Below Ground Waste Disposal Silos. These concrete domes form the caps for underground silos at the Oak Ridge Reservation, each measuring 8 feet in diameter. These disposal silos are 15-20 feet deep and were placed in the ground at least two feet above the highest known groundwater levels. These silos were used from 1986 to 1993 for the disposal of laboratory equipment, construction debris, and other dry waste contaminated principally with cesium-137, strontium-90, and cobalt-60. Although no final cleanup decisions have been made, long-term groundwater monitoring is currently being conducted and may be required for decades. *Melton Valley Area, Solid Waste Storage Area 6, Oak Ridge Reservation, Tennessee, January 1994.*

Appendices

A) The December 1998 PEIS Lawsuit Settlement Agreement

B) Regulatory Requirements

C) Methodology

D) Glossary of Terms

E) Site Profiles - Not in Document, available at *www.em.doe.gov/lts*

Appendix A:
The December 1998 PEIS Lawsuit Settlement

Satellite Dish at Rocky Flats Environmental Technology Site. The phrase, "Make it Safe, Clean it Up, Close it Down" was developed through a public process to summarize the new mission for the site after the nuclear weapons component production ended. In March 1995, DOE sponsored a "Rocky Flats Summit" in Arvada, Colorado involving 150 people, including state and federal regulators, local and headquarters DOE officials, state officials, oversight group members and community activists. At this meeting the fundamental goals and priorities for the site were established, which were subsequently used to negotiate the Rocky Flats Compliance Agreement. *Rocky Flats Environmental Technology Site, Colorado, September 1999.*

On December 14, 1998, DOE settled a lawsuit with the Natural Resources Defense Council (NRDC), and 38 other environmental organizations.[1] The terms of the Settlement Agreement include three major items:

- A central Internet database with information on waste, facilities, and contaminated media, as well as information on waste transfers;
- A study on long-term stewardship; and
- A $6.25 million fund for technical and scientific reviews.

DOE is preparing to conduct a national study on long-term stewardship in compliance with the settlement agreement. The breadth of this study will be determined through a public scoping process. The overall objective of the scoping process is to help DOE determine the facts, analysis, questions, issues, resources, and other matters that should be included in the national study, within the general parameters established by the Settlement Agreement. The specific terms of the Settlement Agreement

1. Natural Resources Defense Council, et. al. v. Richardson, et. al., Civ. No. 97-963 (SS).

regarding the long-term stewardship national study are as follows:

> DOE will prepare a study on its long-term stewardship activities. By "long-term stewardship," DOE refers to the physical controls, institutions, information and other mechanisms needed to ensure protection of people and the environment at sites where DOE has completed or plans to complete "cleanup" (e.g., landfill closures, remedial actions, removal actions, and facility stabilization). This concept of long-term stewardship includes, inter alia, land use controls, monitoring, maintenance, and information management. While DOE's study on long-term stewardship will not be a NEPA document or its functional equivalent, DOE will, nevertheless, follow the procedures set forth in the regulations of the President's Council on Environmental Quality (CEQ) for public scoping, 40 C.F.R § 1501.7(a)(1)-(2), and the procedures set forth in DOE's NEPA regulations for public review, of environmental impact statements (EIS's), 10 C.F.R. § 1021.313, except that (a) DOE will not transmit the study, in draft form, to EPA, and DOE (not EPA) will publish a Notice of Availability in the Federal Register, as set forth in 10 C.F.R. § 1021.313(a); and (b) DOE will not include any Statement of Findings as set forth in 10 C.F.R. § 1021.313(c). In the study, DOE will discuss, as appropriate, alternative approaches to long-term stewardship and the environmental consequences associated with those alternative approaches.

Appendix B:
Regulatory Requirements Governing Long-Term Stewardship

Storage of Uranium Metal Billets. A worker at the Fernald Environmental Management Project examines storage requirements for depleted uranium metal billets, which once were an essential precursor element in the production of weapons-grade plutonium for nuclear warheads. Today, billets like these are one of DOE's many types of chemicals, metals, radioactive substances, and other materials collectively known as "materials in inventory." Materials in Inventory are not considered by DOE to be waste, but are materials for which no use is expected for one year and that have not been used for at least one year. *Fernald Environmental Management Project, Ohio, December 1993.*

Exhibit B-1: DOE Orders and Policies Providing a Framework for Long-Term Stewardship	
DOE Order 200.1 Information Management Program.	Provides a framework for managing information, information resources, and information technology investment.
DOE Order 430.1 Life Cycle Asset Management and DOE Order 4320.1B Site Development Planning.	Identify what analyses must be conducted in order for a site manager to determine whether a particular portion of DOE real property is considered to be excess and available for transfer to another entity.
DOE Order 435.1 Radioactive Waste Management.	Requires DOE radioactive waste management activities to be systematically planned, documented, executed, and evaluated in a manner that protects worker and public safety, as well as the environment.
DOE Order 1230.2 DOE American Indian Tribal Government Policy.	Requires DOE sites to consult with potentially affected Tribes concerning impacts of proposed DOE actions (including real property transfers), and to avoid unnecessary interference with traditional religious practices.
DOE Order 5400.5 Radiation Protection of the Public and the Environment.	Establishes acceptable levels for the release of property on which any radioactive substances or residual radioactive material was present.
Secretary of Energy's Land and Facility Use Policy, issued December 21, 1994, and DOE Policy 430.1, also titled "Land and Facility Use Planning Policy," issued July 9, 1996.	State that DOE sites must consider how best to use DOE land and facilities to support critical missions and to stimulate the economy while preserving natural resources, diverse ecosystems, and cultural resources.

Exhibit B-2: Regulatory Requirements by Waste Type

Waste Type	Typical Radioactive and Chemical Characteristics	Disposal Plans and Long-Term Requirements
High-Level Waste (HLW) The highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.	Contains short- and long-lived fission products, usually in high concentrations, as well as hazardous chemicals and heavy metals.	DOE currently plans to vitrify HLW and dispose of it in a geologic repository. DOE also plans to dispose of SNF in a repository. Disposal of HLW and SNF in a potential repository at Yucca Mountain in Nevada would be licensed by NRC in accordance with licensing criteria that have been proposed (64 FR 8640) and radiation protection standards to be issued by EPA (40 CFR 197), under the authority of the Nuclear Waste Policy Act and the Energy Policy Act of 1992.
Spent Nuclear Fuel (SNF) Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.	Usually contains high concentrations of short- and long-lived isotopes, including fission products, activation products, and transuranic isotopes.	
Transuranic Waste (TRU) Radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR 191 disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.	Contains neptunium, plutonium, curium, americium, and other elements with an atomic number greater than 92.	DOE plans to dispose of defense TRU wastes in the Waste Isolation Pilot Plant (WIPP). EPA issued its final permit for certification of WIPP in May 1998. The New Mexico Environmental Department, delegated the authority by EPA, is currently reviewing the draft RCRA "Part B" permit it issued in August 1998. WIPP began receiving waste in March 1999. For WIPP, EPA must certify that there is a reasonable expectation that the waste will remain isolated for 10,000 years. Although permanent DOE control is required by law and regulation, for purposes of analysis, EPA prohibits reliance on active institutional controls for longer than 100 years. For purposes of analysis, passive institutional controls cannot be relied upon to delay possible human intrusion into the site longer than several hundred years following disposal (40 CFR 191 and 194).
Low-Level Waste (LLW) Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material.	Contains a wide variety of radionuclides. Some wastes in this category may have more short-lived radioactivity per unit volume than average high-level waste, although most wastes contains small amounts of radioactivity among large volumes of other material (e.g., trash, soil, debris, water).	Low-level waste is disposed of in landfills, shafts, concrete vaults, or other near-surface containment units. DOE guidance interpreting DOE Order 435.1 states that for purposes of performance assessment, lapses in active institutional controls should be considered following a 100-year period. Performance assessments look forward for a minimum of 1,000 years.

