Mixed Low-Level Waste (MLLW) Storage and Disposal at the Nevada National Security Site (NNSS) - 11082

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ABSTRACT

This paper describes permitting, design, and construction activities for continued mixed low-level radioactive waste (MLLW) storage and disposal at the Nevada National Security Site (NNSS), formerly the Nevada Test Site. The original MLLW disposal cell (Cell 3) at NNSS ceased receiving mixed waste on November 30, 2010 at 5:00 p.m., as required under the conditions of a *Resource Conservation and Recovery Act* (RCRA) permit issued by the State of Nevada Division of Environmental Protection (NDEP) in 2005. With the closure of Cell 3, the potential existed that there would be no U.S. Department of Energy (DOE) waste management disposal facility or commercial facility permitted to dispose off-site generated greater than Class A equivalent MLLW beginning in December 2010. The DOE environmental cleanup effort and other mission-related activities that generate MLLW would not have a path to disposal, putting these activities in jeopardy.

In response to this concern, the DOE, National Nuclear Security Administration Nevada Site Office (NSO) prepared and submitted two separate RCRA permit applications to NDEP. The first application was for a new RCRA-compliant, double-lined mixed waste disposal unit (MWDU) with a permitted waste disposal capacity of 25,485 cubic meters (900,000 cubic feet). Because availability of this new MWDU was originally planned for March 2011, a mixed waste storage unit (MWSU) permit application was also submitted to NDEP so that MLLW could be received at the NNSS from on-site and off-site generators beginning in December 2010. This storage unit utilizes former mixed transuranic waste storage facilities not previously permitted under RCRA, but approved under a separate agreement with NDEP. This agreement did not authorize receipt of off-site generated waste.

Coordination with and reviews by NDEP regulators during permit development and the subsequent design phase resulted in a timely permit issuance. The MWDU permit application was submitted in September 2009 and received conditional approval in December 2009, subject to NDEP approval of the final design. Since NDEP participated in all stages of the design review, the final permit was approved in July 2010 following NSO's submittal of the final design in June..

The NSO completed construction, quality assurance, and certification activities of the MWDU by mid-December 2010. The MWSU was RCRA permitted on October 17, 2010. Continued MLLW disposal and storage capabilities at the NNSS depended on the permitting process. Timely NDEP regulatory review and approval was essential in facilitating successful project completion to allow continued acceptance of MLLW on the NNSS from across the DOE Complex.

INTRODUCTION

The NNSS, located in southern Nevada approximately 105 kilometers (km) (65 miles [mi]) northwest of Las Vegas, served as the nation's primary site for the development and testing of nuclear weapons and experiments from 1951 to 1992. National Security Technologies, LLC (NSTec) currently serves as the management and operating contractor of the NNSS for the NSO. Existing site facilities and infrastructure

enable the execution of operations and experiments in support of the nation's Stockpile Stewardship Program and the new National Center for Nuclear Security. There is also an ongoing Environmental Management mission at the NNSS that includes the Area 5 Radioactive Waste Management Complex (RWMC), a radioactive waste management disposal facility where low-level waste (LLW) and MLLW are safely and permanently disposed.

The Area 5 RWMC is located in one of the most arid and least populated regions of the United States, which provides an ideal location for near-surface disposal of LLW and MLLW. Annual potential evapotranspiration is approximately 15 times annual precipitation. Approximate annual precipitation is 5 inches. Accumulation of chloride in the vadose zone indicates that percolation of rainwater below the root zone ceased at least 10,000 to 15,000 years ago. The saturated zone occurs more than 241 meters [m] (790 feet [ft]) below the surface. The median travel time through the thick dry vadose zone is estimated to be greater than 50,000 years [1]. Transport of contaminants to the uppermost aquifer is extremely unlikely under current climatic conditions.

Mixed Low-Level Waste Disposal History

A MWDU designated as Cell 3 was constructed at the NNSS Area 5 RWMC in 1985, and LLW and MLLW were initially disposed at this location in late 1985. In September 1987, NDEP concurred with the NSO that the MWDU met regulatory requirements for interim status under Title 40 *Code of Federal Regulations* (CFR) 270.10(e) [2] for disposal of MLLW. Between 1985 and 1990, both LLW and MLLW were disposed in the eastern end of the Cell 3 MWDU. In 1990, the State of Nevada prohibited disposal of out-of-state MLLW. The NSO sought unsuccessfully to obtain a Part B RCRA permit for MLLW disposal under the alternative design provisions of hazardous waste landfill regulations.

