Closure of the 92-Acre Area at the Nevada Test Site Area 5 Radioactive Waste Management Site – 10338

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ABSTRACT

The 92-Acre Area at the Nevada Test Site (NTS) is part of the Area 5 Radioactive Waste Management Site (RWMS) and consists of several engineered shallow-land burial cells along with deep disposal boreholes. The Area 5 RWMS is well suited for the disposal of waste as it is located in an access-controlled government facility far removed from population centers. Its windy, arid climate features an average annual precipitation far less than the average annual potential evapotranspiration. Depth to groundwater is significant, and the groundwater is unaffected by current and/or historical waste management activities.

The 92-Acre Area has been operational for over 45 years. Several waste types have been disposed at this location, including low-level waste (LLW), asbestiform LLW, mixed waste (MW) and a small amount of transuranic (TRU) waste and TRU MW. The initial waste placements occurred prior to the implementation of federal radioactive waste management regulations and the *Resource Conservation and Recovery Act* (RCRA). Information on the earliest waste disposal is less complete than in later years, leading to significant uncertainty regarding the older waste inventory. There is one active RCRA MW disposal cell in operation, which will cease receiving waste in December 2010 and close in 2011.

Four major assessments of landfill performance have been completed to date, demonstrating that waste disposal operations at the Area 5 RWMS are in compliance with the U.S. Department of Energy (DOE) regulations and providing assurance that the public and the environment will be protected for 1,000 years after closure. These assessments include a performance assessment (PA) for LLW, a composite analysis (CA), a PA for TRU waste in boreholes, and a special analysis (SA) for a small amount of inadvertently disposed TRU waste. These assessments sufficiently address the existing waste inventory, and further characterization of the waste inventory is deemed unnecessary.

The 92-Acre Area will be closed by installing an evapotranspiration cover. Post-closure monitoring is a key element of the closure. Conditions at the Area 5 RWMS make the typical RCRA monitoring approach of groundwater monitoring impractical because contaminant migration to groundwater from the Area 5 RWMS is predicted to be non-existent. A progressive monitoring approach will be implemented that consists of near-surface monitoring and progresses to deeper, more complex monitoring only if there are indications of contaminant migration or changed climatic conditions. This approach successfully manages the risk from the unknowns in the waste.

INTRODUCTION

The 92-Acre Area at the NTS is part of the Area 5 RWMS and consists of several engineered shallow-land burial cells, in which packaged waste was disposed, along with deep boreholes (greater confinement disposal [GCD]) boreholes. With the exception of three active pits, the trenches and pits in the 92-Acre Area currently have operational covers approximately 2.4 meters (m) thick.

The burial cells include both legacy disposal sites and an active MW disposal unit, Pit 3, which is governed by RCRA Permit NEV HW0021 [1]. While currently active, Pit 3 has a closure date of 2011 and must be closed in accordance with Title 40 Code of Federal Regulations (CFR) 265, “Interim Status

Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" [2], as adopted by Nevada Administrative Code (NAC) 444.8632, "Compliance with Federal Regulations Adopted by Reference" [3].

As agreed upon by the Nevada Division of Environmental Protection (NDEP) and the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), the entire 92-Acre Area will be closed under the *Federal Facility Agreement and Consent Order* (FFACO). The FFACO is a legally binding document that, by agreement, supersedes the corrective action requirements of RCRA [4]. The FFACO process not only meets all the requirements of RCRA [2], it also includes development of a conceptual site model (CSM), data quality objectives, and a detailed analysis and comparison of corrective action alternatives.

SITE CHARACTERISTICS

The 92-Acre Area is well suited for the disposal of waste as it is located in an access-controlled government facility far removed from population centers. It is located in a topographically closed basin surrounded by mountains. Erosion has resulted in deposition of up to 4,900 feet of alluvium, underlain and interbedded with ash-flow and ash-fall tuff estimated to be up to 3,900 feet thick. Its windy, arid climate features an average annual precipitation far less than the average annual potential evapotranspiration.

Depth to groundwater is approximately 770 feet. The groundwater gradient is nearly flat, with calculated flow velocities less than 0.5 feet per year. Sampling data indicates that the groundwater is unaffected by current and/or historical waste management activities [5].