Exhibit B-2: Continued

Waste Type	Typical Radioactive and Chemical Characteristics	Disposal Plans and Long-Term Requirements
Mixed Waste Waste that contains both source, special nuclear, or byproduct material subject to the *Atomic Energy Act of 1954*, as amended, and a hazardous component subject to the *Resource Conservation and Recovery Act.*	Can include all of the radioactive waste characteristics described for high level, TRU, or low-level wastes, as well as heavy metals or hazardous organic constituents.	A variety of treatment and disposal technologies and requirements are being used to treat and manage mixed wastes. Statutory or regulatory requirements pertaining to the hazardous (i.e., RCRA) constituents of the material apply as well as those for the radioactive constituents.
Uranium Mill Tailings Tailings or waste produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content. **11e.(2) Materials** The tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material (i.e., uranium or thorium) content.	Contain several long-lived constituents, including uranium-238 and radium-226, in extremely large volumes of soil.	Mill tailings are generally disposed in landfills in accordance with design requirements prescribed in 40 CFR 192. Control and stabilization features must be designed to provide, to the extent reasonably achievable, an effective life of 1,000 years with a minimum life of at least 200 years. 11e.(2) materials are generally disposed in landfills in accordance with design requirements prescribed in 40 CFR 192. Control and stabilization features must be designed to provide, to the extent reasonably achievable, an effective life of 1,000 years with a minimum life of at least 200 years.
Hazardous Waste Wastes defined by either listing, exhibiting a hazardous characteristic under Subtitle C of the *Resource Conservation and Recovery Act*, or declared hazardous by the generator.	Can contain a wide variety of organic, heavy metal, and other constituents.	Subject to a wide variety of treatment and disposal processes, some of which may destroy certain contaminants (e.g., bioremediation), or render them less hazardous, followed by disposal in landfills. Encapsulation is often required for metals, which reduces their hazards as long as encapsulation is effective. RCRA requires post-closure care (maintenance and monitoring) for at least 30 years after a waste unit has been cleaned to closure standards. The EPA Regional Administrator can either shorten or extend the 30 year post-closure care period in order to protect human health and the environment.
Hazardous Substances Substances not regulated as hazardous waste under RCRA, but considered hazardous under CERCLA, TSCA, etc.	Includes contaminants such as PCBs, asbestos, and petroleum products.	Subject to a wide variety of treatment and disposal processes, some of which may destroy certain contaminants (e.g., bioremediation), or render them less hazardous, followed by disposal in landfills. CERCLA requires 5-year reviews of residually contaminated areas and waste disposal units. In addition all cleanup levels are subject to Applicable and Relevant and Appropriate Requirements (ARARs).

Appendix C: Methodology

Remaining Foundation of Building 889 at the Rocky Flats Environmental Technology Site. The first radioactively contaminated building at the site to be demolished, this multi-purpose facility was a former uranium and beryllium waste repackaging plant that supported rolling and milling operations. Current plans call for virtually all of the facilities at Rocky Flats to be demolished and rubble to be disposed of appropriately. Foundations and utilities will remain in place unless removal is necessary to remediate underlying soil. Subsurface utilities between facilities will be capped and left in place. Future use options for this portion of the site include open space or light industrial uses. *Rocky Flats Environmental Technology Site, Colorado, September 1999.*

DOE reviewed and analyzed the Department's existing data on anticipated cleanup levels to determine the type and amount of residual contamination likely to remain when cleanup activities are completed (i.e., when the site reaches its end state). DOE then determined the appropriate unit of measure for analyzing stewardship and identifying the scope of the Department's stewardship obligations.

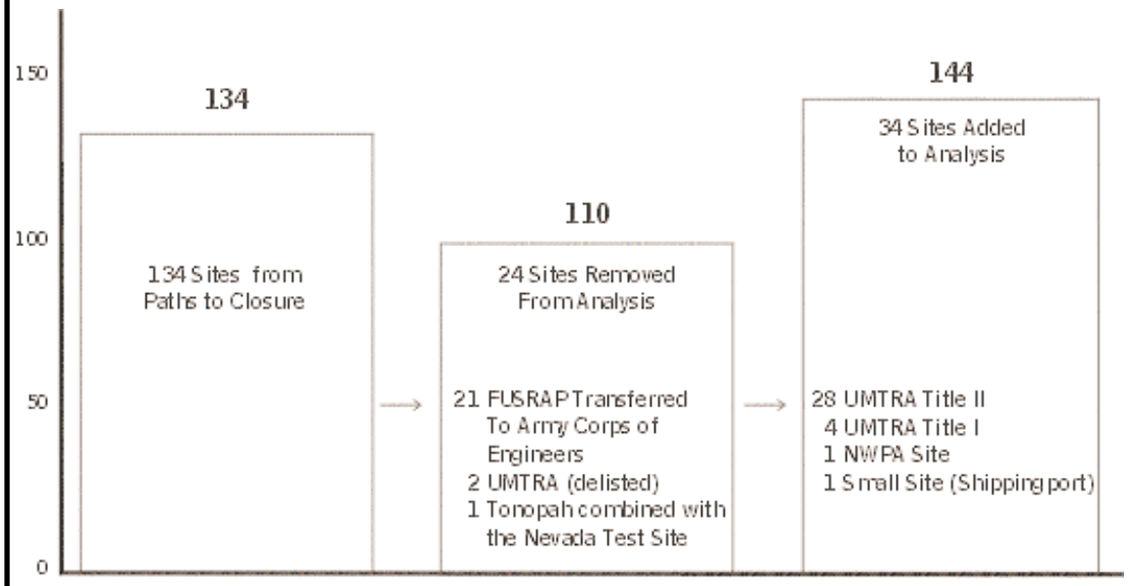
DOE identified those sites where residually contaminated facilities, water, soil, and/or engineered units are expected to remain. This allowed the Department to estimate the long-term stewardship activities that will be required to protect human health and the environment. Information for each site includes:

- The location of sites expected to require stewardship by DOE;
- The expected nature and extent of DOE stewardship;
- The projected costs of stewardship activities;
- The timing and duration of stewardship activities;
- The projected post-cleanup site ownership and land use; and
- The organizations expected to be responsible for stewardship.