Alternative designs for hazardous waste landfills are allowed in accordance with Title 40 CFR, Part 264.301(b) [3], where "alternative design and operating practices, together with location characteristics, will prevent the migration of any hazardous constituents (see §264.93) into the ground water or surface water at any future time." Area 5 RWMC provides an ideal location for such an alternative design.

Justification was developed to demonstrate that the NNSS alternate design and operating practices for an unlined MWDU were sufficient to prevent migration of hazardous constituents. The alternative landfill design of the Cell 3 MWDU used a systems approach comprising natural and engineered components to protect surface and subsurface waters. Under the alternative design, a pathway to groundwater 241 m (790 ft) deep does not exist. The natural components of the design system included lateral and lower buffer zones; and the engineered components included an operational cover, and a monolayer, vegetated closure cover. The lateral buffer zone (3 m, [10 ft]) surrounding Cell 3 would contain any component of lateral transport of moisture and/or contaminants, and would ensure no interference with or from adjacent disposal units. A lower buffer zone of native alluvium (20 m [66 ft]) contained and dispersed wetting fronts, and isolated any contaminants moving with wetting fronts from surface and subsurface waters. An operational cover of screened alluvium soil protected the waste zone from precipitation events and minimized drainage downward into the waste zone, thereby reducing production of leachate. The vegetated monolayer cover of native alluvium would maintain the high storage capacity of the operational cover and add plant transpiration to increase the natural evapotranspiration processes of moisture removal in the arid climate setting. The boundary where upward liquid advection rates approach zero is referred to as the no-liquid flux boundary (NLFB), shown in Figure 1. These features significantly reduce infiltration into the waste zone and help assure that there is no pathway to groundwater.

