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Study Examining a DOE Proposal to Dispose of Mixed Low Level Waste at the Nevada Test Site Using an Alternative Landfill Design

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May 13th, 2005

ABSTRACT

The Department of Energy has set forth a proposal to use an Alternative Landfill Design (ALD) for the Mixed Low Level Waste disposal facility, in Area 5 of the Nevada Test Site in place of a traditional engineered liner for the facility. The purpose of this thesis is to examine the impasse between the DOE and the State of Nevada regarding the proposal of placing a traditional liner versus the alternative landfill design, using a case study method to provide recommendations to policy makers and the NTS CAB. This project used secondary data to evaluate, and determine the effectiveness of the ALD.¹

¹ The author wishes to thank the Nevada Test Site Community Advisory Board and the DOE for supporting this thesis. The views expressed in this thesis do not necessarily reflect those of the NTS CAB or the DOE. The author is responsible for all content and possible errors.
**Introduction**

The Nevada Test Site (NTS) consists of 1,380 square miles of land (roughly the size of the state of Rhode Island), approximately 65 miles northwest of Las Vegas, in the southeastern corner of Nye County (DOE/NV-958 2004). The NTS is one of two United States Department of Energy (DOE) facilities designated to accept and dispose of low-level radioactive waste from approved DOE and defense industry sites across the U.S. (DOE/NV-829 2003). A map depicting the location of the NTS in the state of Nevada is provided below (NTS Site ER 2001, pg. 40):

**Fig. 1 Map of Nevada showing the location of the Nevada Test Site**
There are two types of waste disposed\(^1\) of at the NTS: Low-Level Waste (LLW) and in the past Mixed Low Level Waste (MLLW). Currently a major issue regarding MLLW at the NTS is the proposed acceptance of other DOE sites’ MLLW for disposal at the NTS. There is an estimated 419,000 cubic meters of MLLW in the nation (roughly the equivalent volume of four-7 story buildings, each the size of a football field), that needs to be stored at an acceptable location (DOE/IG-0426, 1998). A portion of this waste is already stored at various sites across the country; however, the majority of the waste will come from future cleanup of many DOE sites nationwide. The DOE Waste Management Programmatic Environmental Impact Statement\(^2\) identified two DOE sites for MLLW disposal: the NTS and the Hanford facility near Richland, WA.

The main issue with the possibility of disposing additional MLLW to the NTS disposal facilities is that the current waste pit does not have an engineered liner\(^3\) protecting the area from leachate that may accumulate from disposed waste. The Nevada Division of Environmental Protection (NDEP) recently stated that before any additional MLLW is disposed, the facility must be fitted with an engineered liner. However, the DOE contends that because of Nevada’s climate and geologic conditions, it is a prime candidate for a waiver provided in the Resource Conservation and Recovery Act (RCRA) part B permit (Appendix C), which states that an alternative design may be used in place of a traditional liner, pending approval from all proper agencies.

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\(^1\) The term disposal is used in reference to long term or permanent placement of the waste, where as storage implies short term placement of the waste.

\(^2\) “This EIS is a nationwide study that examines the environmental impacts of managing radioactive wastes from past, present, and future DOE activities. It assists in helping the DOE in improving the efficiency and reliability of management of its current and anticipated volumes of hazardous and radioactive wastes”(DOE WM PEIS).

\(^3\) A traditional liner is typically constructed of clay or heavy-duty polyethylene and is often used in areas with very different environmental conditions than what are found at the NTS.
The purpose of this thesis is to examine the impasse between the DOE and the State of Nevada regarding the issue of placing a traditional liner versus the alternative landfill design, using a case study method to provide recommendations to policy makers and the NTS CAB.¹

**Background/Literature Review**

**Background (Federal):**

In order to better understand why it is important to use specific protocols in the storage and handling of Mixed Low Level Waste, MLLW is defined as follows:

**Mixed Low-Level Waste:** any waste containing hazardous and chemical waste, source materials, special nuclear materials, and or by-product materials. It contains both radioactive and Resource Conservation and Recovery Act (RCRA) waste. Hazardous waste is defined by the EPA as “waste that is harmful to human health or the environment and includes substances such as ethyl alcohol, Freon, and various metals” (DOE/NV—540 Rev1).

(For additional definitions and an acronym list of all important departments or substances listed throughout the paper see Appendix A).

¹ The Community Advisory Board (CAB) for the NTS was established in 1994 to provide a forum for community involvement in all aspects of the site’s Environmental Management (EM) program. The CAB deals with a myriad of issues related to environmental restoration, waste management and technology development. Nine DOE sites have formed and funded Site Specific Advisory Boards typically comprised of citizen volunteers, with varying backgrounds, who provide input on DOE EM projects.
The Resource Conservation and Recovery Act (RCRA), was enacted by Congress in 1976 to establish a system for managing non-hazardous and hazardous solid waste in an environmentally sound manner. Specifically, it provides for the management of hazardous wastes from the point of origin to the point of final disposal (i.e., “cradle to grave”). RCRA also promotes resource recovery and waste minimization (DOE/EPG, 2004).

In 1984, Congress added new amendments to RCRA, known as the Hazardous and Solid Waste Amendments of 1984, which expanded and increased the requirements of RCRA. More specifically, these initiatives were developed to enhance RCRA by adding more strenuous restrictions. These include the Land Disposal Restrictions (Section 3004(d) of RCRA), which prohibit the land disposal of untreated hazardous wastes. In addition, structural and area restrictions were strengthened, and the EPA now had the power to “require corrective action for releases of hazardous waste and hazardous constituents from any solid waste management unit, regardless of when the waste was placed in the unit” (DOE Environmental Policy and Guidance, 2004).

