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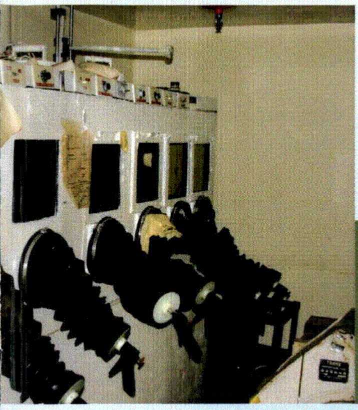
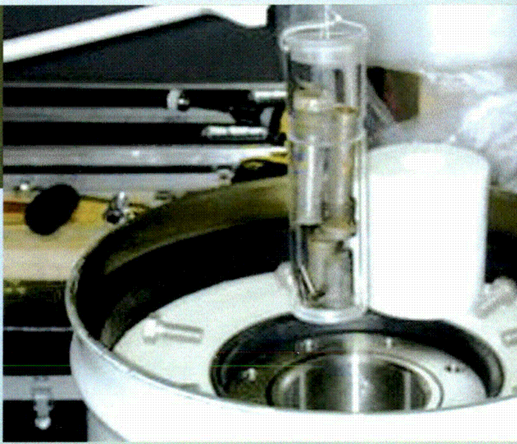


SUMMARY



Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375)

January 2016

U.S. DEPARTMENT OF ENERGY

COVER SHEET

Lead Agency: U.S. Department of Energy (DOE)

Cooperating Agency: U.S. Environmental Protection Agency (EPA)

Title: Final *Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE/EIS-0375)[1]

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Abstract: The U.S. Department of Energy (DOE) has prepared this Final *Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (GTCC EIS) to evaluate the potential environmental impacts associated with the proposed development, operation, and long-term management of a disposal facility or facilities for GTCC low-level radioactive waste (LLRW) and DOE GTCC-like waste. GTCC LLRW has radionuclide concentrations exceeding the limits for Class C LLRW established by the U.S. Nuclear Regulatory Commission (NRC). These wastes are generated by activities licensed by the NRC or Agreement States and cannot be disposed of in currently licensed commercial LLRW disposal facilities. DOE has prepared and is issuing this EIS in accordance with the National Environmental Policy Act, Section 631 of the Energy Policy Act of 2005 (Public Law 109-58), and Section 3 (b) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240).

The NRC LLRW classification system does not apply to radioactive wastes generated or owned by DOE and disposed of in DOE facilities. However, DOE owns or generates LLRW and non-defense-generated transuranic (TRU) radioactive waste, which have characteristics similar to those of GTCC LLRW and for which there may be no path for disposal at the present time. DOE has included these wastes for evaluation in this EIS because similar approaches may be used to dispose of both types of radioactive waste. For the purposes of this EIS, DOE refers to this waste as GTCC-like waste. The total volume of GTCC LLRW and GTCC-like waste

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[1] Vertical change bars in the margins of this Final EIS indicate revisions and new information added since the Draft EIS was issued in February 2011. Editorial changes are not marked.

addressed in the EIS is about 12,000 m^3 (420,000 ft^3), and it contains about 160 million curies of radioactivity. About three-fourths of this volume is GTCC LLRW, with GTCC-like waste making up the remaining one-fourth of the volume. Much of the GTCC-like waste is TRU waste. DOE has evaluated the potential environmental impacts associated with the range of reasonable alternatives for disposal of GTCC LLRW and GTCC-like waste in this GTCC EIS.

Alternatives Considered: DOE evaluated five alternatives in this GTCC EIS, including a No Action Alternative. One of the four action alternatives is disposal of GTCC LLRW and GTCC-like waste in a geologic repository at the Waste Isolation Pilot Plant (WIPP). The other three action alternatives involve the use of land disposal methods at six federally owned sites and at generic commercial sites. The land disposal alternatives consider the use of intermediate-depth borehole, enhanced near-surface trench, and above-grade vault facilities. The land disposal alternatives cover a spectrum of concepts that could be implemented to dispose of these wastes in order to enable an appropriate site and disposal technology to be selected. Each alternative is evaluated with regard to the transportation and disposal of the entire inventory, but the evaluation of human health and transportation impacts is done on a waste-type basis, so decisions can be made on this basis in the future, as appropriate.

Preferred Alternative: The preferred alternative for the disposal of GTCC and GTCC-like waste is the WIPP geologic repository (Alternative 2) and/or land disposal at generic commercial facilities (Alternatives 3-5). These land disposal conceptual designs could be altered or enhanced, as necessary, to provide the optimal application at a given location. The preferred alternative does not include land disposal at DOE sites. In addition, there is presently no preference among the three land disposal technologies at the generic commercial sites. The analysis in this Final GTCC EIS has provided the Department with the integrated insight needed to identify a preferred alternative with the potential to enable the disposal of the entire waste inventory analyzed in this EIS. Due to the uncertainty regarding the need for legislative changes and/or licensing or permitting changes, further analysis will be needed before a Record of Decision is announced. The Department has determined the preferred alternative would satisfy the needs of the Department for the disposal of GTCC and GTCC-like waste. Prior to making a final decision on which disposal alternative to implement, DOE will submit a Report to Congress to fulfill the requirement of Section 631(b)(1)(B)(i) of the Energy Policy Act of 2005 and await action by Congress. Section 631(b)(1)(B)(i) requires that the report include all alternatives under consideration and all the information required in the comprehensive report to ensure safe disposal of GTCC LLRW that was submitted by the Secretary to Congress in February 1987. DOE will not issue a Record of Decision until its required Report to Congress has been provided and appropriate action has been taken by Congress in accordance with the Energy Policy Act of 2005.