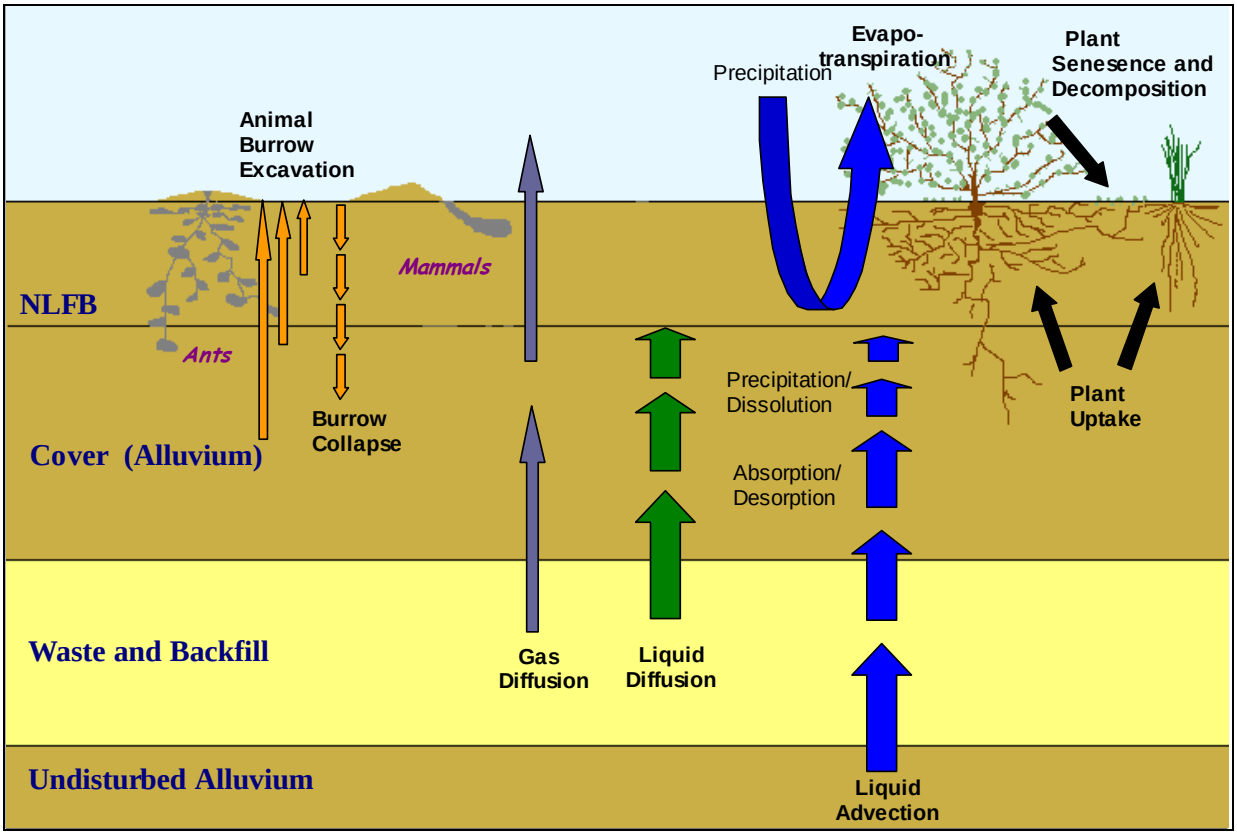

Fig. 1. Transport pathways from arid landfills.

Mixed Low-Level Waste Permitting History

NSO sought a Part B RCRA Permit for the Cell 3 MWDU contending that the physical and engineering features of the alternative landfill design fulfilled the requirements of 40 CFR 264.301(b) [3] and provided confidence that hazardous constituents from the Cell 3 MWDU would not migrate to groundwater. However, the State of Nevada denied a RCRA Part B Permit of the alternative design and continued to allow under interim status only limited MLLW generated within the state to be disposed from 1990 to 2005. NSO continued negotiations and in 2005 NDEP permitted MLLW disposal in the Cell 3 MWDU under the following conditions:

(1) The DOE agreed to close the Cell 3 MWDU the earlier of December 1, 2010, or when 20,000 cubic meters (m^3) (706,000 cubic feet [ft^3]) of MLLW was disposed.

(2) If more MLLW disposal capacity was needed at that time, then DOE would build a new MLLW disposal cell in compliance with Title 40 CFR 264 [3] requirements.

At the time of the agreement, DOE was of the opinion that the Hanford Site and commercial sites would be able to meet the MLLW disposal needs of the DOE Complex. However, due to stakeholders' intervention, the Hanford Site is unable to accept DOE Complex MLLW at least until 2015. Commercial MLLW disposal has not yet been able to meet DOE's continued need to dispose classified MLLW and greater that Class A equivalent MLLW.

CONCEPTUAL DESIGN

In 2009, DOE decided to seek a new RCRA Permit for a replacement MWDU at the NNSS so NSO initiated discussions with NDEP to pursue this goal. DOE funded the required permit application and in 2009, NSTec completed a conceptual design to serve as the basis of a permit application. The proposed MWDU met the siting criteria of 40 CFR 264.18, "Location Standards" [3], and met all of the design requirements of 40 CFR 264, "Subpart N–Landfills" [3].

In order to facilitate NDEP review and approval, the design concept was based on NDEP-approved RCRA Subtitle C waste landfill designs at the hazardous waste facility operated by the U.S. Ecology Nevada, Inc. (USEN), in Beatty, Nevada. Beatty is approximately 60 miles west of the Area 5 RWMC, located in a similar hydrogeologic and climatic setting.

The new Area 5 MWDU conceptual liner configuration was modeled closely on USEN's liner. The conceptual design is shown in Fig. 2 and consisted from the top down of (1) an earthen working surface to prevent liner damage; (2) a primary leachate collection and removal system of double-sided geocomposite to allow leachate drainage; (3) a 80-mil high-density polyethylene (HDPE) geomembrane as the primary liner; (4) a secondary leachate collection and leak-detection system of double-sided geocomposite to allow leachate drainage and detection of any leakage from the primary liner; (5) a composite liner of 60-mil HDPE geomembrane; and (6) a geosynthetic clay liner (GCL) as the secondary composite liner. The cell sideslopes had a similar configuration, except a 30-mil HDPE sacrificial layer was planned to protect the liner sideslopes as the top layer instead of an earthen surface.