**Background (local):**

MLLW, regardless of its type of radioactive element is hazardous waste and consequently is subject to RCRA hazardous waste regulations, including Federal land disposal restrictions; therefore, it requires an extensive process for storage, treatment, and disposal. Under its delegated RCRA authority from the EPA, the State of Nevada’s, Division of Environmental Protection (NDEP) Bureau of Waste Management, and its Hazardous Waste Management Program, regulate MLLW. The purpose of the program
is "to protect human health, public safety and the environment from the effects of improper, inadequate or unsound management of hazardous waste; establish a program for regulation of the storage, generation, transportation, treatment and disposal of hazardous waste; and ensure safe and adequate management of hazardous waste” (NDEP, 2004).

“The hazardous waste program is responsible for permitting and inspecting hazardous waste generators and disposal, transfer, storage and recycling facilities. It is also responsible for enforcing state hazardous waste statutes and regulations and is authorized to enforce Federal hazardous waste regulations in lieu of the EPA. The EPA requires an authorized state's hazardous waste regulations to be at least as stringent as those established at the Federal level. To accomplish this, Nevada adopts by reference, with certain modifications, Federal hazardous waste regulations. To remain authorized the hazardous waste program must periodically update the existing state regulations to reflect changes approved by the EPA” (NDEP, 2004).

The State of Nevada felt that an agreement needed to be made between; Nevada, the DOE and the DOD (Department of Defense) that would help monitor cleanup schedules for all sites contaminated by the DOE and the DOD, and to allow communication between relevant parties without excess litigation. In 1996 the State through the NDEP created the Federal Facility Agreement and Consent Order (FFACO) that would change this agreement into a regulation (NTS CAB EM 101 Notebook, 2004).

The NTS currently disposes of MLLW on property in the Pit 3 Mixed Waste Disposal Unit (MWDU), which was constructed in 1985. The pit is located within the
boundaries of the Area 5 Radioactive Waste Management Complex (RWMC) (Appendix B). An overview picture of the site is provided below (NTS WAC, pg. 27).

**Fig. 2 Overview of Area 5, MLLW disposal pit 3 at the NTS**

The pit currently contains MLLW that was collected from off site and onsite locations prior to 1990. The NTS currently accepts and disposes MLLW generated solely from on-site activities. “The waste handled at this facility must be dealt with in accordance with strict treatment/disposal regulations established by the Nevada Division of Environmental Protection (NDEP) (DOE/NV-920).” The pit in which the MLLW is currently disposed does not have an engineered liner; however, it has been carefully monitored since 1987 to ensure that any leachate does not contaminate groundwater. Because RCRA provides for a waiver from an engineered liner under specific conditions, the DOE is currently seeking a waiver from the requirement for a liner. This waiver
provision is found in RCRA 40 CFR-Chapter 1- Part 264.301 Design and operating requirements (Appendix C).

In 2000, the DOE and the NDEP (Nevada Department of Environmental Protection) approved the alternative design clause in RCRA for the MLLW pit at the NTS. This regulation was viewed as acceptable at the NTS because of the composite geology of the area, the weather patterns at the site, and because the ground water is 775 feet below the surface of the ground, generally allowing for all water to evaporate before it reaches groundwater level. With the ALD the pit would be left as is, which according to the DOE, is in complete compliance with the RCRA part B permit. It is believed that the risks to leave the pit as it is would be far less than installing a traditional, engineered liner in the pit.

“On May 17, 2004, the NDEP reversed its decision and filed a Notice of Deficiency with the DOE stating that it required that a traditional liner be placed in the pit. On July 7, 2004 the DOE gave an in-depth justification for the Alternative Design, yet on August 3, 2004 the NDEP filed its final Notice of Deficiency against the DOE stating that they still were requiring that a traditional liner be in place. In October 2004, the final notice was revised and stated that the DOE should either request a variance from the State Environmental Commission or submit an application with the liner engineering documents” (Giblin, 2005).

The next section will show the method established to examine the alternative landfill design and its effectiveness at the NTS, and additional factors included when making the decision between the alternative landfill design and a traditional liner for the MLLW pit at the NTS.
Method

This thesis used the case study method focusing on Environmental Risk, Policy and Law pertaining to this proposal. The following questions (based from Beierle, 2002) were used to determine the effects and changes that the proposal could have on the NTS and surrounding areas.

- How does the alternative landfill design work, and is it suitable for placement at the Nevada Test Site?
- What is the cost and risk of placing a traditional liner?
- Examine Nevada’s hazardous and solid waste management requirements and ensure that they will be met with the proposal.
- Does this proposal follow all laws and regulations set forth by RCRA and the U.S. government regarding safe disposal and management of MLLW?
- What might be the environmental effects over time to the NTS and the surrounding areas?

Each question will be addressed in separate sections in the following data section, and the findings described in detail to offer the most thorough conclusion possible.

Data:

(1) How does the Alternative Landfill Design work, and is it suitable for placement at the Nevada Test Site? (The next four parts to question one are taken directly from the RCRA part B permit, the parts that are required to be meet when asking for use of the waiver)
Alternative Landfill Design and RCRA part B permit

(A) “In deciding whether to grant an exemption, the Regional Administrator will consider:

(1) The nature and quantity of the waste:”

The NTS has specific criteria that must be met, as stated in Appendices E & F. Waste will not be accepted at the NTS without first meeting these strict regulations. However, the quantity of the waste may increase, due to the fact that there are only two sites to dispose of MLLW in the U.S., Hanford (being the only alternative to the NTS) has filed a referendum and legally cannot accept any MLLW for the time being.

