011 sampling event. Because of the ACL exceedance, two new alluvium monitoring wells were installed downgradient of well T(M) in summer 2011 to help determined the extent of contamination. Well 21(M) was installed near the site boundary where the alluvial groundwater presumably exits the site, and well 22(M) was installed between well T(M) and well 21(M).

Graphs of the uranium concentrations at the three wells are shown in Figure 2. Although the uranium concentrations in the new wells are below the ACL, they are above the Uranium Mill Tailings Radiation Control Act maximum concentration limit of 0.044 mg/L and the New Mexico drinking water standard of 0.030 mg/L.

To further characterize the alluvial groundwater contamination, sampling of the nearest private domestic well downgradient of the site will begin in May 2012, and a new well is planned for installation approximately 1,600 feet downgradient of well 21(M) in summer 2012. An evaluation of alluvial groundwater quality and of the disposal cell cover performance may help determine if the alluvial aquifer contamination is correlated to disposal cell performance.

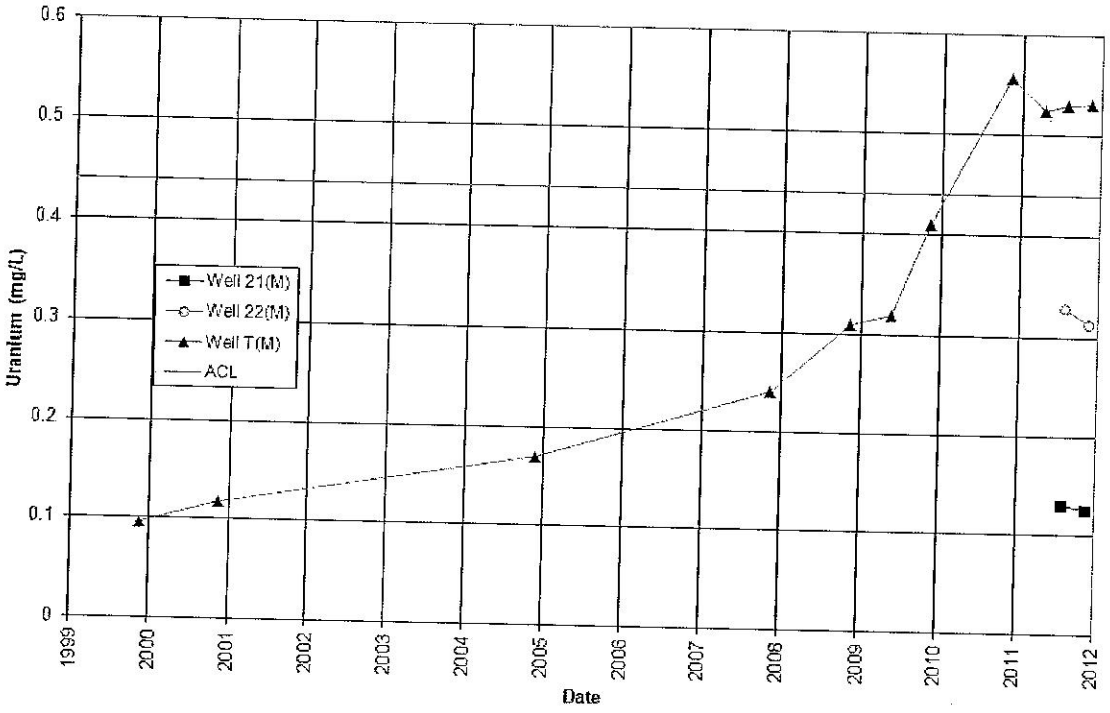

Figure 2. Uranium Concentrations in the Alluvial Aquifer at the Bluewater Disposal Site

3.0 Scope of Investigation

The goal of the proposed cover performance evaluation is to determine the functional status of the cover. Three phased activities are recommended to evaluate the design, construction, and performance of the main tailings disposal cell cover. A subsequent fourth phase, if warranted, would include potential follow-up investigations and cover enhancement.

The purpose of the cell cover is to encapsulate the tailings, thus isolating the tailings from being a continuing source of contamination. If this investigation concludes that the cell cover is not performing as designed, then risks associated with that conclusion will be evaluated. As noted previously, site groundwater monitoring wells indicate that the alluvial aquifer has uranium concentrations that exceed regulatory limits. The results of this investigation will be used as part of an ongoing investigation to evaluate if the elevated uranium concentrations are the result of a legacy contaminant plume from milling operations, continued drainage from the disposal cell, a combination of both, or other causes.