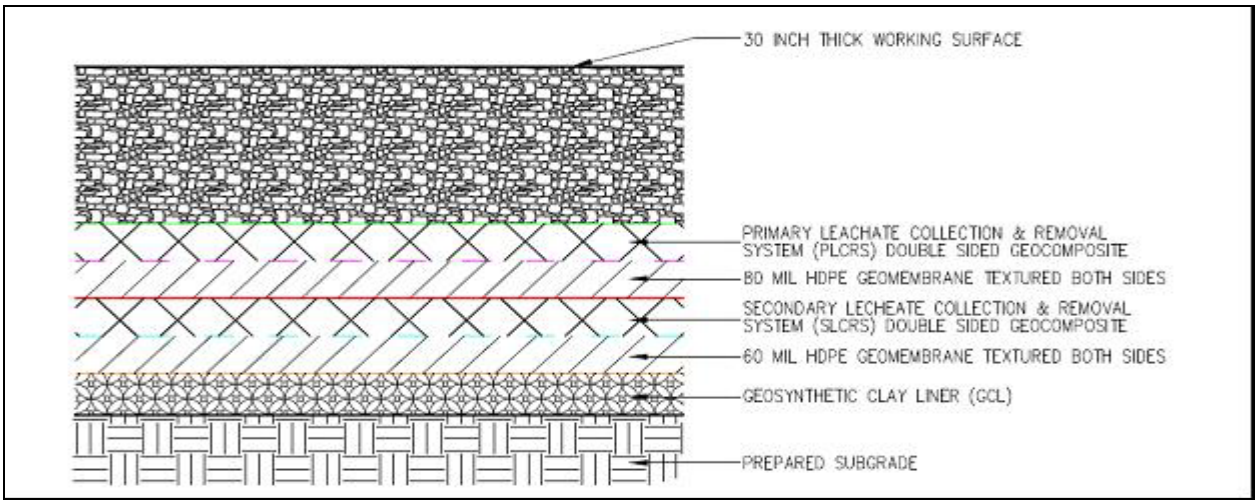

Fig. 2. Conceptual mixed waste disposal unit liner configuration.

The new Area 5 MWDU was conceptualized to have approximate floor dimensions of 45.7 m by 91.4 m (150 ft by 300 ft) and a depth of approximately 6 m (20 ft) below the ground surface. The proposed cell was located in the extreme northwestern portion of the RWMC nuclear facility to be close to available power and to provide an area for future cell expansion. The conceptual site plan is shown in Fig. 3.