Public Comments: DOE issued an Advance Notice of Intent (ANOI) in the *Federal Register* on May 11, 2005, inviting the public to provide preliminary comments on the potential scope of the EIS. DOE then issued a Notice of Intent (NOI) to prepare this EIS on July 23, 2007; a printing correction was issued on July 31, 2007. The NOI provided responses to the major issues identified by commenters on the ANOI, identified the preliminary scope of the EIS, and announced nine public scoping meetings and a formal scoping comment period lasting from

July 23 through September 21, 2007. DOE used all input received during the scoping process to prepare the Draft GTCC EIS.

A 120-day public comment period on the Draft GTCC EIS began with the publication of the EPA Notice of Availability in the *Federal Register* on February 25, 2011 and closed on June 27, 2011. DOE conducted public hearings at nine locations during April and May of 2011. All comments received on the Draft GTCC EIS were considered in the preparation of this Final GTCC EIS.

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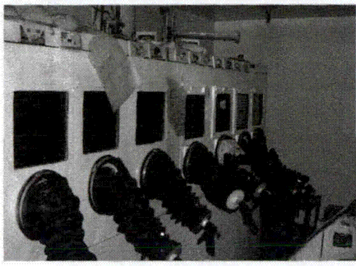
U.S. DEPARTMENT OF ENERGY

SUMMARY



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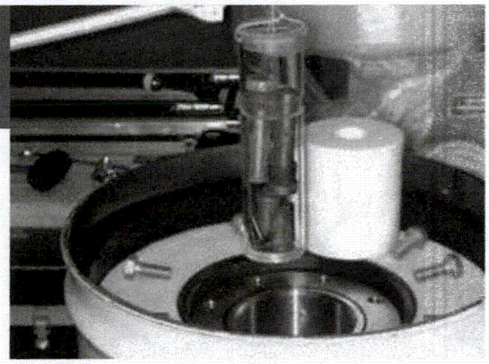

Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375)

January 2016

U.S. DEPARTMENT OF ENERGY

CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ags	above ground surface
ANOI	Advance Notice of Intent
bgs	below ground surface
BWR	boiling water reactor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CGTO	Consolidated Group of Tribes and Organizations
CH	contact-handled
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FR	*Federal Register*
FTE	full-time equivalent
GMS/OSRP	Office of Global Material Security/Off-Site Source Recovery Project (NNSA)
GTCC	greater-than-Class C
HOSS	hardened on-site storage
INL	Idaho National Laboratory
K_d	distribution coefficient
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LLRW	low-level radioactive waste
LLRWPAA	Low-Level Radioactive Waste Policy Amendments Act of 1985
LWA	Land Withdrawal Act (WIPP)
LWB	Land Withdrawal Boundary (WIPP)
NDA	NRC-Licensed Disposal Area
NEPA	National Environmental Policy Act of 1969
NOI	Notice of Intent
NRC	U.S. Nuclear Regulatory Commission
NNSS	Nevada National Security Site (formerly the Nevada Test Site or NTS)
ORR	Oak Ridge Reservation

P.L.	Public Law
PWR	pressurized water reactor
RH	remote-handled
RH LLW EA	Remote-Handled Low-Level Waste Environmental Assessment (INL)
ROD	Record of Decision
SDA	State-Licensed Disposal Area
SRS	Savannah River Site
TA	Technical Area (LANL)
TC&WM EIS	Tank Closure and Waste Management EIS (Hanford)
TRU	transuranic
USC	*United States Code*
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

RADIONUCLIDES

Am-241	americium-241
Am-243	americium-243
C-14	carbon-14
Co-60	cobalt-60
Cs-137	cesium-137
Fe-55	iron-55
I-129	iodine-129
Mn-54	manganese-54
Mo-99	molybdenum-99
Nb-94	niobium-94
Ni-59	nickel-59
Ni-63	nickel-63
Pu-238	plutonium-238
Pu-239	plutonium-239
Pu-240	plutonium-240
Sr-90	strontium-90
Tc-99	technetium-99

UNITS OF MEASURE

ac	acre(s)
ft	foot (feet)
ft^3	cubic foot (feet)
h	hour(s)
ha	hectare(s)
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
m^3	cubic meter(s)
MCi	megacurie(s)
mi	mile(s)
mi^2	square mile(s)
mrem	millirem
rad	radiation absorbed dose
rem	roentgen equivalent man
yr	year(s)

CONVERSION TABLE[a]

Multiply	By	To Obtain
English/Metric Equivalents		
acres (ac)	0.4047	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
Metric/English Equivalents		
cubic meters (m^3)	35.31	cubic feet (ft^3)
hectares (ha)	2.471	acres (ac)
kilometers (km)	0.6214	miles (mi)
meters (m)	3.281	feet (ft)
square kilometers (km^2)	0.3861	square miles (mi^2)

[a] Values presented in this Summary have been converted (as necessary) using the above conversion table and rounded to two significant figures.