(2) “The proposed alternative design and operation:”

The alternative design was accepted into RCRA specifically for areas of the country that would meet the established requirements. The design is simple. As illustrated below (Giblin, 2005), the design incorporates a lower buffer zone that is 20m (66ft) deep, a lateral buffer zone that is 3m (10ft) in width, and a closure cover that is 4m (13ft) in width.
Waste will initially be covered by soil as it is emplaced; however, the final closure cover will not be placed on the pit until the pit has been completely filled. The closure cover will be graded to ensure that runoff water flows off and away from the pit. Native vegetation will be planted along the cover of the pit to help retain ground soil and prevent erosion of the pit cover.

(3) “The hydrogeologic setting of the facility, including the attenuative capacity and thickness of the liners and soils present between the landfill and ground water or surface water:”

The pit 3 in area 5 of the NTS is located within a geologic area referred to as Frenchman Flat. There are six separate geologic locations that differ in size and composition at the NTS. Each is evaluated and explained in detail each year in the NTS Annual Site Environmental Report. The following is an overview of
the geologic and hydrogeologic information for Frenchman Flat region. (The figure below is from the NTS Site ER 2001 pg.185)

Fig. 3 Generalized Geologic Map of the NTS and Vicinity

Since Area 5 is located within the Frenchman Flat region, this paper will limit information to that area. The Frenchman Flat area has a very complex geology. The NTS is located within an active fault plain, with numerous types of faults occurring throughout the region. “During the late Mesozoic era, the region
was subjected to compressional deformation, which resulted in folding, thrusting, uplift, and erosion of the pre-Tertiary rocks” (NTS Site ER 2001 pg. 190). This is shown in the following figure (NTS Site ER 2001 pg. 190).

Fig. 4 Conceptual East-West Cross Section Through Frenchman Flat Showing SubBasins Formed by Fault Blocks

“The strata in the Frenchman Flat area have been subdivided into five Tertiary-age HSU’s (Hydrostratigraphic Units) (including the Quaternary/Tertiary alluvium) and three pre-Tertiary HSU’s. In descending order these units are: the AA, the Timber Mountain aquifer (TMA), the Wahmonie volcanic confining unit (WVCU), the tuff confining unit (TCU), the volcaniclastic confining unit (VCU), the LCA, and the LCCU” (NTS Site ER. 2001, pg. 191). These HSU’s are defined in detail in the following table, which is from the NTS Site ER 2001, pg. 203.
### Table 1 Hydrostratigraphic Units of the Frenchman Flat Area

<table>
<thead>
<tr>
<th>Hydrostratigraphic Unit (Symbol)</th>
<th>Dominant Hydrogeologic Unit</th>
<th>Typical Lithologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial Aquifer (AA)</td>
<td>AA, minor LFA</td>
<td>Alluvium (gravely sand); also includes relatively thin basalt flow in northern Frenchman Flat and playa deposits in south-central part of basin.</td>
</tr>
<tr>
<td>Timbor Mountain Aquifer (TMA)</td>
<td>WTA, VTA</td>
<td>Welded ash-flow tuff and related nonwelded and air-fall tuffs; vitric to devitrified.</td>
</tr>
<tr>
<td>Wahmonie Volcanic Confining Unit (WVCU)</td>
<td>TCU, minor LFA</td>
<td>Air-fall and reworked tuffs; debris and breccia flows; minor intercalated lava flows. Typically altered: zeolitic to argillic.</td>
</tr>
<tr>
<td>Tuff Confining Unit (TCU)</td>
<td>TCU</td>
<td>Zeolitic bedded tuffs, with interbedded but less significant zeolitic, nonwelded to partially welded ash-flow tuffs</td>
</tr>
<tr>
<td>Volcaniclastic Confining Unit (VCU)</td>
<td>TCU, Minor AA</td>
<td>Diverse assemblage of interbedded volcanic and sedimentary rocks including tuffs, shale, tuffaceous and argillaceous sandstones, conglomerates, minor limestones.</td>
</tr>
<tr>
<td>Upper Clastic Confining Unit (UCCU)</td>
<td>CCU</td>
<td>Argillite, quartzite; present only in northwest portion of model in the CP Basin</td>
</tr>
<tr>
<td>Lower Carbonate Aquifer (LCA)</td>
<td>CA</td>
<td>Dolomite and limestone; the &quot;regional aquifer&quot;</td>
</tr>
<tr>
<td>Lower Clastic Confining Unit (LCCU)</td>
<td>CCU</td>
<td>Quartzites and siltstones; the &quot;hydrologic basement&quot;</td>
</tr>
</tbody>
</table>

(Tables retrieved from NTS Site ER. 2001, pg. 200 and 201)

(These tables help to explain the ability of each type of rock in the Frenchman Flat area to conduct water. In addition, it explains size and structure of the rocks to better understand what they are and how the ground under the area is constructed.)
Table 2 Hydrogeologic Units of the NTS Area