Unit of Measure

DOE first had to determine the appropriate unit of measure for analyzing stewardship obligations. Although the number of acres that will require stewardship seemed to be the most consistent unit of measure, data were not readily available at that level of detail for most sites; most DOE data are currently recorded and

Exhibit C-1: Origin of Number of Sites in This Analysis



reported at the site level. Therefore, the Department chose to measure stewardship on a site level.[1] For the purpose of this analysis, the Department defined a "site" as a contiguous geographically distinct area (as opposed to a release site or sub-area of a site). For example, the Idaho National Engineering and Environmental Laboratory, Fernald, and the Tuba City UMTRA Cell are each considered one site although they differ significantly in size as well as type and extent of contamination.

In identifying those sites that are expected to require stewardship, the Department started with the list of sites identified in the *Accelerating Cleanup: Paths to Closure* report, hereinafter referred to as *Paths to Closure* (see Exhibit C-1). The *Paths to Closure* report included 134 geographic sites that EM has historically included in its scope (including the Waste Isolation Pilot Plant). In addition to the 134, DOE included additional sites where long-term stewardship responsibilities have been transferred to the Department through existing laws. The additional sites include 28 sites transferred under the authority of UMTRCA of 1978, one site transferred under the NWPA, and one additional small site.

The universe of sites identified in this report also differs from *Paths to Closure* because this analysis did not include the 21 FUSRAP sites transferred to the Army Corps of Engineers in 1998 (Exhibit C-2). Also excluded from the list of sites included in this report are the Belfield and Bowman sites, which were delisted from UMTRCA in May of 1998. Lastly, the Tonopah Test Range was combined with the Nevada Test Site because the long-term planning for the sites is based on the two areas being managed as one site. This resulted in a net difference of 10 sites, and an overall list of 144 sites where the

1. The data used in this report were drawn from existing DOE Headquarters sources used for high-level planning efforts. Specific sites and field offices may have more detailed information, however, obtaining more detailed information from sites was outside the scope of this document, due to time and budget constraints.

Exhibit C-2: 21 FUSRAP Sites Transferred to Army Corps of Engineers in 1998

Connecticut
- Combustion Engineering

Illinois
- Madison

Maryland
- W.R. Grace & Company

Massachusetts
- Shpack Landfill

Missouri
- Latty Avenue Properties
- St. Louis Airport Site
- St. Louis Airport Site Vicinity Properties
- St. Louis Downtown Site

New Jersey
- DuPont & Company
- Maywood Chemical Works
- Middlesex Sampling Plant
- Wayne Interim Storage Site

New York
- Ashland Oil #1
- Ashland Oil #2
- Bliss and Laughlin Steel
- Colonie Site
- Linde Air Products
- Niagara Falls Storage Site
- Seaway Industrial Park

Ohio
- Luckey
- Painesville

Department potentially has long-term stewardship obligations. A complete list of the sites included in this analysis is provided in Chapter 2.

Sites included under Title I of UMTRCA are those that operated prior to 1978 and where all or most of the uranium was used for a Federal Agency. Title II of UMTRCA includes sites that were operating under an NRC license in 1978 when the Act was promulgated. Section 202 of UMTRCA gave NRC the authorization to transfer title and custody of these sites (other than land owned by Federal, state, or Tribal governments) to either the Federal government (DOE) or a state government. This transfer of custody would occur prior to termination of the license, and NRC would then issue a separate license for long-term care and maintenance of the site. Because the responsibility for providing long-term stewardship at 28 sites is likely to be transferred to DOE, these sites are included in the scope of DOE's long-term obligations.

According to the NWPA, Subtitle D, Section 151(b), low-level radioactive waste disposal sites with privately held licenses can be transferred to DOE upon the termination of the site's license, provided that NRC requirements for site closure, decontamination, and decommissioning have been met, title and custody of the site will be transferred to DOE at no cost to the Federal government, and DOE ownership and management of the site is necessary or desirable in order to protect public health and safety and the environment. Section 151(c) states that if low-level radioactive waste is the result of a licensed activity to recover zirconium, hafnium and rare earth metals from source material, DOE can accept title and custody of the site if requested by the site owner. Currently, responsibility for one NWPA Section 151(c) site has been transferred to the Department and is included in this analysis.

Data Sources

DOE analyzed the data submitted by the sites in support of *Paths to Closure* to determine a site's expected cleanup levels and resulting end state. Determining the overall site end state from the data submitted for *Paths to Closure* involved interpreting and compiling data from numerous project-level data elements known as project baseline summaries (PBSs). To ensure that the data were aggregated correctly, site and operations office contacts were asked to review the information compiled, verify the accuracy of

The number of sites where DOE has stewardship responsibility may increase over time. Additional sites may be identified and added to DOE's responsibility under existing or new laws.

the data, fill in data gaps, and update the data based on any changes in site cleanup plans that may have occurred since the original data were submitted. For sites that did not submit data for *Paths to Closure*, site cleanup and end state descriptions were obtained from the *Accelerating Cleanup: Focus on 2006 Discussion Draft* or the *1996 Baseline Environmental Management Report*. To the extent possible, site and operations contacts were also contacted to verify data for sites where the majority of the data were obtained from older source documents. For all sites included in this analysis, the assumptions used as the foundation for this analysis are likely to change as site-specific factors change or are better understood (see Exhibit C-3 for a discussion of how stewardship activities are likely to change over time).

Date Cleanup Complete

The Department identified the anticipated date for completing cleanup activities or putting ongoing remediation systems in place. These dates were determined based on the projected date for completing cleanup identified in *Paths to Closure*, or on the actual date that remediation was completed if the site is already closed. The date for completing cleanup represented the start date when long-term stewardship is the sole remaining mission for the site. Any activities aimed at containing, managing, or providing long-term maintenance for contamination or remedies that are in place after this date are included as part of the site's long-term stewardship responsibility.

Exhibit C-3: Levels of Stewardship Activities Are Likely to Change Over Time

Stewardship activities identified in this analysis indicate the activities expected when cleanup is completed; however, the stewardship process is dynamic and the specific activities at a site will change over time in response to both site-specific and external factors. These factors include regulatory changes, technology developments, demographic shifts, and changes in the contamination due to attenuation or ongoing remediation. For example, changes in scientific understanding of the effects of residual contamination may result in changes to our regulatory standards resulting in more or less stringent stewardship activities. Similarly, technology developments may enable additional contamination to be removed, which could decrease the need for long-term stewardship.

Site End State

Although general information on the extent of residual contamination was available in *Paths to Closure*, that report did not focus on the anticipated long-term stewardship requirements after cleanup was completed. DOE had to look more in-depth at the types of residual contamination likely to remain on the site once all cleanup was completed in order to determine the long-term stewardship requirements for each site. To develop a more informed understanding of the residual contamination and resulting stewardship activities, DOE divided the overall site end state information by the type of media that was contaminated:

- Water (groundwater and surface waters);
- Soil (including buried waste);
- Engineered units (e.g., landfills); and
- Facilities.