RADIATION BASICS

A number of terms and concepts related to radiation and radiation doses are used in this Summary. The following text boxes are provided to describe these terms and concepts to aid the readers in understanding the information provided in this Summary.

Radiation Terms and Concepts

What Is Radioactivity? Radioactivity (or activity) is the property of unstable (radioactive) atoms that causes them to spontaneously release energy (radiation) in the form of subatomic particles or photons. Radioactivity is generally measured in curies, which is a rate of radioactive decay. One curie is defined to be 37 billion disintegrations per second.

What Is Radiation? Radiation consists of energy, generally in the form of subatomic particles (neutrons and alpha and beta particles) or photons (x-rays and gamma rays) given off by unstable (radioactive) atoms as they decay to reach a more stable configuration.

How Can Radiation Be Classified? Radiation can be classified as being in one of two categories: ionizing and nonionizing (such as from a laser). The radiation associated with GTCC LLRW and GTCC-like waste is ionizing radiation.

What Is Ionizing Radiation? Ionizing radiation is radiation that has sufficient energy to displace electrons from atoms or molecules when it interacts with matter, creating ion pairs. Ionizing radiation is a known human carcinogen.

What Types of Ionizing Radiation Are Associated with GTCC LLRW and GTCC-Like Waste? There are five types of ionizing radiation associated with GTCC LLRW and GTCC-like waste.

Alpha Particle – An alpha particle consists of two protons and two neutrons and is identical to the nucleus of a helium atom. An alpha particle has a short range in air and cannot penetrate a sheet of paper or the outer layer of skin.

Beta Particle – A beta particle can be either negative (negatron) or positive (positron) and has the mass of an electron. A high-energy beta particle can travel a few meters in air and pass through a sheet of paper but is generally stopped by a thin layer of plastic or aluminum.

Gamma Ray – A gamma ray is electromagnetic radiation (photon) given off by the nucleus of an atom as a means of releasing excess energy. A high-energy gamma ray can travel several hundred meters in air and requires the use of lead, steel, and concrete shielding to stop it.

X-ray – An x-ray is similar to a gamma ray but originates external to the nucleus (from movement of electrons between energy shells). X-rays have less energy than gamma rays, have a shorter range, and are easier to shield.

Neutron – A neutron is one of the two primary building blocks of the nucleus (the other being a proton), and it has no electrical charge. High-energy neutrons can travel long distances in air (similar to gamma rays) and are most effectively stopped with shielding having high concentrations of hydrogen, such as water, concrete, paraffin, and plastic.

What Is Half-Life? The half-life of a radionuclide is the length of time for a given amount of a radionuclide to decrease to one-half of its initial amount by radioactive decay.

Radiation Dose

What Is Radiation Dose? In general terms, radiation dose is simply a measure of the amount of energy deposited by ionizing radiation per unit mass of any material and is generally reported in rad (acronym for radiation absorbed dose). One rad is equal to 100 ergs per gram or 0.00001 joule per gram or 0.0000024 calorie per gram. An erg, a joule, and a calorie are units of measures of energy.

How Is Radiation Dose Measured in Humans? The radiation dose to humans is typically given in rem (acronym for roentgen equivalent man) and is the product of the absorbed dose (in rad) and factors related to the relative biological effectiveness of the radiation.

What Are Sources of Radiation? Radiation can come from natural sources and man-made sources. Natural sources of radiation include cosmic radiation, radioactive elements naturally present in the earth's crust and human body, and radon gas naturally present in soil and rock. Man-made sources of radiation include medical procedures, consumer products, nuclear technology (including nuclear power plants), and fallout from past atmospheric nuclear weapons tests.

How Much Radiation Dose Does an Individual Receive? The amount of radiation dose that an individual receives depends on several factors. Cosmic radiation increases with altitude, and terrestrial radiation varies by location in the country. The National Council on Radiation Protection and Measurements recently estimated that an average individual in the United States receives an annual radiation dose of about 620 mrem/yr; half of this dose is from natural sources, and half is from man-made sources, most of which is associated with medical sources.

Typical doses from various natural and man-made sources and activities are provided as follows for additional context. These examples were obtained from a website of the U.S. Environmental Protection Agency, which can be consulted for further information (http://www.epa.gov/radiation/understand/calculate.html).

Source	Average Annual Dose (mrem/yr)	Source	Average Annual Dose (mrem/yr)
Cosmic radiation		Internal radiation (in your body)	
(from outer space)		From food and water (e.g., potassium-40)	40
At sea level	26	From indoor air (radon and its decay products)	200
Elevation up to 1,000 ft	28	Plutonium-powered pacemaker	100
Elevation from 1,000 to 2,000 ft	31		
Elevation from 2,000 to 3,000 ft	35	Air travel by jet	
Elevation from 3,000 to 4,000 ft	41	For each 1,000 miles traveled	1
Elevation from 4,000 to 5,000 ft	47		
Elevation from 5,000 to 6,000 ft	55	Medical diagnostic procedures	
Elevation from 6,000 to 7,000 ft	66	Each medical x-ray	40
Elevation from 7,000 to 8,000 ft	79	Each nuclear medicine procedure	14
Above 8,000 ft	96		
		Nuclear weapons fallout (global average)	1
Terrestrial radiation			
(from soil and rocks)		Household sources	
Gulf States and Atlantic Coast	23	House constructed of brick, stone, or concrete	7
Colorado Plateau	90	Watching television	1
Elsewhere in the United States	46	Computer use	0.1
		Smoke detector	0.08

S.1 INTRODUCTION

This Summary provides an overview of the Final *Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (GTCC EIS) prepared by the U.S. Department of Energy (DOE). This Summary describes the wastes and the range of reasonable disposal alternatives evaluated in the GTCC EIS and provides a brief compilation of the major results of the evaluation included in this impact statement. In addition, guidance is provided for locating more detailed information on specific topics in the main body of the document.