3.1 Phase I—Records Review

Phase I includes review of cover design documents and completion reports to acquire information on cover design objectives, specifications, and as-built conditions. This information is required to understand the performance expectations of the cell cover when DOE received the site. The review would include searches for the following information:

- Design criteria for soil physical and hydraulic properties for the low-permeablility radon barrier and underlying relocated contaminated materials. Low-permeability covers such as Bluewater rely on the low saturated hydraulic conductivity of compacted soil layers.
- As-built data for the placement and compaction of the low-permeablility radon barrier and underlying relocated contaminated material during construction. This information will be used to determine if the design criteria were achieved during construction.
- Soil edaphic properties for the radon barrier and relocated contaminated materials. Soil edaphic or fertility properties are needed to evaluate the suitability of the cover for plant growth.
- Design slopes for the cover and as-built data on slopes and depressions. This information is needed to evaluate how the topography of the cover has changed since construction.
- Slope stability calculations. If tailings become wetter, disposal cell slopes may become less stable.
- Soil water balance or percolation flux calculations and/or modeling. If the cover was designed to limit percolation, then it will be important to know if and how percolation rates for the design were determined.
- Radon flux modeling input data and results. This information is necessary to determine how radon flux may change as the cover changes.
- Calculations or modeling of runoff and lateral drainage. If the cover was designed to shed precipitation, then it will be important to know if and how runoff rates for the design were determined.
- Evaluations of potential uptake of contaminants of concern by deep-rooted plants. Plant uptake of tailings constituents is a potential release pathway.

Some of this information may not be readily available, may be required from sources outside of DOE, or may not exist. If necessary, NRC, the New Mexico Environment Department (NMED), and perhaps ARCO may need to be contacted to obtain design and construction data. Visits to NMED or ARCO offices may be necessary to find and obtain copies of the needed information.

3.2 Phase II — Evaluation of Cover Design and As-Built Conditions

Phase II will begin with an evaluation of the information obtained during Phase I to determine the design parameters of the disposal cell cover, if the cover construction met the design parameters, and data gaps. This evaluation will be used to determine the type of data that will need to be collected and the best methods necessary to verify the performance of the disposal cell cover.

3.3 Phase III — Cell Cover Characterization and Analysis

The scope of work necessary to characterize and analyze the performance of the cell cover is dependent on the results of the first two phases. As directed by DOE, the scope of work and associated schedule and cost will be developed for Phase III activities.

To compare the as-built conditions with current conditions, it is anticipated that the current soil hydrology, soil morphology, and plant ecology related to cover performance and potential exposure pathways will need to be characterized.

The characterization plan may include an approach for determining or estimating the following cell cover conditions:

- Acreage of the cover consisting of depressions where water ponds.
- Infiltration rates in the surface of the radon barrier, particularly within the area containing the depressions.
- Saturated hydraulic conductivity of the radon barrier and relocated materials.
- Radon flux monitoring or modeling.
- Air radon monitoring on the cover, such as on the perimeter of the cover and at potential radon pathways through the cover (live plants and dead plant root systems).
- Tissue samples from Siberian elm and fourwing saltbush populations for a bio-uptake evaluation.

Characterization data will be used to evaluate if the disposal cell cover is performing as designed. If it is determined that the cover is not performing as designed, a risk evaluation will be performed. Risk associated with the performance of the disposal cell, primarily as a continuing source for a groundwater contamination exposure pathway, and secondarily as a source for radon flux and bio-uptake exposure pathways will be evaluated. Potential and perceived risks to human health and the environment, and the risks of exceeding a regulatory standard, will also be evaluated. If this evaluation indicates the presence of unacceptable risk, the project will continue to Phase IV.

3.4 Phase IV — Follow-up Investigations and Cover Enhancement

Phase IV involves the application of the results of the cell cover investigation to the performance of the disposal cell and its association with the site groundwater systems. Therefore, it is beyond the scope of this cell cover evaluation. For planning purposes, however, the following additional investigations and cover enhancement may be warranted if the cell cover evaluation indicates that the cover is not performing as designed and if it is concluded that the condition may present unacceptable risks to human health and the environment.

- Evaluate the soils, hydrology, and ecology of the cover and nearby reference areas.
- Evaluate water content and water-holding capacity of tailings and relocated materials. Estimate how much precipitation has to infiltrate the cell cover before the holding capacity of the tailings is exceeded.

- Estimate long-term drainage rates from the disposal cell. Evaluate the impact to the water quality of the aquifers and update the risk to human health and the environment estimated during Phase III.
- Predict how the cover performance may change over time due to changes in climate, soils, cover rock, and ecology.
- Evaluate the need to enhance the cover. Predict, through use of models, calculations, and/or analogs, the short-term and long-term effects of cover enhancement on the water balance of the disposal cell, radon attenuation, and bio-uptake.
- If warranted, develop a cover enhancement design and submit to DOE for review and approval. NRC concurrence is required prior to "significant constructions, actions, or repairs" (10 CFR 40.28(e)). Therefore, the proposed cover enhancement design will be submitted by DOE to NRC for review, consultation, and concurrence. Potential cover enhancement options may include seeding the cover to speed up vegetation succession and increase evapotranspiration, adding soil to the cover and seeding it to increase vegetation and evapotranspiration, or regrading the cover to eliminate the depressions and allow drainage.
- If approved, implement the cover enhancement.
- If implemented, test the effectiveness of the cover enhancement and refine it as necessary.