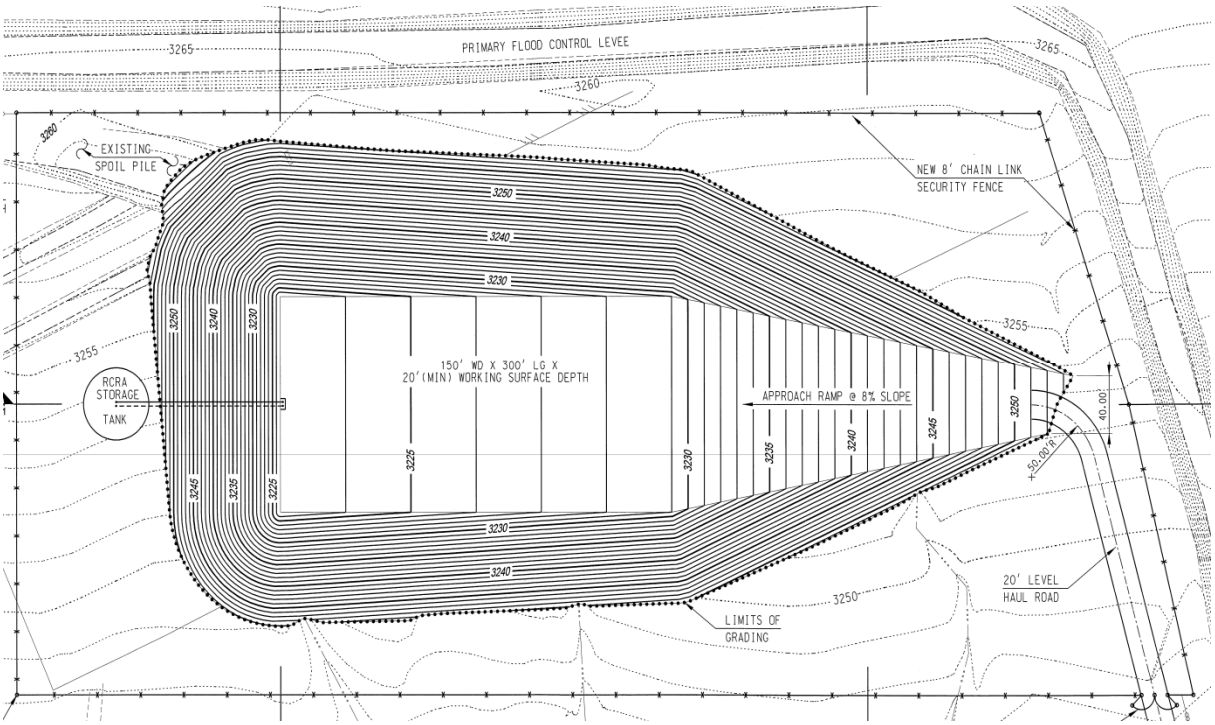

Fig. 3. Conceptual mixed waste disposal unit site plan included in permit application.

The draft permit application was completed in spring 2009 and was reviewed by NSO and DOE headquarters (HQ). Several meetings were also held with NDEP to ensure that the application would be complete upon submittal and to facilitate their review. A pre-application public meeting was held on September 2, 2009, to inform the public of the intent to submit the application and to solicit comments. The public meeting was held as an open house poster session with several subject matter experts available for one-on-one discussions. This format worked well both to provide information to the public and to answer any questions or concerns.

The RCRA Part B application was submitted to NDEP on September 29, 2009 [4]. Due to previous discussions, NDEP was able to review the application and provide a completeness determination in early October. At the same time, a fact sheet was prepared and the draft permit made available for a 45-day public comment period as required by 40 CFR 124.10 [5]. During the public comment period, NSO made a presentation to the Nevada Site Specific Advisory Board (NSSAB), which provided a letter of support for the new MWDU to NDEP. The public comment period closed on December 11, 2009, with no adverse comments received. NDEP provided conditional approval of the permit on December 17, 2009, under the condition of approval of the final design before issuance of the final permit to allow construction of the cell to commence.

DESIGN REVIEW PROCESS AND FINAL DESIGN

State regulators were provided full access to the traditionally internal design review meetings at 30, 60, and 90 percent stages. This access and preliminary review allowed the regulators to conduct in-depth reviews during the four-month design process in March through June 2010, which allowed the final review and approval to be accomplished in a two-week period. The design review participation by NDEP also provided assurance that the NSTec design review used geotechnical and liner experts to provide a superior, critical review of the design for compliance, constructability, and long-term performance.

The 30 percent design review kick-off meeting was held on April 5, 2010, with NNSS, NSO, and NDEP representatives participating. Several comments on the 30 percent design resulted in improved performance and lower cost. As discussed below, cell gross volumetric capacity was increased by 22 percent, liner materials were reduced by approximately 5 percent, and leachate tank size was reduced by 70 percent.

The conceptual design (Fig. 4) utilized a 3H:1V sideslope. In observation of current disposal cells at the Area 5 RWMC and others in the state of Nevada, a 2H:1V sideslope was approved and maintained the slope crest with the same footprint to increase the floor size to increase the available disposal capacity. The cell floor size was increased from 4,181 square meters (m^2) (45,000 square feet [ft^2]) to 5,106 m^2 (54,964 ft^2) by using the steeper sideslopes. Waste disposal volume remained within the RCRA permit application submittal at 25,485 m^3 (900,000 ft^3) when considering the approximate 70 to 75 percent placement efficiency of containerized waste.