The method used to differentiate among media types (e.g., soil vs. engineered units) is solely for purposes of this analysis and does not reflect regulatory or policy determinations.

The first step in identifying media that will have residual contamination was to determine if any contamination of those media had ever occurred. If no evidence existed of any prior contamination, that medium was assumed to require no stewardship. If contamination had occurred and the planned cleanup strategy will not return the medium to a degree of residual contamination suitable for unrestricted use, then that medium was assumed to require some degree of long-term stewardship. Remediation to levels

acceptable for unrestricted use is not considered to require stewardship because this level of use is based on calculations that project that unacceptable human health risks will not occur even under the most extensive exposure scenarios (e.g. residential use).

Water

Ongoing groundwater remediation will continue at many sites after the official site "closure" date. This situation exists because of the long time frames required to capture and remediate contaminated groundwater. Therefore, unlike other media, the end date for groundwater remediation was often set at the time that the remedy was put in place, and the ongoing natural attenuation or pump and treat activities are included as part of the water stewardship activities. The Department assumed that stewardship would be required for any groundwater or surface water areas where remediation will not return the water to below drinking water standards or, in some cases, to background levels. Drinking water standards are not the norm for all sites since in many areas the natural background levels of contaminants are above drinking water standards. This is particularly true for some uranium mill tailings sites where the natural background levels of uranium in the groundwater are above drinking water standards and/or the groundwater is not naturally potable due to other concerns (e.g. elevated salinity or turbidity levels).

Soil

The Department assumed stewardship will be required for all discrete areas of soil that will have residual contamination above levels that will allow for unrestricted use. Soil areas are defined to include soils, sediments, burial grounds, burn pits, and other historical disposal areas that do not have engineered containment structures. For many residually contaminated soil areas, the remedial approach includes placing a cap over the residual contamination to prevent precipitation from infiltrating the contamination and transporting the contamination to groundwater. Capped soil areas are primarily areas where contaminated soils are partially excavated but some residually contaminated soils will remain in place; however, they also include some burial grounds where waste was disposed. These areas are not classified as "engineered units" for this analysis, because they do not have liners, engineered side walls, or leachate collection systems. The caps over residually contaminated soil areas (typically composed of clay, asphalt, cement, or multi-layer synthetic material) will need to be actively maintained to ensure that cracks or breaks in the cap, implied into the contaminant, do not occur or are repaired when necessary.

Engineered Units

For this analysis, the Department defined engineered units as permanent, land-based disposal units such as landfills, vaults, and tank farms that have engineered containment structures such as liners and leachate collection systems. Engineered units also include units designed for long-term retrievable storage of nuclear materials or high-level waste. In evaluating the stewardship needed for engineered units, DOE identified those units currently accepting waste, as well as historical units that no longer receive waste but that will remain onsite following the completion of remediation activities. All engineered units that are likely to remain onsite are assumed to require some type of long-term stewardship, partially as a result of the post-closure care activities required in the various regulations that apply to DOE's waste disposal activities, but also due to the general nature of the units. Engineered units are areas where wastes and residual contamination are consolidated for permanent disposal or long-term retrievable storage. Therefore, these units will require stewardship activities.

Exhibit C-4: Potential Stewardship Activities by Media

Water
- Conducting ongoing pump and treat;
- Providing alternate sources for drinking water;
- Restricting either ground or surface water use;
- Posting signs;
- Conducting groundwater or surface water monitoring at various frequencies; and
- Maintaining records of contamination, departmental activities, and use restrictions.

Soil
- Maintaining and repairing soil caps;
- Establishing zoning and land use restrictions;
- Establishing easements and deed restrictions;
- Erecting and maintaining fences and other physical barriers;
- Posting warning signs;
- Conducting soil monitoring at various frequencies; and
- Maintaining records of contamination, departmental activities, and use restrictions.

Engineered Units
- Maintaining and repairing engineered unit caps, liners, and leachate collection systems;
- Erecting and maintaining fences and physical barriers;
- Posting warning signs;
- Establishing easements and deed restrictions, monitoring and inspections; and
- Maintaining records of contamination, departmental activities, and use restrictions.

Facilities
- Monitoring residual contamination;
- Maintaining access restrictions;
- Enforcing limitations on reuse;
- Posting signs;
- Conducting structural maintenance and repairs; and
- Maintaining records of contamination, departmental activities, and use restrictions.

Facilities

Many of the Department's contaminated facilities will be fully demolished, including all below-grade structures and foundations. The Department defined facilities requiring stewardship as any contaminated buildings no longer in use where the future plans include maintaining the structure with contamination in place (regardless of the assumed future use). Additionally, the Department included in this analysis any entombed facilities and facilities that will be demolished to grade with the below-grade structure capped in place. These facilities range in size and character from slightly contaminated laboratories and support structures to reactors and canyons. No feasible remediation or decommissioning technology currently exists for the reactors and canyons without seriously endangering the health of workers.

Stewardship Activities

The Department identified the anticipated stewardship activities necessary to protect human health and the environment. The anticipated stewardship activities are a function of the anticipated future land uses, existing regulations, as well as the type and amount of contamination that will remain in place. In some cases the site data indicated the specific stewardship activities that are planned for a site. For the most part, the sites that are able to identify specific, planned, stewardship activities are either currently undergoing stewardship, or are nearing site closure. Sites with a more distant closure date are less likely to be able to identify the specific stewardship activities that might be required to protect human health and the environment. When the specific stewardship activities are not identified, DOE estimated the stewardship activities that will be required. Exhibit C-4 presents the stewardship activities identified for each of the contaminated media. In addition to these activities identified by the Department, most engineered units will require repairs over time. These repairs will be needed because the wastes consolidated in the engineered units tend to remain hazardous longer than the design life of the units that contain them. Because the Department did not have sufficient data to evaluate the deterioration rate of engineered

units, DOE did not attempt to estimate the frequency of repairs for this analysis.

Stewardship Categories

For analysis purposes, this background document divides long-term stewardship activities into two categories, active and passive. Active stewardship entails performing certain activities to control risk at a site, including pumping groundwater; performing maintenance work such as repairing fences, caps, and erosion gullies; and collecting water samples for monitoring purposes. Passive stewardship generally refers to the long-term function of conveying information about site hazards and/or limiting access to a site through physical or legal means. Other terminology has been used to describe long-term stewardship activities. For example, EPA regulations for WIPP (40 CFR 191) define the term "institutional controls" to encompass all three of the types of activities considered "long-term stewardship" in this background document. The definitions of the stewardship categories used by the Department for this analysis are presented in Exhibit C-5.

After categorizing each residually contaminated medium, DOE then combined the results to categorize the overall type of stewardship expected for each site, with the overall ranking defaulting to the most rigorous case. For example, if three of the four residually contaminated media at a site will require only passive stewardship, but the fourth is expected to require active stewardship, the overall type of stewardship at the site is categorized as active. Another example would be at sites where one or more media are not expected to require stewardship, but the remaining media will have residual contamination requiring passive controls. In this case, the overall site stewardship level is identified as passive.