DISPOSAL HISTORY

The 92-Acre Area began receiving waste in 1960s and has been operational for over 45 years. Waste types include LLW, asbestiform LLW, MW, and a small amount of TRU waste and TRU MW. The initial waste placements occurred prior to the implementation of federal radioactive waste management regulations and RCRA. Therefore, information on these earliest disposal practices is of a more general nature and is less complete than in later years, leading to significant uncertainty regarding the older waste inventory. While most of the waste is LLW, process knowledge and general descriptions indicate that some of the older wastes are MW. Much of this MW was placed in the oldest disposal units prior to the promulgation of RCRA, and subsequently these units were operationally closed by 1978. However, there currently remains one active RCRA MW disposal cell in operation, which will cease receiving waste in December 2010 and close in 2011.

INVESTIGATION AND MONITORING

Four major assessments of landfill performance have been completed to date, demonstrating that waste disposal operations at the Area 5 RWMS are in compliance with DOE regulations and providing assurance that the public and the environment will be protected after closure. These assessments include a PA for LLW, a CA, a PA for TRU waste in boreholes, and a special analysis for a small amount of inadvertently disposed TRU waste. The compliance period is 1,000 years under the LLW PA, and 10,000 years under the TRU PAs.

A monitoring plan was developed and implemented to provide assurance that members of the public and the environment are protected and will continue to be protected after closure. Monitoring includes direct radiation monitoring, air monitoring of tritium and radioactive particulates, radon flux monitoring, groundwater monitoring, vadose zone monitoring, soil gas monitoring, meteorological monitoring, and biota monitoring. Monitoring results are reported annually in the *Nevada Test Site Waste Management*

Monitoring Report Area 3 and Area 5 Radioactive Waste Management Sites. Groundwater monitoring results are reported annually in the *Nevada Test Site Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site*. Results of the monitoring show that all regulatory objectives are obtained. The monitoring confirms that there is no pathway or risk to an offsite receptor. The waste cells and monitoring network is shown in Figure 1 [5].