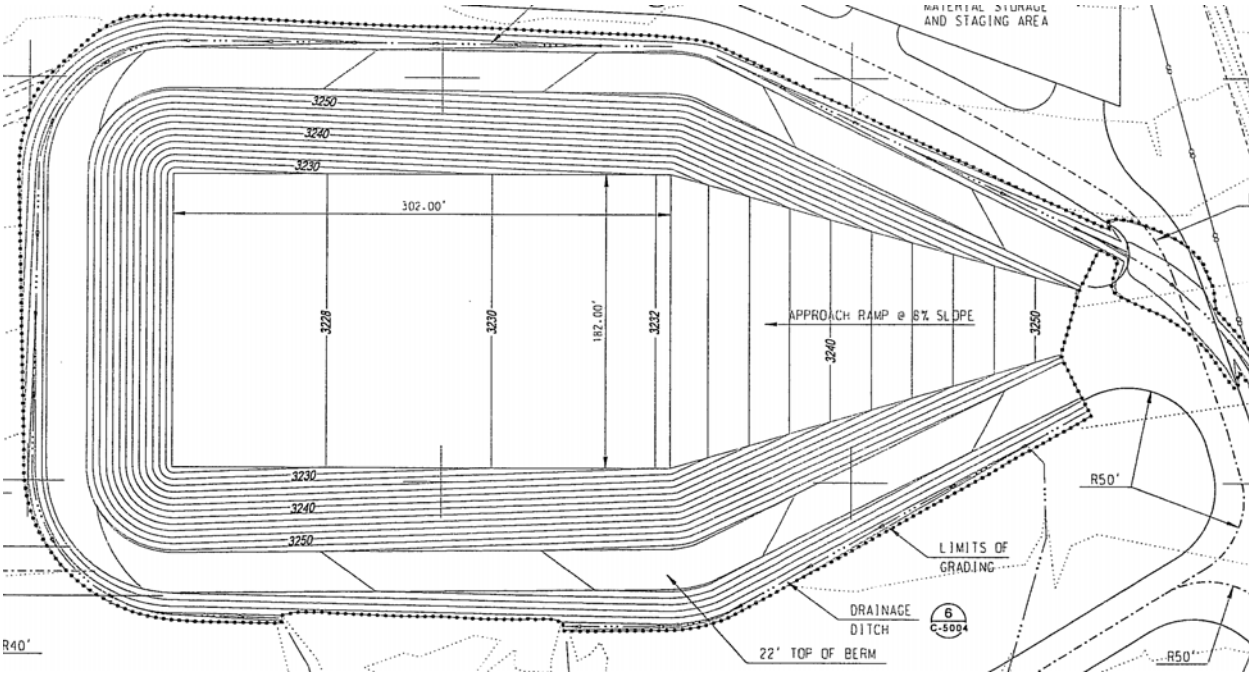

Fig. 4. Final mixed waste disposal unit site plan.

The addition of a road around the crest of the cell at a constant elevation, as opposed to the varying crest elevation of the conceptual design, reduced the liner materials requirement by approximately 15 percent. This was especially important as material prices escalated markedly during the design period.

The expected leachate receiving tank volume was estimated using the Hydraulic Evaluation of Landfill Performance (HELP) model. By using site experts and local meteorological data, the tank volume was reduced from 37,854 liters (10,000 gallons) to 11,356 liters (3,000 gallons). Leachate is projected to be collected only from precipitation events during the active period when the cell is open.

The primary geomembrane layer was proposed to be reduced from an 80-mil HDPE to a 60-mil HDPE liner. However, based on the approved Beatty design, an 80-mil primary liner was maintained.

The in-cell leachate collection sump, where the highest head of liquid would be seen, was double-lined with HDPE to provide additional protection.

The conceptual floor design consisted of a two percent floor grade from the toe of the ramp to the leachate collection sump on the west side of the RCRA lined cell. With this design, leachate would have collected along the entire west toe. A one percent cross slope was added on the floor to the center line of the cell, so that leachate drains towards the sump, rather than the entire west floor toe of slope.

Most of the major technical and regulatory issues were addressed in the 30 percent design review. The 60 and 90 percent reviews covered mostly routine issues associated with design report and specification format. However, one issue was addressed that resulted in replacement of the 30-mil sacrificial HDPE layer with 24-inch select native soils cover. The decision to use the 2-ft protective cover was determined by all reviewers to provide a superior cover based on several design factors. The GCL could have become hydrated and lose stability without confining pressure of overburden soil. Also, wind loading on the approximate 2.3 acres of sideslope could have compromised the long-term stability of the 30-mil HDPE. Placement of the soil cover by the construction contractor also greatly simplified the later operational placement of waste cover in the cell.