Informing the public and fostering public participation are important requirements of the GTCC EIS process. At the end of this Summary is a discussion of the public review opportunities that includes representative comments received from stakeholders during the public scoping period and public comment period for the Draft GTCC EIS. For the GTCC EIS, stakeholders are the people or organizations who have an interest in or may be affected by (1) the lack of disposal capability for these wastes, (2) transportation of these wastes to an alternative disposal site, and (3) activities at the alternative disposal sites for these wastes. Stakeholders include members of the general public; representatives of environmental groups, industry, educational groups, unions, and other organizations; and representatives of Congress, federal agencies, American Indian tribes, state agencies, and local governments.

Readers interested primarily in the major issues and results presented in the GTCC EIS should find their information needs met by this Summary. Key information is presented about the purpose and need for agency action, the proposed action, the range of reasonable alternatives, the potential short- and long-term impacts of implementing each of the alternatives, uncertainties in the analyses, and the public participation process for this EIS. Considerations for developing the preferred alternative are included near the end of this Summary in Section S.7. A preferred alternative has been identified in Section S.8 and included in the Final GTCC EIS following public comment on the Draft GTCC EIS. In addition to the preferred alternative, other major changes made between the Draft and Final GTCC EIS are also summarized in Section S.9. Readers who would like more detail on these and other topics are directed to the pertinent sections of the GTCC EIS. Figure S-1 shows the organization of the GTCC EIS and relationships of its components.

S.1.1 What Is the Purpose and Need for Agency Action?

At this time, there is no disposal capability for GTCC low-level radioactive waste (LLRW). GTCC LLRW is generated by U.S. Nuclear Regulatory Commission (NRC) or Agreement State (i.e., a state that has signed an agreement with NRC to regulate certain uses of radioactive materials within the state) licensees. The NRC identifies four classes of LLRW in Title 10 of the *Code of Federal Regulations* (10 CFR 61.55) for disposal purposes on the basis of the concentrations of specific long- and short-lived radionuclides: Class A, B, C, and GTCC. GTCC LLRW has radionuclide concentrations exceeding the limits for Class C LLRW as