Exhibit C-5: Category Definitions

Active stewardship is the direct performance of continuous or periodic custodial activities such as controlling access to a site; controlling or cleaning up releases from a site; performing maintenance operations; or monitoring performance parameters.

Passive stewardship is the long-term responsibility to convey information warning about the hazards at a site or limiting access to, or use of, a site through physical or legal mechanisms.

No stewardship required is where cleanup has been completed to levels that will allow for an unrestricted or residential future use.

Data Limitations

Although the data used for this analysis are the best currently available to DOE Headquarters, the following limitations apply:

- Stewardship activities are linked to site cleanup and future use decisions. As these decisions are finalized, the Department's stewardship activities will be modified accordingly.
- Data on the completion of cleanup and transition to stewardship imply that stewardship does not begin until all remediation is complete. At many sites, cleanup and stewardship activities will occur simultaneously. Because data available for this analysis existed only at the geographic site level, this analysis does not account for or represent the areas of sites where stewardship will be occurring before all site remediation is complete.
- Site stewardship activities are extrapolated from data submitted for other purposes. The Department is in the process of developing a framework for sites to more explicitly report these data at the level of detail and quality necessary for adequately estimating the long-term stewardship requirements.
- Data were only available at the geographic site level, which results in each site being represented as an equal unit. The variance in the size and complexity of individual DOE sites would be better captured by the ability to link stewardship requirements to a consistent unit of measure such as site acres.

Appendix D: Glossary of Terms

Active Stewardship: The direct performance of continuous or periodic custodial activities such as controlling access to a site by means other than passive institutional controls; controlling or cleaning up releases from a site; performing maintenance operations on remediated areas at a site; or monitoring performance parameters at a disposal or release site.

Activity: The rate at which radioactive material emits radiation, stated in terms of the number of nuclear disintegrations occurring in a unit of time; the common unit of radioactivity is the curie (Ci).

Agricultural land use: Unfenced areas where subsistence or commercial agriculture predominates without any restrictions on surface or groundwater use.

Atomic Energy Act: The Federal law that regulates the production and uses of atomic power. The act was passed in 1946 and amended substantially in 1954 and several times since then.

Atomic Energy Commission: Created by the United States Congress in 1946 as the civilian agency responsible for producing nuclear weapons. It also researched and regulated atomic energy. In 1975, its weapons production and research activities were transferred to the Energy Research and Development Administration, and its regulatory responsibility was given to the new Nuclear Regulatory Commission.

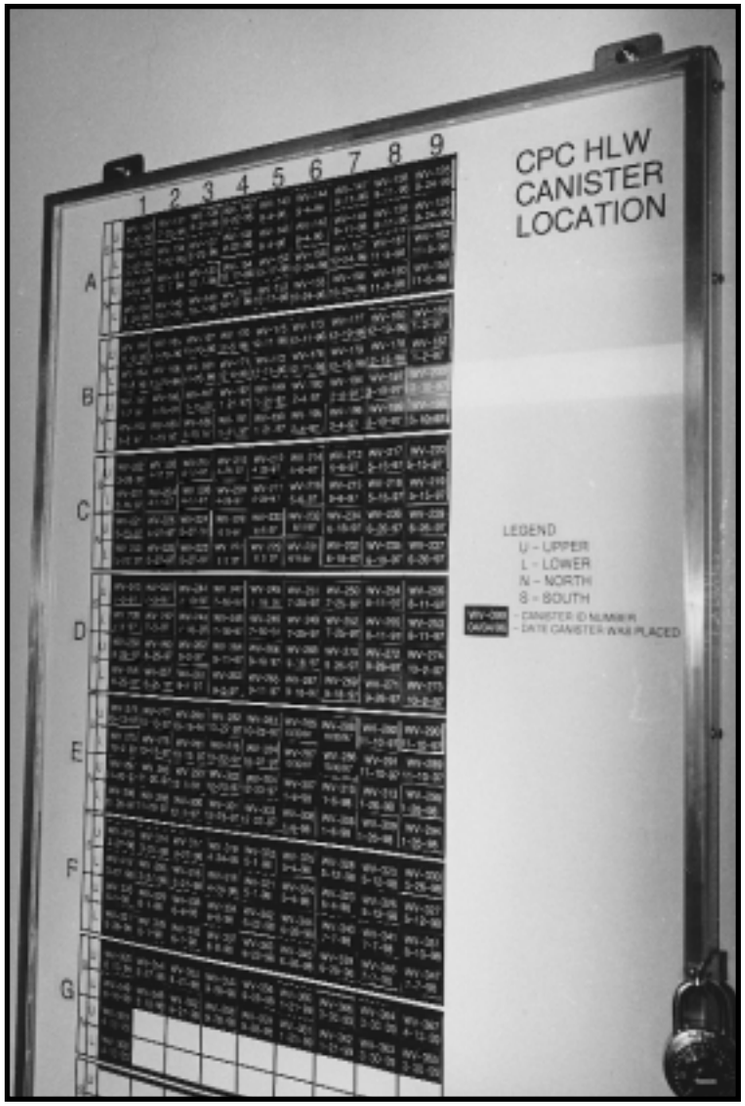


Chart of Vitrified Waste Canisters. At the West Valley Demonstration Project, high-level radioactive waste is being combined with borosilicate glass-forming chemicals and melted in a high-temperature melter in a process called vitrification. Heating the melter to approximately 2000°F produces a molten waste/glass blend that is poured into stainless steel canisters and placed in an interim storage facility to await disposal in the proposed geologic repository. The interim storage facility currently holds approximately 240 canisters and eventually may hold as many as 300. As each canister is placed in the storage facility, the date and location are noted on this chart. *West Valley Demonstration Project, New York, June 1999.*

Base Case: The estimate of total program cost (e.g., in the 1995 and 1996 *Baseline Environmental*

Management Reports) that reflects the most likely activities and schedule under current projections.

Baseline Environmental Management Report (Baseline Report): Congressionally mandated report prepared by the Secretary of Energy to estimate the cost and schedule of cleaning up the nation's nuclear weapons complex.

Brownfields: Abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination.

Burial Grounds: Areas designated for near-surface disposal of containers of low-level radioactive waste and obsolete or worn-out radioactively contaminated equipment.

Cleanup: The process of addressing contaminated land, facilities, and materials in accordance with applicable requirements. Cleanup does not imply that all hazards will be removed from the site. The term "remediation" is often used synonymously with cleanup. See also "environmental restoration."

Cold War Mortgage: The cost and effort associated with addressing the environmental legacy of 50 years of nuclear weapons production.

Completion of Cleanup: A condition in which cleanup of a site is considered complete when deactivation or decommissioning of all facilities currently in the Environmental Management program has been completed, excluding any long-term surveillance and monitoring; all releases to the environment have been cleaned up in accordance with agreed-upon cleanup standards; groundwater contamination has been contained, or long-term treatment or monitoring is in place; nuclear material and spent fuel have been stabilized and/or placed in safe long-term storage; and "legacy" waste (i.e., waste produced by past nuclear weapons production activities, with the exception of high-level waste) has been disposed of in an approved manner.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): A Federal law (also known as Superfund), enacted in 1980 and reauthorized in 1986, that provides the legal authority for emergency response and cleanup of hazardous substances released into the environment and for the cleanup of inactive waste sites.