<table>
<thead>
<tr>
<th>Hydrogeologic Unit</th>
<th>Typical Lithologies</th>
<th>Hydrologic Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial Aquifer (AA)</td>
<td>Unconsolidated to partially consolidated gravelly sand, eolian sand, and colluvium;</td>
<td>Has characteristics of a highly conductive aquifer, but less so where lenses of clay-rich paleocolluvium or playa deposits are present.</td>
</tr>
<tr>
<td></td>
<td>thin, basalt flows of limited extent</td>
<td></td>
</tr>
<tr>
<td>Welded-Tuff Aquifer (WTA)</td>
<td>Welded ash-flow tuff; vitric to devitrified</td>
<td>Degree of welding greatly affects interstitial porosity (less porosity as degree of welding increases) and permeability (greater fracture permeability as degree of welding increases).</td>
</tr>
<tr>
<td>Vitric-Tuff Aquifer (VTA)</td>
<td>Bedded tuff, ash-fall and reworked tuff; vitric</td>
<td>Constitutes a volumetrically minor hydrogeologic unit. Generally does not extend far below the static water level due to tendency to become zeolitized (which drastically reduces permeability) under saturated conditions. Significant interstitial porosity (20 to 40 percent). Generally insignificant fracture permeability.</td>
</tr>
<tr>
<td>Lava-Flow Aquifer (LFA)</td>
<td>Rhyolite lava flows; includes flow breccias (commonly at base) and pumiceous zones</td>
<td>Generally a caldera-filling unit. Hydrologically complex; wide range of transmissivities; fracture density and interstitial porosity differ with lithologic variations.</td>
</tr>
<tr>
<td></td>
<td>(commonly at top)</td>
<td></td>
</tr>
<tr>
<td>Tuff Confining Unit (TCU)</td>
<td>Zeolitized bedded tuff with interbedded, but less significant, zeolitized,</td>
<td>May be saturated but measured transmissivities are very low. May cause accumulation of perched and/or semi-perched water in overlying units.</td>
</tr>
<tr>
<td></td>
<td>nonwelded to partially welded ash-flow tuff</td>
<td></td>
</tr>
<tr>
<td>Intracaldera Intrusive</td>
<td>Highly altered, highly injected/intruded country rock and granitic material</td>
<td>Assumed to be impermeable. Conceptually underlies each of the SWNF calderas and Calico Hills.</td>
</tr>
<tr>
<td>Confining Unit (ICU)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granite Confining Unit (GCU)</td>
<td>Granodiorite, quartz monzonite</td>
<td>Relatively impermeable; forms local bulbous stocks, north of Rainier Mesa and Yucca Flat; may contain perched water.</td>
</tr>
<tr>
<td>Clastic Confining Unit (CCU)</td>
<td>Argillite, siltstone, quartzite</td>
<td>Clay-rich rocks are relatively impermeable; more siliceous rocks are fractured, but with fracture porosity generally sealed due to secondary mineralization.</td>
</tr>
<tr>
<td>Carbonate Aquifer (CA)</td>
<td>Dolomite, limestone</td>
<td>Transmissivity values differ greatly and are directly dependent on fracture frequency.</td>
</tr>
</tbody>
</table>
Table 3 Summary of Hydrologic Properties for Hydrogeologic Units at the NTS

<table>
<thead>
<tr>
<th>Hydrogeologic Unit (a)</th>
<th>Fracture Density (h.o)</th>
<th>Relative Hydraulic Conductivity (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial Aquifer</td>
<td>Very low</td>
<td>Moderate to very high</td>
</tr>
<tr>
<td>Vitrific-Tuff Aquifer</td>
<td>Low</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Welded-Tuff Aquifer</td>
<td>Moderate to High</td>
<td>Moderate to very high</td>
</tr>
<tr>
<td>Lava-Flow Aquifer (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumiceous Lava</td>
<td>Low</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Vitrific</td>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>Zeolitic</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>Stony Lava and Vitrophyre</td>
<td>Moderate to High</td>
<td>Moderate to very high</td>
</tr>
<tr>
<td>Flow Breccia</td>
<td>Low to Moderate</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Tuff Confining Unit</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>Intrusive Confining Unit</td>
<td>Low to Moderate</td>
<td>Very Low</td>
</tr>
<tr>
<td>Granite Confining Unit</td>
<td>Low to Moderate</td>
<td>Very Low</td>
</tr>
<tr>
<td>Carbonate Aquifer</td>
<td>Low to high (variable)</td>
<td>Low to very high</td>
</tr>
<tr>
<td>Clastic Confining Unit</td>
<td>Moderate</td>
<td>Very low to low (k)</td>
</tr>
</tbody>
</table>

The area is made up of Quaternary-Tertiary Alluvial Sediments, which are mainly volcanic in origin, with the exception of the alluvial aquifer, which is the uppermost Hydrostratigraphic Unit (HSU) (NTS Site ER 2001). “HSUs are groupings of contiguous stratigraphic units that have a particular hydrogeologic character, such as an aquifer or a confining unit. The concept of HSUs is very useful in volcanic terrains where stratigraphic units can vary greatly in hydrologic character, both laterally and vertically” (NTS Site ER 2001 pg. 182).

The quaternary-tertiary rocks are important because “(1) most of the underground nuclear tests were done in these units, (2) they constitute a large percentage of the rocks in the area, and (3) they are inherently complex and heterogenous” (NTS Site ER 2001, pg.184).
The alluvial sediments of the Frenchman Flat area vary in size and texture, comprised primarily of a loosely consolidated mixture made up of silicic volcanic and Paleozoic-age sedimentary rocks. Throughout the Frenchman Flat area, the alluvium thickness ranges from 100 ft. to 3,732 ft. in the deepest sub-basins. With this, and the depth of the water table being so deep, the alluvium is generally unsaturated (NTS Site ER, 2001).

(4) “All other factors which would influence the quality and mobility of the leachate produced and the potential for it to migrate to ground water or surface water:” (This and all previous quotes in Data section- RCRA part B permit Appendix C).

With regards to the leachate transferring to the groundwater, this is explained in detail in the previous section. However groundwater is monitored onsite and offsite as enforced by the Clean Water Act (CWA). The objectives of the groundwater monitoring include:

“Water Supply Well Monitoring: Determine if onsite water supply wells are impacted from radionuclides originating from NNSA operations on the NTS.

Permitted Facilities Monitoring: Determine if there are groundwater impacts from surface and shallow vadose zone sources of radionuclides on the NTS.
Aquifer Monitoring: Determine if groundwater at the NTS and its vicinity is further degraded as a result of the expansion of the radionuclide plumes associated with the underground test areas.