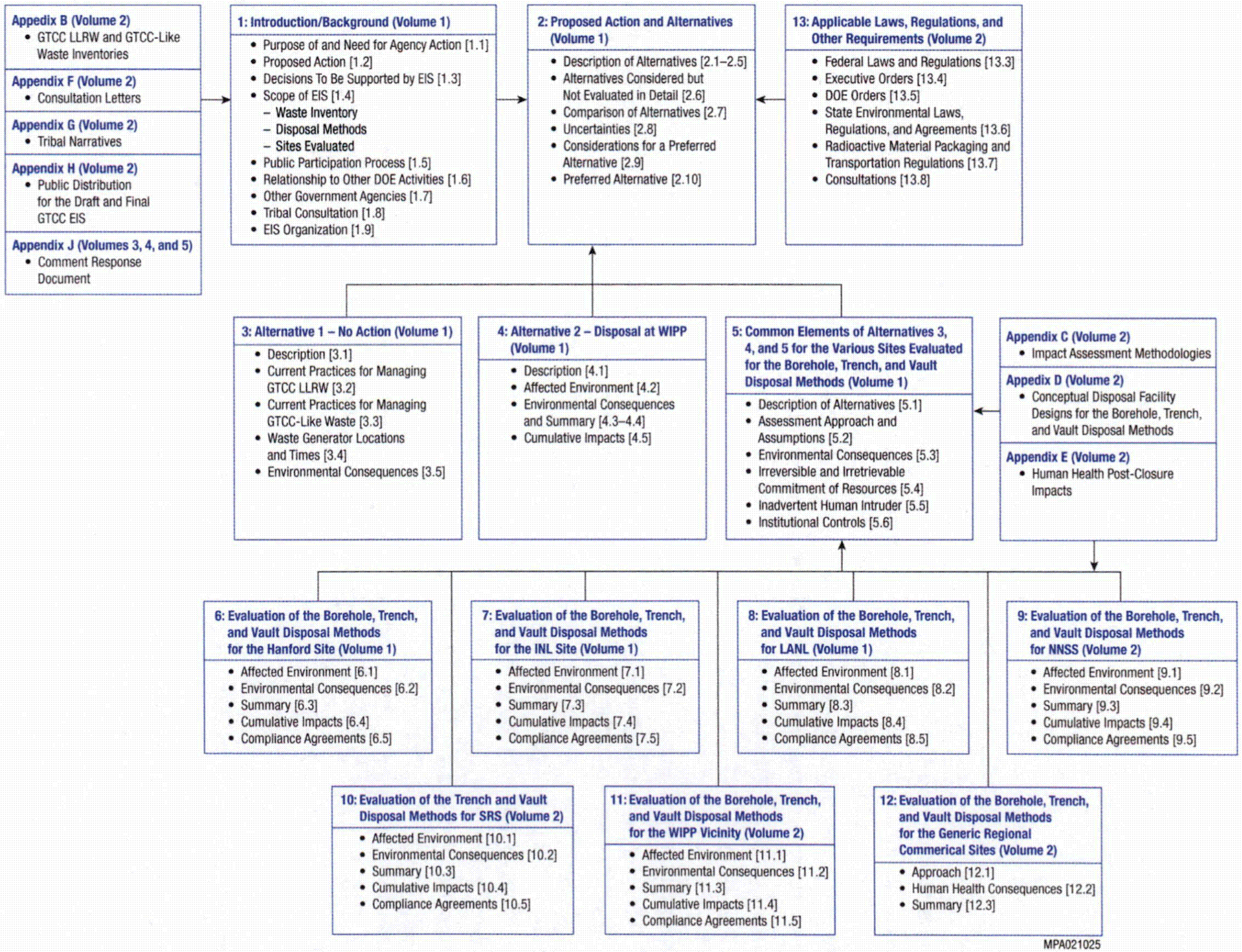

FIGURE S-1 Organization of the GTCC EIS and Relationships of Its Components (Note that in addition to this Summary, the main body of the GTCC EIS is made up of five volumes; the specific volume in which each component is contained is indicated in the figure above.)

provided in 10 CFR 61.55 and requires isolation from the human environment for a longer period of time than do Class A, B, and C LLRW, which are disposed of in existing commercial disposal facilities. GTCC LLRW consists of activated metals from the decommissioning of nuclear reactors, disused or unwanted sealed sources, and Other Waste (i.e., GTCC LLRW that is not activated metals or sealed sources). Other Waste consists of contaminated equipment, debris, scrap metal, filters, resins, soil, and solidified sludges.

Legislative Requirements

Section 3(b)(1)(D) of the LLRWPAA

- Specifies that the federal government is responsible for the disposal of GTCC LLRW.
- Specifies that GTCC LLRW be disposed of in a facility licensed by the NRC.

Section 631 of the Energy Policy Act of 2005

- Requires DOE to submit a report to Congress on disposal alternatives under consideration and await Congressional action before issuing a Record of Decision.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA, Public Law [P.L.] 99-240) specifies that the GTCC LLRW that is designated a federal responsibility under Section 3(b)(1)(D) is to be disposed of in a facility that is adequate to protect public health and safety and is licensed by the NRC. In addition, DOE owns and generates both LLRW and non-defense-generated TRU waste, which have characteristics similar to those of GTCC LLRW and for which there may be no path for disposal at the present time. DOE is referring to these wastes as GTCC-like wastes. The use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste. Although GTCC-like waste is not subject to the requirements in the LLRWPAA, DOE also intends to determine a path to disposal that is similarly protective of public health and safety.

The September 11, 2001, terrorist attacks and subsequent threats in the U.S. have heightened concerns that terrorists could gain possession of radioactive sealed sources (see text box on page S-11), including sealed sources requiring management as GTCC LLRW, and use them for malevolent purposes. Such an attack has been of particular concern because of the widespread use of sealed sources and other radioactive materials in the United States for beneficial uses by hospitals and other medical establishments, industries, and academic institutions. While secure storage of disused sealed sources is a temporary measure, a disposal capability is needed. The interagency Radiation Source Protection and Security Task Force, established under Section 651(d) of the Energy Policy Act of 2005 (P.L. 109-58), is charged with evaluating and providing recommendations related to the security of radiation sources in the United States from potential terrorist threats, including the use of a radiological source in a radiological dispersal device (e.g., dirty bomb). In August 2006, August 2010, and August 2014 the Task Force submitted reports to the President and

Disused radioactive sealed sources previously used in medical treatments and other applications are one of the GTCC LLRW types for which a disposal capability is needed. Every year, thousands of sealed sources become disused and unwanted in the United States. While secure storage is a temporary measure, unlike permanent disposal, the longer sources remain disused or unwanted, the greater the chance that they will become unsecured or abandoned. Due to their concentrated activity and portability, radioactive sealed sources could be used in radiological dispersal devices (RDDs), commonly referred to as "dirty bombs." An attack using an RDD could result in extensive economic loss, significant social disruption, and potentially serious public health problems.

U.S. Congress. The 2006 report (NRC 2006) stated that "providing disposal methods for GTCC LLRW will have the greatest effect on reducing the total risk of long-term storage for risk significant sources." The 2010 report (NRC 2010) further stated that "by far the most significant challenge identified is access to disposal for disused radioactive sources." The 2014 report (NRC 2014) recommended that "DOE should continue its ongoing efforts to develop GTCC [LLRW] disposal capability." Since 2003, the U.S. Government Accountability Office has issued several reports on matters related to the security of uncontrolled sealed sources. In particular, the 2003 report (GAO 2003, Executive Summary page) stated a concern with DOE's progress in developing a GTCC LLRW disposal facility. In addition, the Energy Policy Act of 2005 (P.L. 109-58) contains several provisions directed at improving the control of sealed sources, including disposal availability.