Comprehensive Land Use Planning: A required site planning and management system which involves stakeholders to develop and maintain current and future land use plans and any type of development, use, or disposal planning for the site.

Controlled Access land use: The Department maintains restricted access areas for secure storage or disposal of nuclear materials or waste. Barriers and security fences prevent access by unauthorized persons. Wildlife and plants are controlled or removed.

Curie (Ci): A unit of radioactivity equal to 37 billion disintegrations per second (i.e., 37 billion becquerels); also a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

Decommissioning: Retirement of a nuclear facility, including decontamination and/or dismantlement.

Decontamination: Removal of radioactive or hazardous contamination by a chemical or mechanical process.

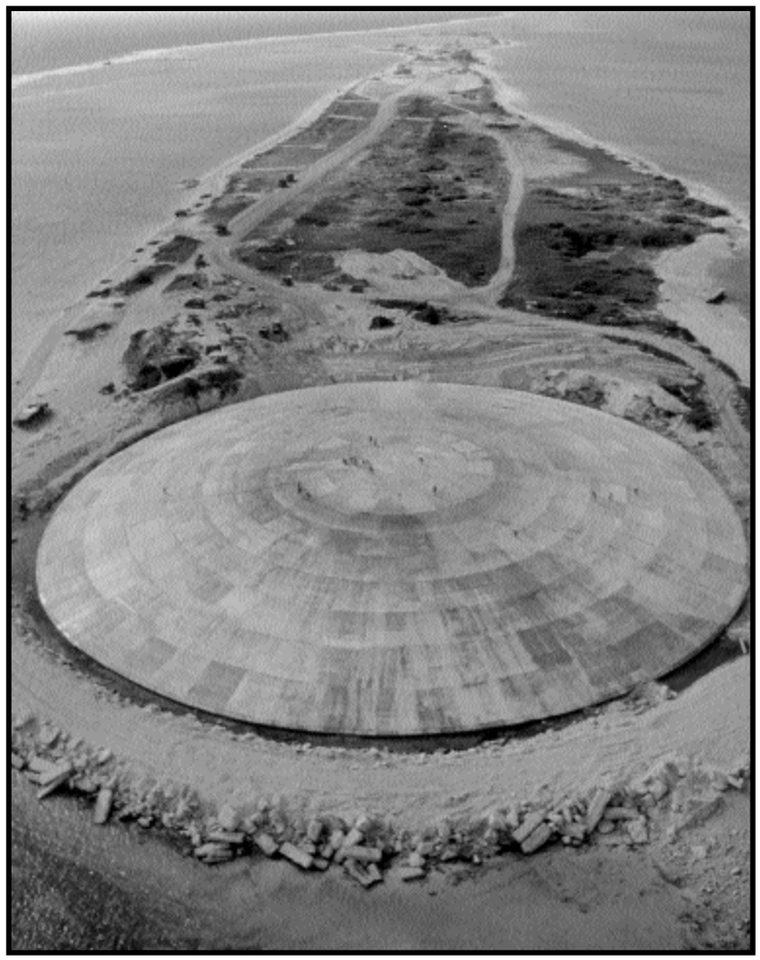
DNAPL: An acronym for denser-than-water nonaqueous-phase liquid–an organic liquid, composed of one or more contaminants, that does not mix with water and is denser than water. The most common DNAPL contaminants in ground water are chlorinated solvents.

End State: The physical state of a site after agreed upon remediation activities have been completed.

Engineered Units: Includes radioactive, hazardous, and sanitary landfills; vaults; tank farms; and other units with man-made containment systems.

Environmental Impact Statement (EIS): The detailed written statement that is required by section 102(2)(C) of NEPA for a proposed major Federal action significantly affecting the quality of the human environment. A DOE EIS is prepared in accordance with applicable requirements of the Council on Environmental Quality NEPA regulations in 40 CFR 1500-1508, and the DOE NEPA regulation in 10 CFR 1021.

The statement includes, among other information, discussions of the environmental impacts of the proposed action and all reasonable alternatives, adverse environmental effects that can not be avoided should the proposal be implemented, the relationship between short-term uses of the human environment and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources.



The Cactus Dome at Runit Island. Beneath this concrete dome on Runit Island (part of Enewetak Atoll), built between 1977 and 1980 at a cost of about $239 million, lie 111,000 cubic yards (84,927 cubic meters) of radioactive soil and debris from Bikini and Rongelap atolls. The dome covers the 30-foot (9 meter) deep, 350-foot (107 meter) wide crater created by the May 5, 1958 Cactus test. Note the people atop the dome. *Enewetak Atoll, Marshall Islands. Photo circa 1990. Source: Defense Special Weapons Agency.*

Environmental Management (EM) Program: An Office of DOE that was created in 1989 to oversee the Department's waste management and environmental cleanup efforts. Originally called the Office of Environmental Restoration and Waste Management, it was renamed in 1993.

Environmental Restoration: Often described broadly as "cleanup," this function encompasses a wide range of activities, such as stabilizing contaminated soil; treating ground water; decommissioning process buildings, nuclear reactors, chemical separations plants, and many other facilities; and exhuming sludge and buried drums of waste.

Feasibility Study: An analysis of the practicality of a proposal such as a description and analysis of the potential cleanup alternatives for a site. The Feasibility Study emphasizes data analysis and usually recommends selecting a cost-effective alternative. It is usually performed with and uses

data from a Remedial Investigation; together, they are commonly referred to as a "RI/FS" or Remedial Investigation/Feasibility Study.

Fissile Material: Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning; namely, any material fissionable by low-energy (i.e., thermal or slow) neutrons. Fissile materials include Uranium-235, Uranium-233, Plutonium-239, and Plutonium-241.

Formerly Utilized Sites Remedial Action Program (FUSRAP): A Federal program initiated in 1974 to identify and remediate sites around the country that were contaminated during the 1940s and 1950s as a result of researching, developing, processing, and producing uranium and thorium, and storing processing residues.

Future Land Use: The ultimate uses to be permitted for currently contaminated lands, waters, and structures at each DOE installation. land use decisions will strongly influence the cost of environmental management.

Geologic Repository: A mined facility for disposal of radioactive waste that uses waste packages and the natural geology as barriers to provide waste isolation.

Half Life: The time in which one half of the atoms of a particular radionuclide disintegrate into another nuclear form. Half lives for specific radionuclides vary from millionths of a second to billions of years.

Hazard: A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to an operation or to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation).

Hazardous Substances: Substances not regulated as hazardous waste under RCRA, but considered hazardous under CERCLA, TSCA, etc.

Hazardous Waste: A category of waste regulated under RCRA. To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20 through 40 CFR 261.24 (i.e., ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the Environmental Protection Agency in 40 CFR 261.31 through 40 CFR 261.33. Source, special nuclear, or by-product materials as defined by the Atomic Energy Act are not hazardous waste because they are not solid waste under RCRA.