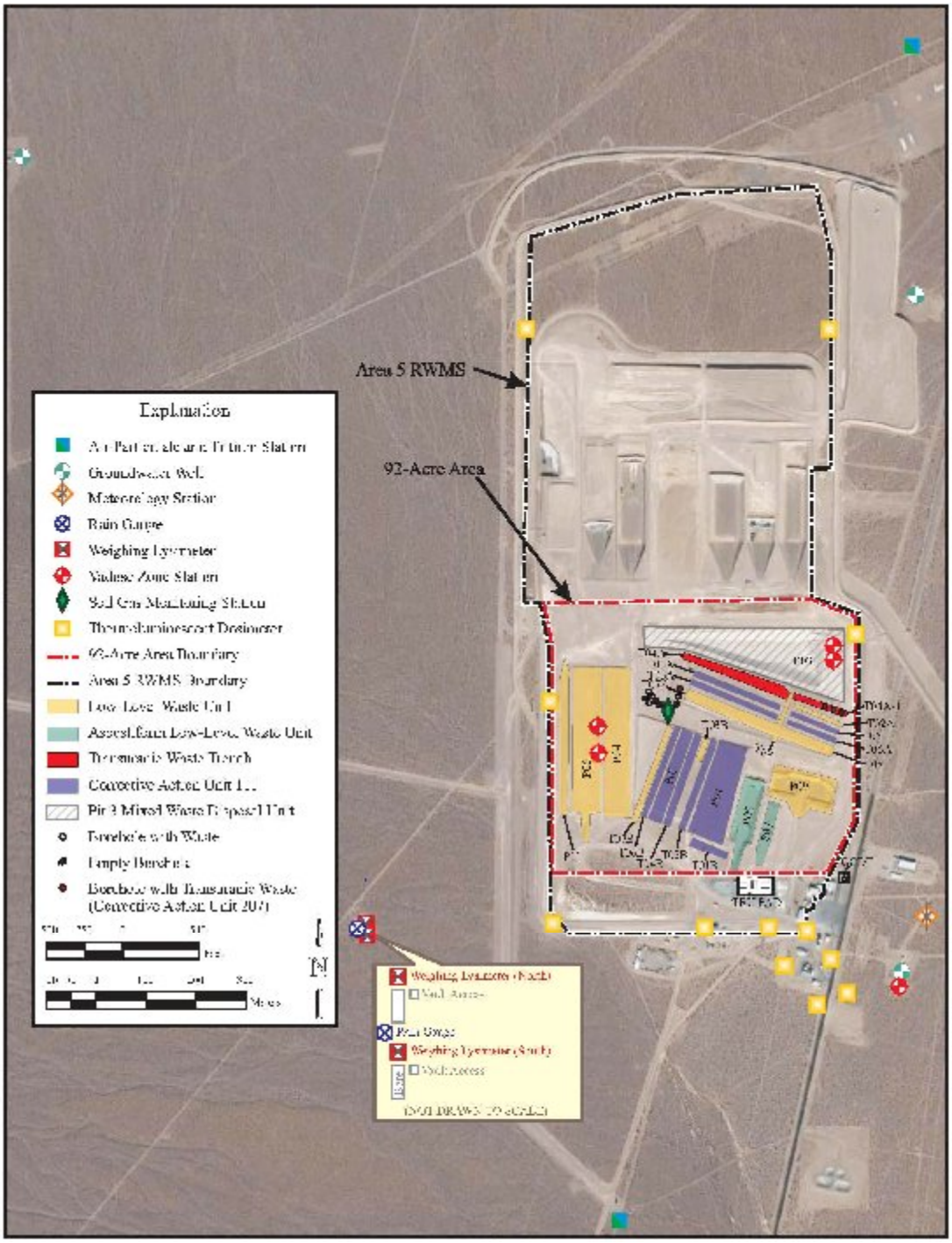

Fig. 1. Monitoring Network at the 92-Acre Area.

The PAs and CAs, along with the integrated closure and existing monitoring plan, are the basis for the Disposal Authorization Statement for the Area 5 RWMS. These assessments utilize an extremely conservative approach to the evaluation of risk from the waste inventory. A CSM was developed that evaluates the potential of waste release to groundwater, surface soil, and air. It demonstrates that the potential for groundwater quality impacts from waste disposed at the 92-Acre Area is low because the general movement of moisture in 92-Acre Area is vertical and upward. If leachate exists, there is no known preferential pathway that could enable its transmission to deeper strata. The previously mentioned inventory uncertainty is addressed in the assessments through the assignment of probability density functions to the waste inventory. The CSM shows that performance of the closed landfill is relatively insensitive to the waste inventory. The potential for radionuclide release is most sensitive to intrusion into the cover by plant roots and animals. Because of this, further characterization of the waste inventory is deemed unnecessary.

CLOSURE APPROACH

Monitoring data, modeling results, and the CSM show that risk associated with no further action is negligible; however, closure must minimize the need for further maintenance, and control, minimize, or eliminate, to the extent necessary to protect human health and the environment, migration of waste to the groundwater, surface water, or atmosphere [2]. Therefore, corrective action is required.

Four alternatives were developed and evaluated based on review of the existing data, future use, and current operations. These include the following:

- Alternative 1 – No Further Action
- Alternative 2 – Clean Closure
- Alternative 3 – Closure in Place with Administrative Controls
- Alternative 4 – Closure in Place with Administrative Controls with Removal of TRU Waste from Trench T04A

Alternatives were evaluated based on the following four general corrective action standards:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control of the source(s) of the release
- Compliance with applicable federal, state, and local standards for waste management

Alternatives that met all four of the general standards were further evaluated based on the following five remedy selection decision factors:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

Based on this evaluation, Alternative 2, Clean Closure, did not pass the first corrective action standard, protection of human health and the environment, and was not considered further. This alternative presents a significant risk to workers during excavation, repackaging, transportation, and placement of waste, with no overall benefit or reduction of risk to the environment.

The other alternatives passed the initial screen and were evaluated further. For each decision factor, the alternatives were ranked relative to the others. The least desirable alternative for each decision factor was

given a 1, and the most desirable alternative for each decision factor was given a 3. Scores per alternative were totaled, and the highest total score was selected as the recommended alternative. The selected alternative was Alternative 3, Closure in Place with Administrative Controls.

Alternative 3 will be implemented by installing an evapotranspiration cover over the 92-Acre Area. The cover will be a vegetated, natural alluvium mono-layer cover. While there are several engineered cover options available, in arid environments, the native soil evapotranspiration cover has proven to be the most protective with long-term stability and effectiveness [6, 7, 8, 9]. This approach was previously used and evaluated at the NTS for Corrective Action Unit (CAU) 110, Area 3 RWMS U-3ax/bl Disposal Unit, a historic RCRA disposal unit [10]. The CAU 110 cover has been demonstrated to be very effective since its installation in 2000. Consistent with industry experience and the successful cover at CAU 110, an evapotranspiration cover has been selected as the appropriate engineered cover for the 92-Acre Area.