Accordingly, DOE has prepared this EIS to evaluate the range of reasonable alternatives for the safe and secure disposal of GTCC LLRW and GTCC-like waste. The range of reasonable alternatives addresses approximately 12,000 m^3 (420,000 ft^3) of in-storage and projected (anticipated through 2083) GTCC LLRW and GTCC-like waste. Waste quantity data obtained in 2008 had verification updates made in 2010 as needed, see Sandia (2008) and Argonne (2010). In performing its due diligence in the preparation of this Final EIS, DOE reviewed the waste quantity data and has determined that the expected waste quantity estimates remain valid and are conservative and bounding for the comparative analysis in the Final EIS, and revisions to this information are not necessary.

Disposal Method and Sites

Geologic Repository	WIPP
Intermediate-Depth Borehole	Hanford, INL, LANL, NNSS, WIPP Vicinity, and generic commercial sites
Enhanced Near-Surface Trench	Hanford, INL, LANL, NNSS, SRS, WIPP Vicinity, and generic commercial sites
Above-Grade Vault	Hanford, INL, LANL, NNSS, SRS, WIPP Vicinity, and generic commercial sites

S.1.2 What Is the Proposed Action?

DOE proposes to construct and operate a new facility or facilities or to use an existing facility for the disposal of GTCC LLRW and GTCC-like waste. DOE would then close the facility or facilities at the end of each facility's operational life. Institutional controls, including monitoring, would be employed for a period of time determined during the implementation phase. A combination of disposal methods and locations might be appropriate, depending on the characteristics of the waste among other factors. Disposal methods evaluated are the use of deep geologic disposal (via a geologic repository), an intermediate-depth borehole, an enhanced near-surface trench, and an above-grade vault. The disposal locations evaluated are the Hanford Site, the Idaho National Laboratory (INL) Site, Los Alamos National Laboratory (LANL), the Nevada National Security Site (NNSS), which was formerly known as the Nevada Test Site or NTS, the Savannah River Site (SRS), the Waste Isolation Pilot Plant (WIPP), and the WIPP Vicinity (where two locations are evaluated – one within and one outside the land withdrawal boundary of WIPP). Generic (commercial) sites are also evaluated for the borehole, trench, and vault methods, as applicable. The assumed locations of the generic sites coincide with the four NRC regions. Figures S-2 and S-3 show the sites being considered and the four NRC regions.

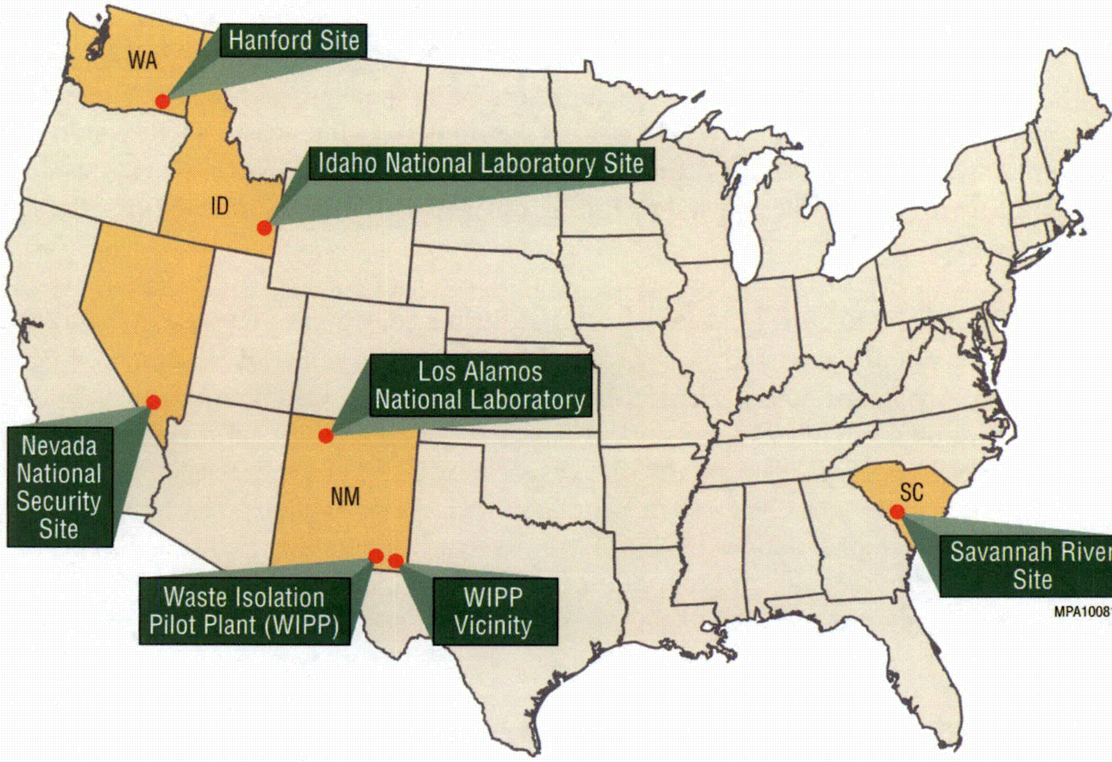

FIGURE S-2 Map of DOE Sites Being Considered for Disposal of GTCC LLRW and GTCC-Like Waste