Water-level Information: Determine the potential impact of demand for groundwater around the NTS on the long-term availability of water” (NTS Site ER 2001; pg. 79).

Vadose Zone Monitoring (VZM) is an ongoing requirement at the Area 5 Pit 3 zone at the NTS. A vadose zone (also called the unsaturated zone) can be defined as the area that lies between the ground surface and the top of the groundwater. The particles in this area are partially filled with air and partially with water. This region is regularly monitored to ensure that it does not become too saturated to risk leakage into the groundwater (GWRTAC, 2005). This process also allows for monitoring that would detect problems before they would reach the groundwater allowing corrective actions to be made early.

Overall the NTS has very suitable qualities for radioactive waste disposal operations: complicated geologic structures and groundwater that is at least 775 feet beneath the waste disposal region. Those conditions, combined with the fact that the region receives only about 3-5 inches of annual precipitation provide nearly ideal conditions. In addition, the average daily temperature in the summer is 92°F degrees, while winter months typically average about 46°F (City Rating, 2005). These conditions combine to provide extremely high evaporation rates, which results in minimal opportunity for leachate to penetrate to groundwater levels.
(2) What is the cost estimate for placing a traditional liner?

The cost estimate received by the NTS CAB for placing a traditional liner is between five to ten million dollars (as quoted by Dr. Helen Neill, Dept. Head, ENV Studies at UNLV). This cost does not take into account any removal of waste currently occupying the pit, only lining of the portion of the pit that does not contain any waste at this time.

(3) Examine Nevada’s hazardous and solid waste management requirements and ensure that they will be met with the proposal.

The NTS has specific waste acceptance criteria that must be met by all generators intending to ship wastes to the NTS for disposal. Section 3 of the Nevada Test Site Waste Acceptance Criteria (NTS WAC) (prepared by the DOE, the National Nuclear Security Administration, the Nevada Site Office, and the Waste Management Division) explains the criteria in detail (Appendix D). It states that, “Waste accepted at the NTS must be radioactive and shall meet the waste form criteria outlined. Generators must ensure waste is handled, stored, and shipped in accordance with applicable DOE, DOT, U.S. EPA, state, and local regulations and requirements. Waste streams deviating from these requirements will be evaluated in accordance with Section 3.4, WAC Deviations” (NTS WAC; 3-1). Waste is evaluated using the Waste Profile Approval Process (Appendix E), to see if it can be accepted at the NTS. Additionally, the NTS must follow
federal and state regulations regarding the acceptance of only certain types of characterized MLLW (Appendix F).

All waste that is currently on site at the NTS has received approval for disposal using the WAC guidelines, unless the waste was in the pit prior to these regulations being established. All MLLW that may reach the NTS for disposal will also be subject to stringent waste acceptance criteria. Also, all waste must meet regulations established by the Federal Facilities Compliance Act of 1992, which states that: “All MLLW must be classified, at minimum waste stream; the amount that is subject to land disposal prohibition requirements and waste that is not subject to such prohibition requirements; an estimate that each DOE location will produce in the next 5 years; and an inventory of waste that has not been characterized by sampling and analysis at each DOE facility” (FFCA, 1992). The WAC also looks at how well the site would perform with the waste that may be accepted.

(4) Does this proposal follow all laws and regulations set forth by RCRA and the U.S. government regarding safe disposal and management of MLLW?

The proposal follows all laws set forth by RCRA that pertain to the state of Nevada and the NTS. Due to RCRA part B, the proposal set forth by the DOE meets all requirements for RCRA, with evidence to back this proposal up for the NDEP. The alternative design meets all the requirements set forth in RCRA part B.
(5) What are the possible current and long term environmental effects to the NTS and the surrounding areas?

There is no evidence that shows that the groundwater would be affected from the waste, or that other harmful contaminants would penetrate enough into the ground soil to cause any long term problems. However there may be some risks involved with the current MLLW pit at the NTS. It is unclear when a design is chosen, the ALD or the traditional liner, if the original waste that is occupying the pit will be removed. If the waste is removed there are several risks associated with moving large amounts of hazardous waste, some of which has been deposited there for over 50 years.

Due to the various components that make up MLLW there are varying degrees of hazards associated with it. Depending on the types of chemicals associated with the waste, it may cause different types of hazards to the area and the environment (LWVEF, 1993). The hazards associated with the waste vary between plants, animals, and humans.

(A table summarizing all questions asked of this proposal follows on the next page)
### QUESTIONS ASKED OF PROPOSAL

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MEET THE CRITERIA (yes/no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Landfill Design Proposed. Procedure, Engineering, etc.</td>
<td>Yes</td>
</tr>
<tr>
<td>Cost Estimate for Traditional Liner</td>
<td>$5 to $10 million</td>
</tr>
<tr>
<td>Examine Nevada’s hazardous and solid waste management requirements and ensure that they will be meet with proposal</td>
<td>Yes</td>
</tr>
<tr>
<td>Does the Proposal follow all laws and regulations set forth by RCRA and the U.S. Government regarding safe disposal and management of MLLW</td>
<td>Yes</td>
</tr>
<tr>
<td>What might be the environmental effects over time to the NTS and surrounding areas</td>
<td>No immediate danger</td>
</tr>
</tbody>
</table>

### Analysis:

The schematics for the ALD follow all guidelines set forth by the RCRA part B permit application. The design has already been approved by the DOE and was originally approved by the NDEP, though the reason for revoking their original approval has not been explained. After reviewing all the information pertaining to the design I have yet to find anything that would give them cause to revoke their approval. However it could be said that they may be choosing to err on the side of caution, even though Nevada is a prime candidate for the RCRA part B permit.
The NTS has a diverse geology and hydro-geology that is very eclectic in nature. The area of Frenchman Flat, where the MLLW area is located, is no exception. The diversity of the rocks themselves cause for differing levels of conductivity of water and other substances to have the chance of penetrating the ground water. However with the climate conditions of the Southern Nevada Area, it changes the chances of almost anything reaching the water table.