POST-CLOSURE MONITORING

Post-closure monitoring is a key element of closure. Conditions at the Area 5 RWMS make the typical RCRA monitoring approach of groundwater monitoring impractical because contaminant migration to groundwater from the Area 5 RWMS is predicted to be non-existent given the depth to groundwater and arid climate. Therefore, the potential for groundwater contamination from waste disposal activities is negligible. However, monitoring is required to verify that transport is not occurring. Therefore, a progressive monitoring approach will be implemented that consists of near-surface monitoring and progresses to deeper, more complex monitoring only if there are indications of contaminant migration or changed climatic conditions. This approach will successfully manage the risk from unknowns in the waste, allowing assurance that the selected closure approach is the most effective.

Post-closure activities that will be conducted include visual inspections, groundwater sampling, subsidence surveys, vegetation surveys, thermoluminescent dosimeter measurements, air monitoring, radon flux monitoring, meteorology monitoring, and vadose zone monitoring. These monitoring activities will verify that the conditions are constant, and that migration or changed conditions are not occurring.

Vadose zone monitoring will consist of simple, near-surface monitoring near the waste cells and includes a time-domain reflectometry and heat-dissipation probes at three operational covers, one pit floor, and two weighing lysimeters. If changed conditions are detected, additional, deeper monitoring will be implemented to determine if contaminants or water is migrating downward. If deeper contamination is detected, then additional monitoring will be implemented. This approach will allow detection of changed conditions, and progress to deeper, more complex monitoring.

The proposed monitoring program is more conservative and more protective than required by 40 CFR 265 or precedence. The program is sufficient to identify migration of any potential contaminants within the landfill units. In addition, the monitoring program will be evaluated every 5 years to determine whether the frequency and/or approach should be modified based on monitoring results, changes in climatic conditions, potential change in the direction of the aquifer flow, or offsite activities that could impact water quality.

CONCLUSION

The 92-Acre Area at the NTS is well suited for the disposal of waste as it is located in an access-controlled government facility far removed from population centers. The windy, arid climate with an average annual precipitation far less than the average annual potential evapotranspiration, combined with the great depth to groundwater, results in little risk to the human health or the environment from waste disposal at this location.

Therefore, the 92-Acre Area will be closed by installing an evapotranspiration cover. Post-closure monitoring is a key element of closure, and includes a progressive approach to monitoring that initially monitors shallow, subsurface conditions, and progresses to deeper monitoring if there are indications of contaminant migration or changed climatic conditions. This approach successfully manages the risk from the unknowns in the waste, allowing assurance that the selected closure approach is the most effective. The proposed closure approach, including post-closure monitoring, provides the assurance that the public and the environment will be protected after closure.

REFERENCES

1. Nevada Division of Environmental Protection, 2005. *Permit for a Hazardous Waste Management Facility, Permit Number NEV HW0021.* Carson City, NV.
2. Code of Federal Regulations, 2006. Title 40, Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." Washington, D.C.
3. Nevada Administrative Code, 2006. NAC 444.8632, "Compliance with Federal Regulations Adopted by Reference." Carson City, NV.
4. *Federal Facility Agreement and Consent Order*, 1996 (as amended February 2008). Agreed to by the State of Nevada; the U.S. Department of Energy, Environmental Management; the U.S. Department of Defense; and the U.S. Department of Energy, Legacy Management.
5. U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, 2009. *Corrective Action Decision Document/Corrective Action Plan for the 92-Acre Area and Corrective Action Unit 111: Area 5 WMD Retired Mixed Waste Pits, Nevada Test Site, Nevada.* DOE/NV--1326. Las Vegas, NV.
6. Reynolds Electrical and Engineering Company, Inc, 1994. *Alternative Evaluation Study, Ideal Cells for Arid Areas and Covers for the U-3ax/bl Disposal Unit*. DOE/NV/l1432--191. Las Vegas, NV.
7. Dwyer, S. F., J. C. Stormont, and C. E. Anderson, 1999. *Mixed Waste Landfill Design Report.* SAND99-2514. Sandia National Laboratories. Sandia, NM.
8. U.S. Department of Energy, 2000. *Alternative Landfill Cover.* DOE/EM-0558. Innovative Technology Summary Report. Sandia, NM.
9. Madalinski, K. L., D. N. Gratton, and R. J. Weisman, 2003. Evapotranspiration covers: An innovative approach to remediate and close contaminated sites. *Remediation Journal*, Vol. 14, Iss. 1, pp. 55–67.
10. U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, 2000. *Closure Plan for Corrective Action Unit 110: Area 3 RWMS U-3ax/bl Disposal Unit, Nevada Test Site, Nevada.* DOE/NV--647. Las Vegas, NV.

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