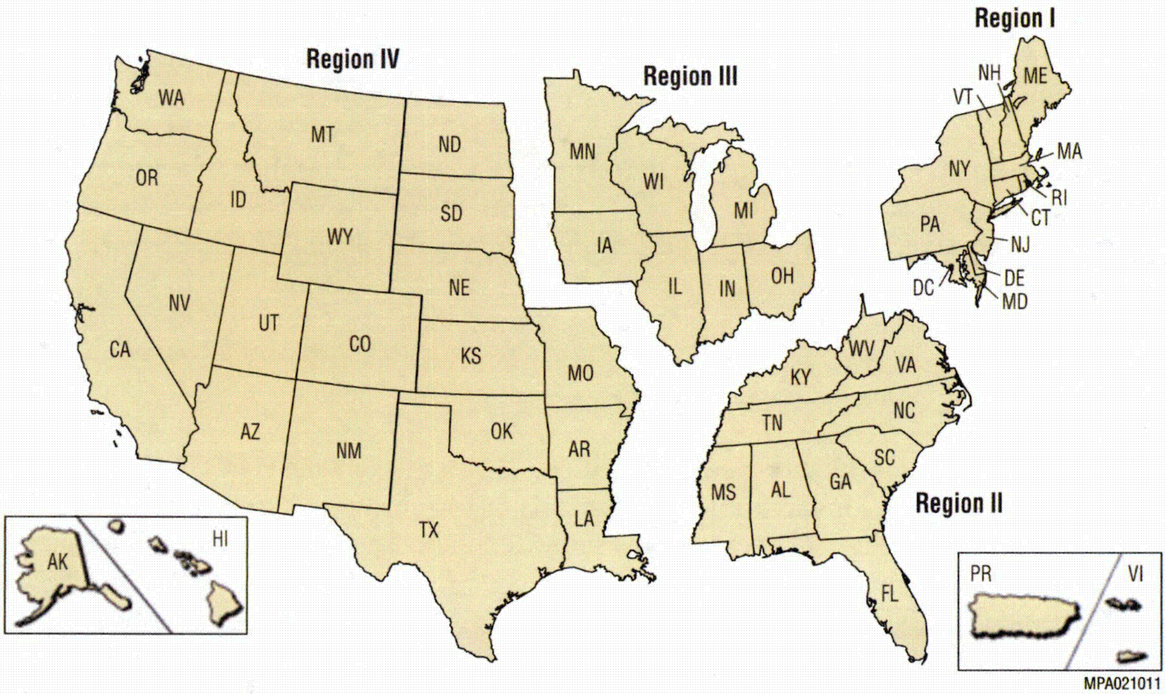

FIGURE S-3 Map Showing the Four NRC Regions Used as the Basis for the Evaluation of the Generic Commercial Sites

S.1.3 What Decisions Are Being Made?

DOE intends for this EIS to provide the information that supports the selection of disposal method(s) and site(s) for the GTCC LLRW and GTCC-like waste. DOE would conduct additional reviews under the National Environmental Policy Act of 1969 (NEPA) to evaluate the potential impacts from constructing and operating the selected disposal method(s) at the selected site(s), as needed.

Before issuing a Record of Decision (ROD) for the selection of disposal method(s) and site(s), DOE will submit a report to Congress to fulfill the requirement of Section 631(b)(1)(B)(i) of the Energy Policy Act of 2005 (P.L. 109-58). Section 631(b)(1)(B)(i) requires that the report include a description of all alternatives under consideration, and all the information required in the comprehensive report on ensuring the safe disposal of GTCC LLRW waste that was submitted by the Secretary to Congress in February 1987. Also, Section 631(b)(1)(B)(ii) requires DOE to await Congressional action. DOE will not issue a ROD until its required Report to Congress has been provided and appropriate action has been taken by Congress in accordance with the Energy Policy Act of 2005.

S.1.4 What Other Government Agencies Are Participating?

Because of its technical expertise in radiation protection, the U.S. Environmental Protection Agency (EPA) participated as a cooperating agency in the preparation of this EIS. The EPA's role as a cooperating agency does not imply its endorsement of DOE's selection of specific approaches, alternatives, or methods. The EPA conducted independent reviews of the Draft and Final EIS and associated documents in accordance with Section 309 of the Clean Air Act (*United States Code*, Volume 42, page 7609 [42 USC 7609]). The NRC participated as a commenting agency on the EIS.

Before implementation of any final decision, DOE would consult with appropriate Federal and state agencies, tribes, the Advisory Council on Historic Preservation, the appropriate State Historic Preservation Officer(s), and pertinent Regional Fish and Wildlife Service Office(s).

S.1.5 What Tribal Consultations Have Been Conducted?