Hazards: Materials or conditions that have the potential to cause adverse effects to health, safety, or the environment.

High-Level Waste (HLW): High-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

In Situ: In place.

Industrial Land Use: Active industrial facility where groundwater may be restricted.

Institutional Controls: Non-engineering measures—usually, but not always, legal controls—intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances. Institutional controls include, but are not necessarily limited to: land and resource (e.g., water) use and deed restrictions; well-drilling prohibitions, building permits and well use advisories and deed notices; other legally enforceable measures. However, they are distinct

from physical engineering measures such as treatment and containment systems.

Isotopes: Any of two or more variations of an element in which the nuclei have the same number of protons (i.e., the same atomic number) but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical properties (e.g., carbon-12 and 13 are stable, carbon-14 is radioactive).

Landlord: Activities that involve the physical operation and maintenance of DOE installations. Specific tasks vary but generally include providing utilities, maintenance, and general infrastructure for the entire installation.

Legacy Waste: Any waste within a complex that was generated by past weapons production or research activities and is in storage awaiting treatment or disposal.

Life-Cycle Cost Estimate: All the anticipated costs, associated with a project or program alternative throughout its life. This includes costs from pre-operations through operations or to the end of the alternative.

Long-Term Stewardship: All activities required to protect human health and the environment from hazards remaining after cleanup is complete.

Low-Level Waste (LLW): Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material.

Manhattan Project: The U.S. Government project that produced the first nuclear weapons during World War II. Started in 1942, the Manhattan Project formally ended in 1946. The Hanford Site, Oak Ridge Reservation, and Los Alamos National Laboratory were created for this effort. The project was named for the Manhattan Engineer District of the U.S. Army Corps of Engineers.

Mixed Waste: Waste that contains both source, special nuclear, or byproduct material subject to the *Atomic Energy Act of 1954,* as amended, and a hazardous component subject to the *Resource Conservation and Recovery Act.*

National Environmental Policy Act of 1969 (NEPA): NEPA is the basic national charter for protection of the environment. It establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. Section 102(2) contains "action-forcing" provisions to ensure that Federal agencies follow the letter and spirit of the Act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information.

National Priorities List (NPL): The Environmental Protection Agency's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under CERCLA. The list is based primarily on the score a site receives from the EPA Hazard Ranking System described in 40 CFR 300, Appendix A. EPA must update the NPL at least once a year.

Nevada Offsites: Underground nuclear tests conducted at eight locations in five different states (Alaska, Colorado, Mississippi, Nevada, and New Mexico) from 1957 to 1973 as part of the Plowshare program to develop peaceful (industrial and scientific) applications for nuclear explosives and the Vela Uniform program to improve the capability of detecting, monitoring, and identifying underground nuclear detonations.

Nuclear Waste Policy Act (NWPA): The Federal law that provides for the development of geologic repositories for disposal of high-level waste and spent nuclear fuel and other issues (see page 29).

Nuclear Weapons Complex: The chain of foundries, uranium enrichment plants, reactors, chemical separation plants, factories, laboratories, assembly plants, and test sites that produced nuclear weapons. Sixteen major U.S. facilities in 12 states formed the nuclear weapons complex.

Open Space Land Use: Posted areas are reserved generally as buffer or wildlife management zones. Native Americans or other authorized parties may be allowed permits for occasional surface area use. Access to or use of certain areas may be prevented by passive barriers (e.g., where soil is capped). Limited hunting or livestock grazing may be allowed.

Passive Stewardship: Includes ongoing custodial controls such as land or resource use restrictions; permanent markers, signs, or restrictions at a site; or public records, deed restrictions, and archived information.

Plutonium (Pu): A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially by neutron bombardment of uranium. Plutonium has 15 isotopes with atomic masses ranging from 232 to 246 and half lives from 20 minutes to 76 million years. Its most important isotope is fissile plutonium-239.

Radioactive: Of, caused by, or exhibiting radioactivity.

Radioactivity: The spontaneous transformation of unstable atomic nuclei, usually accompanied by the emission of ionizing radiation.

Radioisotope or Radionuclide: An unstable isotope that undergoes spontaneous transformation, emitting radiation.

Record of Decision (ROD): A public document that explains the cleanup alternatives to be used at National Priorities List sites where, under CERCLA, trust funds pay for the cleanup. In addition, a ROD under NEPA is a concise public document that records a Federal agency's decision(s) concerning a proposed action for which the agency has prepared an environmental impact statement (EIS). The ROD is prepared in accordance with the requirements of the Council on Environmental Quality NEPA regulations (40 CFR 1505.2). A ROD identifies the alternatives environmentally preferable alternative(s), factors balanced by the agency in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not.

Recreational Land Use: Unfenced areas where daytime use for recreational activities (e.g., hiking, biking, sports), hunting, and some overnight camping is allowed. Fishing may be limited to catch-and-release.

Residential Land Use: Unfenced areas where permanent residential use predominates. There is no restriction on surface water use, but groundwater use may be restricted.

Resource Conservation and Recovery Act (RCRA): A Federal law enacted in 1976 to address the treatment, storage, and disposal of hazardous waste.

Risk: Risk requires the presence of a hazard, but adds to the hazard the probability that the potential harm or undesirable consequences will be realized. Risk is expressed (qualitatively or quantitatively) in terms of the likelihood that an adverse effect will occur as a result of the existence of a hazard. The existence of a hazard does not automatically imply the existence of a risk since risk requires a pathway (to a receptor) for an exposure to occur. Barriers and other controls can block or eliminate

Signing the Atomic Energy Act of 1954. President Eisenhower, at his desk, August 30, 1954, after signing the Atomic Energy Act (see excerpts on page viii). Seated: President Eisenhower, Rep. Sterling Cole (R-NY), Atomic Energy Commission (AEC) Chairman Lewis Strauss. Back: Military Liaison Commission Chairman Herbert B. Loper, Sen. Edwin C. Johnson (D-CO), Rep. Carl Hinshaw (R-CA), Rep. James E. Van Zandt (R-PA), Rep. Melvin Price (D-IL), Rep. Carl T. Durham (D-NC) and AEC Commissioner Thomas Murray. *Washington DC, August 30, 1954. Source: National Archives*

the pathway and related risk from the residual hazard.

Spent Nuclear Fuel (SNF): Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

Stewardship (or long-term stewardship): Encompasses all activities required to maintain an adequate level of protection to human health and the environment posed by nuclear and/or chemical materials, waste, and residual contamination remaining after cleanup is complete.

Stockpile Stewardship: A DOE program to ensure core competencies in activities associated with the research, design, development, and testing of nuclear weapons; it also refers to the assessment and certification of their safety and reliability.

Superfund: A term commonly used to refer to CERCLA.

Toxic Substances Control Act (TSCA): A Federal law enacted in 1976 to protect human health and the environment from unreasonable risk caused by manufacturing, distribution, use, disposal of, or exposure to, substances containing toxic chemicals.

Transuranic Elements: All elements beyond uranium on the periodic table; that is, all elements with an atomic number greater than 92. All transuranic elements are man made. They include neptunium, plutonium, americium, and curium.