However, the additional funding required to engineer and incorporate an engineered liner may be an issue for taxpayers. In fact, the Community Advisory Board recently wrote a formal recommendation to the DOE in which they stated their support for the ALD and expressed concern at additional funds being expended towards a traditional liner. With the ALD the pit would be left as is, no need to redo the pit or start a new one. However the costs involved with starting a new pit, placing a liner, and paying the people to develop the engineering designs and then implement the design is substantial. One option is very economical, the other is not; yet some would say that it is always better to be safe than sorry.

With the design of the ALD, and the way that waste has to be packaged and stored at the NTS, it would be highly unlikely that a spill of materials would occur. Yet with what has been stated previously, with the designed method and the diversity of the area geology and the climate, it would be most unlikely that any harmful material would get deep enough beneath the surface to cause any problems. It would either, evaporate before if goes too far, or become caught in the rock itself and live out its half-life with no threat to any water source in the area.
Many laws govern the issue of hazardous and mixed waste. However, none of them are ignored or dismissed pertaining to the MLLW project at the NTS. With the decision of placing more MLLW waste for disposal at the NTS (if it is done), all laws and regulations will be followed.

**Summary:**

The purpose of this thesis was to examine the proposal presented to the NDEP by the DOE to allow the use of an alternative design for a lining in the area 5 pit 3 MLLW disposal facility at the NTS. Findings are technically sound, however I believe that a final answer can only be reached upon achieving a clearer understanding of the NDEP position on its requirement for an engineered liner.
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Recommended Texts:


*Mixed and low-level treatment facility project. appendix B, waste stream engineering files. part 1, mixed waste streams (1992).* (SW 3050 Ultimate disposal of wastes October 21, 2004, from Environmental Sciences and Pollution Mgmt database.


Appendix A

Definitions & Acronym List:

**AEA:** Atomic Energy Act. “The purpose of the Atomic Energy Act (42 U.S.C. Sect. 2011 - Sect. 2259) (AEA) is to assure the proper management of source, special nuclear, and byproduct material. The AEA and the statutes that amended it delegate the control of nuclear energy primarily to DOE, the Nuclear Regulatory Commission (NRC), and the Environmental Protection Agency (EPA)” (DOE Environmental Policy and Guidance).

**CAB:** Community Advisory Board. “The Community Advisory Board for Nevada Test Site Programs (NTS CAB) is a formal group of volunteers and ex-officio members organized to provide informed recommendations and advice to the U.S. Department of Energy Nevada Site Office Environmental Management program” (CAB for NTS Programs).

**DOE:** Department of Energy. The Department of Energy contributes to the future of the nation by ensuring our energy security, maintaining the safety and reliability of our nuclear stockpile, cleaning up the environment from the legacy of the Cold War, and developing innovations in science and technology (DOE/US).

“The Department of Energy, by consolidating environmental considerations and procedures now within the separate purview of the Federal Energy Administration (FEA), Energy Research and Development Administration (ERDA), Federal Power Commission (FPC), and part of the U.S. Department of Interior (DOI), should provide an effective vehicle for identifying potential environmental, health, safety, socioeconomic, institutional, and control technology issues associated with technology development. It will provide a single, coordinated mechanism for determining necessity and timing of environmental impact assessments and environmental impact statements in order to respond to the needs of specific technologies or resources. It will ensure a complete and fully integrated program with respect to environmental, health and safety impact research and engineering applications.”(Department of Energy Act of 1977)

**DOT:** Department of Transportation. The Department of Transportation was established by an act of Congress on October 15, 1966, its mission is to “Serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future (USDOT).”

**EM:** Environmental Management. In 1989, the Department of Energy created the Office of Environmental Management (EM) to mitigate the risks and hazards posed by the legacy of nuclear weapons production and research (DOE/US-EM).
EPA: Environmental Protection Agency. The mission of the Environmental Protection Agency is to protect human health and the environment. Since 1970, EPA has been working for a cleaner, healthier environment for the American people (US/EPA).

HW: Hazardous Waste. A substance, such as nuclear waste or an industrial byproduct, that is potentially damaging to the environment and harmful to humans and other living organisms. (Online Dictionary).

LLW: Low Level Waste. Low-level waste contains radio-nuclides dispersed within non-radioactive materials including rags, papers, filters, equipment, discarded protective clothing, and construction debris. Currently, low-level waste is disposed in engineered pits and trenches and in subsidence craters at two Radioactive Waste Management Sites on the Nevada Test Site. Low-level waste disposed at the Nevada Test Site can only be accepted from approved U.S. Department of Energy (DOE) and U.S. Department of Defense generators (DOE/NV).

MLLW: Mixed Low Level Waste. Mixed low-level waste contains both radioactive and hazardous components. Hazardous waste is defined as being ignitable, corrosive, reactive, toxic, or listed by the U.S. Environmental Protection Agency as a hazardous waste. The radioactive component of mixed low-level waste is regulated by the Atomic Energy Act, while the hazardous component is regulated by the Resource Conservation and Recovery Act. As a result of the hazardous component, mixed low-level waste is processed and controlled separately from other low-level waste products. A broad spectrum of processes and activities generate mixed low-level waste, including equipment maintenance, materials production, cleaning, environmental restoration, and facility deactivation and decommissioning (DOE/NV).