The Issue for Construction (IFC) design package was completed and approved by the NSTec Design Authority on June 28, 2010. The approved design was submitted to NDEP on June 29, 2010 for review in accordance with the December 2009 conditional. Reviews conducted by NDEP regulators throughout the design review process resulted in granting of the final RCRA permit on July 13, 2010.

CONSTRUCTION SCHEDULE

To meet the December 1, 2010, deadline for closure of the Cell 3 MWDU, the new RCRA cell had to overcome two significant schedule constraints. First, regulatory approval of a new disposal cell is always uncertain, given the required public involvement. The second constraint was related to the permitting process uncertainty, which made DOE HQ reluctant to seek funding until preliminary approval of the permit application in December 2009. At that late date, Congressional reprogramming was required, which eventually resulted in a month-long delay to start construction in summer 2010.

Once commenced on August 11, 2010, construction proceeded considerably with the placement of fill for the southern bermed area of the cell. Excavation of more than 76,000 m^3 (100,000 yd^3) of native soil was completed in just over three weeks by September 9, 2010. Installation of the five layers of geosynthetics totaling more than 65,000 m^2 (700,000 ft^2) was completed by October 22, 2010. Installation of the leachate collection piping, pumps and tank was completed by November 24, 2010 when the cell construction was substantively complete. Finally, fencing was installed to secure the facility as required by the regulations and to provide necessary physical security.

A management self-assessment was conducted by NSTec with observation by NSO and NDEP representatives to assure that all physical and programmatic systems were in place to allow continued receipt of MLLW at the NNSS in support of the DOE Complex. On December 15, 2010, NSO commenced operations for the replacement MWDU.

MIXED WASTE STORAGE UNIT PERMIT

With the uncertainty regarding how long it would take to obtain a RCRA Part B Permit and complete construction of a new MWDU, NSO decided to seek a MLLW storage permit in parallel to bridge any "gap" between when the Cell 3 MWDU would close and the new MWDU would become operational. With existing facilities at the Area 5 RWMC capable of compliantly storing MLLW, the only challenge was to obtain permit approval by November 30, 2010, when the Cell 3 MWDU would cease accepting MLLW.

In response to this request, NSTec proceeded to prepare a RCRA Part B Permit Application for the storage of MLLW. Initially, a public meeting was held to inform the community of NSO's intent to submit a permit application in April 2010. NSO accepted public comments through May 2010. The RCRA Part B Permit Application was submitted to NDEP in June 2010 [6], followed by a formal 45-day public comment period that ended September 15, 2010. No comments were received during this comment period. The final approved permit became effective October 17, 2010. Again, the early and frequent collaborative involvement between the NSO and NDEP resulted in the issuance of this permit in a timely manner.

Four locations at the Area 5 RWMC were identified for the storage of MLLW and included in the permit application. These locations were formerly used for mixed transuranic (TRU) waste storage (disposition completed in 2009) and thus already met RCRA and Documented Safety Analysis (DSA) requirements for mixed waste storage. These facilities are the (1) TRU Pad Cover Building and Storage Pad, (2) Sprung Instant Structure Building, (3) Visual Examination and Repackaging Building, and (4) Drum Holding Pad. Issuance of the MWSU permit was required to terminate the Mutual Consent Agreement with the State of Nevada, which was formerly required for compliant storage in these locations of MLLW generated on-site. With this new permit in place, the NNSS was able to continue to support DOE Complex waste generators without any delay in the ability to receive MLLW for ultimate disposal.

CONCLUSION

The NNSS was able to provide uninterrupted MLLW-receiving capability beyond the December 1, 2010, required closure of the Cell 3 MWDU to support its waste generating customers in the DOE Complex. The waste-generating sites rely on timely disposal of radioactive waste to accomplish their missions in national defense and environmental cleanup. The ability to maintain MLLW-receiving capability at the NNSS was accomplished by closely working with the State regulator (NDEP) to achieve approval of two separate RCRA permit applications: (1) a new MWDU [4] and (2) a MWSU [6]. The new MWDU was constructed ahead of schedule to provide the needed disposal capacity. The MWSU was permitted and ready to provide "gap" storage if the disposal unit schedule could not be accelerated. Timely NDEP regulatory review and approval was essential in facilitating successful project completion to allow continued acceptance of MLLW from across the DOE Complex.

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