Transuranic Waste (TRU): Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha- emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR 191 disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

Unrestricted Land Use: Unfenced areas where there is no restriction on the types of activities that may occur, including permanent residential use.

Uranium (U): A radioactive, metallic element with the atomic number 92; the heaviest naturally occurring element. Uranium has 14 known isotopes, of which uranium-238 is the most abundant in nature. Uranium-235 is commonly used as a fuel for nuclear fission.

Uranium Mill Tailings: Tailings or waste produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content.

Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978: The act that directed DOE to provide for stabilization and control of the uranium mill tailings from inactive uranium milling sites in a safe and environmentally sound manner to minimize radiation health hazards to the public. It authorized the Department to undertake remedial actions at 24 designated inactive uranium processing sites and at an estimated 5,048 vicinity properties (see pages 28 and 29).

Uranium Mill Tailings Remedial Action (UMTRA): A DOE program to plan, implement, and complete environmental restoration (e.g. cleanup of contaminated surface water and groundwater) at inactive uranium-processing sites and their vicinity sites, as directed and authorized by the Uranium Mill Tailings Radiation Control Act of 1978.

Vitrification: A process by which waste is transformed from a liquid or sludge into an immobile solid that traps radionuclides and prevents waste from contaminating soil, ground water, and surface water. DOE has selected vitrification processes to solidify and stabilize certain forms of radioactive and hazardous waste. This process does not reduce radioactivity. The will use borosilicate glass to immobilize its high-level radioactive waste.

Waste Isolation Pilot Plant (WIPP): A DOE facility designed and authorized to permanently dispose of transuranic radioactive waste in a mined underground facility in deep geologic salt beds. It is located in southeastern New Mexico, 26 miles (42 km) east of the city of Carlsbad.

Waste Management: Activities that include treating, storing, and disposing of high-level radioactive waste, transuranic waste, low-level radioactive waste, low-level mixed waste, hazardous chemical waste, and sanitary waste.

Appendix E: Site Profiles

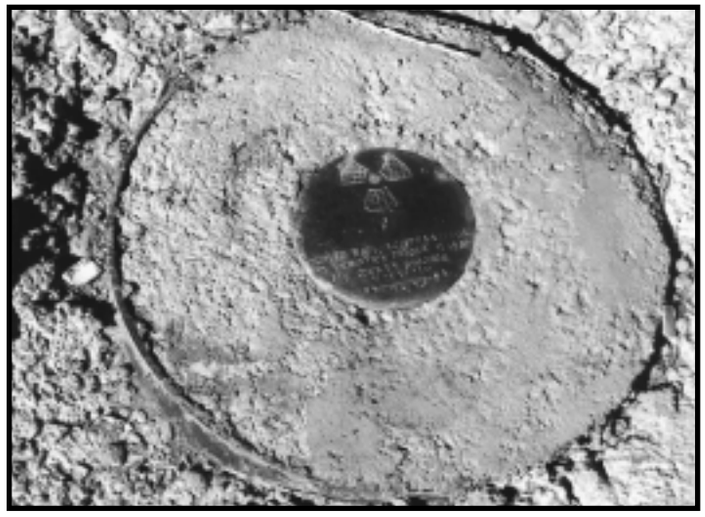
The site profiles in Appendix E provide a description of the anticipated stewardship activities at each geographic site included in the analysis for this report. These profiles are based on the data submitted for the 1998 *Paths to Closure* report and include a site overview that describes the site location, landlord, anticipated future use, and any identified site-wide stewardship issues. Site cleanup plans, anticipated residual contamination, and resulting stewardship activities are then described in more detail for each of the media (i.e., water, soil, engineered units, and facilities) described in this report.

Appendix E is not included in the printed version of this document; however, an electronic version of Appendix E is available at *www.em.doe.gov/lts*. If you do not have access to the internet, copies of the site profiles included in Appendix E can be obtained by contacting the Center for Environmental Management Information at 1-800-7-EMDATA.

Stainless Steel Canister for Vitrified Waste at West Valley Demonstration Project. This 10-foot by 2-foot stainless steel canister is identical to those being used to store vitrified high level radioactive waste prior to disposal in the proposed geologic repository. The waste, primarily cesium-137 and strontium-90, was generated from reprocessing commercial spent nuclear fuel to recover uranium and plutonium and was stored in a 740,000-gallon tank. Vitrification of the liquid high-level waste (containing most of the cesium-137) was completed in June 1998. DOE is now removing and vitrifying the "tank heel," the remaining sludge layer at the bottom of the tank, which contains most of the strontium-90 and transuranic elements. *West Valley Demonstration Project, New York, June 1999.*

Markers at Sites with Residual Contamination

Fermi Marker located 20 miles outside of Chicago, Illinois, identifying the site of buried radioactive wastes that inclulde materials from Enrico Fermi's uranium-graphite pile at the University of Chicago. The text of the inscription is on page 47. *Plot M, Palos Forest Preserve, Illinois, November 1995.*



Bayo Canyon Site Marker identifying a site near Los Alamos, New Mexico, where cleanup was completed in 1982 and strontium-90 was left in subsurface soil. The inscription reads: "Buried Radioactive Materials. No Excavation Prior to 2142 A.D. See County Records. N 21 48 21 W." *Bayo Canyon Site, New Mexico, 1986. Source: DOE EM Visuals Resource Center.*

Rulison Marker identifying the site of the 1969 Rulison underground nuclear explosion. The inscription reads "Project Rulison Nuclear Explosive Emplacement Well (R-E). Site of the second nuclear gas stimulation experiment in the United States. One 43 kiloton nuclear explosive was detonated in this well, 8,426 feet below the surface on September 10, 1969. No excavation, drilling, and/or removal of subsurface materials below a depth of 6,000 feet is permitted within Lot II, NE 1/4 SW 1/4, of Section 25, Township 7, South, Range 95 West, 6th Principal Meridian, Garfield County, Colorado without U.S. Government permission. U.S. Energy Research and Development Administration, September 1976." *Rulison, Garfield County, Colorado, June 1998.*

Buried Waste Pipe Sign indicating location of buried waste pipe. *N Reactor Area, Hanford Site, Washington, July 1998.*

Estes Gulch Disposal Cell Marker identifying the site of buried uranium mill tailings at Estes Gulch, near Rifle, Colorado. In addition to a scale map of the site, the inscription reads: "Rifle, Colorado. Date of Closure April 26, 1996. Dry tons of tailings 4,967,451. Radioactivity 2,738 Curies RA-226." *Estes Gulch Disposal Cell, Rifle, Colorado, June 1998.*

Canonsburg Disposal Cell Marker identifying the site of buried Manhattan Project uranium mill tailings in the town of Canonsburg, Pennsylvania, 20 miles outside Pittsburgh. In addition to a scale map of the site, the inscription reads: "Canonsburg PA. Date of Closure December 1985. Dry tons of tailings 266,000. Radioactivity 100 curies RA-226." *Canonsburg, Pennsylvania, March 1999.*