MWDU: Mixed Waste Disposal Unit. A unit that was constructed in 1985 at the Nevada Test Site that consists of one unlined disposal cell that is trapezoidal in shape. (Appendix B).

NDEP: Nevada Division of Environmental Protection. Their mission is to preserve and enhance the environment of the state in order to protect public health, sustain healthy ecosystems and contribute to a vibrant economy (NDEP Homepage).

NNSA: National Nuclear Security Administration. The mission of the NNSA is:

1. “To enhance United States national security through the military application of nuclear energy.
2. To maintain and enhance the safety, reliability, and performance of the United States nuclear weapons stockpile, including the ability to design, produce, and test, in order to meet national security requirements.
3. To provide the United States Navy with safe, militarily effective nuclear propulsion plants and to ensure the safe and reliable operation of those plants.
4. To promote international nuclear safety and nonproliferation.
5. To reduce global danger from weapons of mass destruction.
6. To support United States leadership in science and technology” (NNSA/US).

**NSO:** Nevada Site Office. The primary role of the NSO is to ensure the accomplishment of all its assigned activities in a safe, responsible, secure, efficient, and environmentally responsible manner. Its responsibilities include: National security, Environmental management, stewardship of the NTS, and technological and economic diversification.

**RCRA:** Resource Conservation and Recovery Act. The Resource Conservation and Recovery Act (RCRA), was in-acted by Congress in 1976 to establish a system for managing non-hazardous and hazardous solid waste in an environmentally sound manner.

**RWMS:** Radioactive Waste Management Site. The NTS is a site that is a radioactive waste management site.

**TRU:** Transuranic Waste. By definition of the DOE:
"Transuranic waste is radioactive waste containing more than 100 nCi of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for:
1) High-level waste
2) Waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by the 40CFR Part 191 disposal regulations; or
3) Waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61."
(DOE Definition).

**WAC:** Waste Acceptance Criteria. Form and guidelines that the NTS follows in order to accept of decline waste from outside locations. The full printout is available in Appendix C.

**WMD:** Waste Management Division. A division of the NTS that supervises all the waste that is currently stored at the NTS. They also manage the transportation and acceptance of new waste sent to the NTS.
Appendix B

United States Department of Energy
Nevada Test Site
Permit HW009
First Issue March 1995; Reissued November 2000

V-1
PART V - MIXED WASTE DISPOSAL UNIT
V.A. SUMMARY

The Pit 3 Mixed Waste Disposal Unit (MWDU), constructed in 1985, consists of one unlined disposal cell that is trapezoidal in shape. It is located within the boundaries of the Area 5 Radioactive Waste Management Site (RWMS). In September 1987, the Nevada Division of Environmental Protection (NDEP) concurred that Pit 3 MWDU met the regulatory requirements for interim status under 40 CFR § 270.10(e) for the disposal of Low Level Mixed Waste (LLMW).

The Permittee is only authorized to dispose mixed wastes generated from NTS activities, such as site remediation. The wastes may consist of both organic and inorganic solids contaminated with radionuclides in concentrations classified as low level. The Permittee is currently seeking a Permit to dispose of mixed wastes from both on-site and off-site generators. A detailed technical review, with DOE/NV revisions to the MWDU application to address NDEP concerns, is on-going for both on-site and off-site generated wastes.

Upon approval of the MWDU Permit Application, this Part will be revised accordingly. The NDEP is providing the following compliance schedule to complete the Part B Permit Application for receipt of off-site generated Mixed Wastes:

Compliance Schedule
December 22, 2000 The Permittee shall submit a complete Permit Application which includes, but is not limited to:

- Alternative Liner justification per 40 CFR 264.301(b).

- Submittal of the Pit 3 MWDU waste verification program for off-site generated mixed waste per 40 CFR 264.13(c), should the Permittee seek to accept off-site generated mixed wastes.

- Criteria by which closure of the MWDU will be initiated. The closure plan shall include criteria for closure of a partially filled Pit.
Should the Permittee not have the complete Permit Application submitted to the NDEP by the above Compliance Date, the Permittee shall initiate closure of the MWDU in accordance with an approved Closure Plan, which shall detail the criteria for closure of a partially filled Pit.

Source: http://ndep.nv.gov/boff/part5.pdf
Appendix C

40 CFR - CHAPTER I - PART 264

§ 264.301 Design and operating requirements.

(a) Any landfill that is not covered by paragraph (c) of this section or §265.301(a) of this chapter must have a liner system for all portions of the landfill (except for existing portions of such landfill). The liner system must have:

(1) A liner that is designed, constructed, and installed to prevent any migration of wastes out of the landfill to the adjacent subsurface soil or ground water or surface water at anytime during the active life (including the closure period) of the landfill. The liner must be constructed of materials that prevent wastes from passing into the liner during the active life of the facility. The liner must be:

(i) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydro-geologic forces), physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(ii) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(iii) Installed to cover all surrounding earth likely to be in contact with the waste or leachate; and

(2) A leachate collection and removal system immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the landfill. The Regional Administrator will specify design and operating conditions in the permit to ensure that the leachate depth over the liner does not exceed 30 cm (one foot). The leachate collection and removal system must be:

(i) Constructed of materials that are:

(A) Chemically resistant to the waste managed in the landfill and the leachate expected to be generated; and

(B) Of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill; and

(ii) Designed and operated to function without clogging through the scheduled closure of the landfill.
(b) The owner or operator will be exempted from the requirements of paragraph (a) of this section if the Regional Administrator finds, based on a demonstration by the owner or operator, that 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. In deciding whether to grant an exemption, the Regional Administrator will consider:

(1) The nature and quantity of the wastes;

(2) The proposed alternate design and operation;

(3) The hydrogeologic setting of the facility, including the attenuative capacity and thickness of the liners and soils present between the landfill and ground water or surface water; and

(4) All other factors which would influence the quality and mobility of the leachate produced and the potential for it to migrate to ground water or surface water.

(e) The owner or operator of each new landfill unit on which construction commences after January 29, 1992, each lateral expansion of a landfill unit on which construction commences after July 29, 1992, and each replacement of an existing landfill unit that is to commence reuse after July 29, 1992 must install two or more liners and a leachate collection and removal system above and between such liners. "Construction commences" is as defined in § 260.10 of this chapter under "existing facility".

(1)(i) The liner system must include:

(A) A top liner designed and constructed of materials (e.g., a geomembrane) to prevent the migration of hazardous constituents into such liner during the active life and post-closure care period; and

(B) A composite bottom liner, consisting of at least two components. The upper component must be designed and constructed of materials (e.g., a geomembrane) to prevent the migration of hazardous constituents into this component during the active life and post-closure care period. The lower component must be designed and constructed of materials to minimize the migration of hazardous constituents if a breach in the upper component were to occur. The lower component must be constructed of at least 3 feet (91 cm) of compacted soil material with a hydraulic conductivity of no more than 1x10⁻⁷ cm/sec.

(ii) The liners must comply with paragraphs (a)(1) (i), (ii), and (iii) of this section.

(2) The leachate collection and removal system immediately above the top liner must be designed, constructed, operated, and maintained to collect and remove leachate from the landfill during the active life and post-closure care period. The Regional Administrator will specify design and operating conditions in the permit to ensure that the leachate
depth over the liner does not exceed 30 cm (one foot). The leachate collection and removal system must comply with paragraphs (3)(c) (iii) and (iv) of this section.

(3) The leachate collection and removal system between the liners, and immediately above the bottom composite liner in the case of multiple leachate collection and removal systems, is also a leak detection system. This leak detection system must be capable of detecting, collecting, and removing leaks of hazardous constituents at the earliest practicable time through all areas of the top liner likely to be exposed to waste or leachate during the active life and post-closure care period. The requirements for a leak detection system in this paragraph are satisfied by installation of a system that is, at a minimum:

(i) Constructed with a bottom slope of one percent or more;

(ii) Constructed of granular drainage materials with a hydraulic conductivity of 1×10⁻² cm/sec or more and a thickness of 12 inches (30.5 cm) or more; or constructed of synthetic or geonet drainage materials with a transmissivity of 3×10⁻⁵ m²/sec or more;

(iii) Constructed of materials that are chemically resistant to the waste managed in the landfill and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and equipment used at the landfill;

(iv) Designed and operated to minimize clogging during the active life and post-closure care period; and

(v) Constructed with sumps and liquid removal methods (e.g., pumps) of sufficient size to collect and remove liquids from the sump and prevent liquids from backing up into the drainage layer. Each unit must have its own sump(s). The design of each sump and removal system must provide a method for measuring and recording the volume of liquids present in the sump and of liquids removed.

(4) The owner or operator shall collect and remove pumpable liquids in the leak detection system sumps to minimize the head on the bottom liner.

(5) The owner or operator of a leak detection system that is not located completely above the seasonal high water table must demonstrate that the operation of the leak detection system will not be adversely affected by the presence of ground water.

(d) The Regional Administrator may approve alternative design or operating practices to those specified in paragraph (c) of this section if the owner or operator demonstrates to the Regional Administrator that such design and operating practices, together with location characteristics:

(1) Will prevent the migration of any hazardous constituent into the ground water or surface water at least as effectively as the liners and leachate collection and removal systems specified in paragraph (c) of this section; and
(2) Will allow detection of leaks of hazardous constituents through the top liner at least as effectively.

(e) The double liner requirement set forth in paragraph (c) of this section may be waived by the Regional Administrator for any monofill, if:

(1) The monofill contains only hazardous wastes from foundry furnace emission controls or metal casting molding sand, and such wastes do not contain constituents which would render the wastes hazardous for reasons other than the Toxicity Characteristic in § 261.24 of this chapter, with EPA Hazardous Waste Numbers D004 through D017; and

(2)(i)(A) The monofill has at least one liner for which there is no evidence that such liner is leaking;

(B) The monofill is located more than one-quarter mile from an underground source of drinking water (as that term is defined in § 144.3 of this chapter); and

(C) The monofill is in compliance with generally applicable ground-water monitoring requirements for facilities with permits under RCRA 3005(c); or

(ii) The owner or operator demonstrates that the monofill is located, designed and operated so as to assure that there will be no migration of any hazardous constituent into ground water or surface water at any future time.

(f) The owner or operator of any replacement landfill unit is exempt from paragraph (c) of this section if:

(1) The existing unit was constructed in compliance with the design standards of section 3004(o)(1)(A)(i) and (o)(5) of the Resource Conservation and Recovery Act; and

(2) There is no reason to believe that the liner is not functioning as designed.

(g) The owner or operator must design, construct, operate, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during peak discharge from at least a 25-year storm.

(h) The owner or operator must design, construct, operate, and maintain a run-off management system to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

(i) Collection and holding facilities (e.g., tanks or basins) associated with run-on and run-off control systems must be emptied or otherwise managed expeditiously after storms to
(j) If the landfill contains any particulate matter which may be subject to wind dispersal, the owner or operator must cover or otherwise manage the landfill to control wind dispersal.

(k) The Regional Administrator will specify in the permit all design and operating practices that are necessary to ensure that the requirements of this section are satisfied.

(l) Any permit under RCRA 3005(c) which is issued for a landfill located within the State of Alabama shall require the installation of two or more liners and a leachate collection system above and between such liners, notwithstanding any other provision of RCRA.