DOE initiated consultation and communication activities on the GTCC EIS with 14 participating American Indian tribal governments that have cultural or historical ties to DOE sites being evaluated in this EIS, as identified in the text box. The consultation activities are being conducted in accordance with President Obama's Memorandum on Tribal Consultation (dated November 5, 2009), Executive Order 13175 (dated November 6, 2000) entitled "Consultation and Coordination with American Indian Tribal Governments," Executive Memorandum (dated September 23, 2004) entitled "Government-to-Government Relationship with Tribal Governments" (White House 2004), and DOE Order 144.1, *American Indian Tribal Government Interaction and Policy*, January 2009. The consultation activities include technical

briefings, development of written tribal narratives included in the GTCC EIS related to the specific site affiliated with the tribe, and/or discussions with elected tribal officials, based on individual tribal preferences and mutually agreed-upon protocols.

DOE respects the unique and special relationship between American Indian tribal governments and the Government of the United States, as established by treaty, statute, legal precedent, and the U.S. Constitution. For this reason, DOE has presented tribal views and perspectives in the GTCC EIS to ensure full and fair consideration of tribal rights and concerns before making decisions or implementing programs that could affect tribes. While DOE may not necessarily agree with these views, DOE is committed to its government-to-government relationship with American Indian tribal governments. DOE will continue to work with tribal governments and their designated representatives to protect American Indian cultural resources, sacred sites, and potential traditional cultural properties and to implement appropriate mitigation measures that may reduce potential adverse effects to American Indian resources and interests.

Tribes and Tribal Organizations Participating in GTCC EIS Consultation Activities

Hanford
- Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Pendleton, OR
- Nez Perce, Lapwai, ID
- Wanapum People, Ephrata, WA
- Yakama Nation, Union Gap, WA

Idaho
- Western Shoshone-Bannock Tribes, Fort Hall, ID

Los Alamos
- Acoma Pueblo, Acoma, NM
- Cochiti Pueblo, Cochiti, NM
- Laguna Pueblo, Laguna, NM
- Nambe Pueblo, Santa Fe, NM
- Pojoaque Pueblo, Santa Fe, NM
- Pueblo de San Ildefonso, Santa Fe, NM
- Pueblo of Jemez, Jemez, NM
- Santa Clara Pueblo, Española, NM

Nevada
- The Consolidated Group of Tribes and Organizations (CGTO) representing 16 Paiute and Western Shoshone Tribes. Consultation with these tribal nations is being conducted through the CGTO.

Tribal narratives, which describe the tribe's unique perspective on the DOE sites and environmental resource areas being analyzed in the GTCC EIS, are presented in the GTCC EIS. The following tribes, by site, chose to participate in the development of tribal narratives: Hanford (Confederated Tribes of the Umatilla Indian Reservation [CTUIR], Nez Perce, Wanapum, Yakama Nation); LANL (Cochiti Pueblo, Nambe Pueblo, Pueblo de San Ildefonso, Santa Clara Pueblo); and NNSS (Consolidated Group of Tribes and Organizations [CGTO], consisting of the Pahrump Paiute Tribe, Colorado River Indian Tribes, Duckwater Western Shoshone Tribe, Moapa Paiute Tribe, Bishop Paiute Tribe, Big Pine Paiute Tribe, Ely Western Shoshone Tribe). In addition to developing written narratives, other agreed-upon consultation activities have been initiated. Tribes contributed to the preparation of the Draft EIS and participated in the review of the Draft EIS by attending public meetings regarding GTCC and submitting comments that are addressed in Appendix J of this EIS. Since the receipt of tribal comments in 2011 on the Draft EIS, DOE has continued routine consultation with tribes as part of normal operations at the DOE sites evaluated in this EIS. DOE will continue to involve the tribes in the decision making process for the disposal of GTCC.

Some common issues identified by the tribes include the following:

Climate change. The climate has changed in the past 10,000 years. Tribes perceived that the lives of American Indian people have changed during these climatic shifts, that plant and animal communities have shifted, and that such shifts would occur again in the future (perhaps in the near future, given the potential impacts of global climate change).

Soils and minerals. At each of the potential GTCC disposal locations, regional soils and minerals found at or around the site play an important role in cultural and ceremonial activities.

Ecological impacts on the traditional use of plant and animal species by American Indians. Ecological concerns relate to the fact that the analyses tend to focus on threatened and endangered species and plants. The full range of species needs to be evaluated, especially in terms of American Indian use of plants and animals. Plants are used for medicine, food, basketry, tools, homes, clothing, fire, and social and healing ceremonies. Animals and insects are culturally important, and the relationship between them, the earth, and American Indian people are represented by the roles they play in the stories of American Indian people.

Human health impacts and American Indian pathways analysis. Tribes raised concerns that pathways specific to American Indian peoples be analyzed. They believe that standard calculations of human health exposure as used in the GTCC EIS for the general public are not applicable to American Indian populations.

Cultural resources. Tribal cultural resources include all physical, artifactual, and spiritual aspects for each of the potential areas being evaluated at Hanford, LANL, and NNSS. All things of the natural environment contribute to the cultural resources for the tribal lifestyle.

Visual resources. Views are important cultural resources that contribute to the location and performance of American Indian ceremonies. Viewscapes are typically experienced from high places or tend to provide panoramic views.

Tribal perspectives, comments, and concerns identified during the consultation process, those received during the public scoping process (also see Section S.7.4.2), and all comments received on the Draft GTCC EIS were considered by DOE in identifying the preferred alternative discussed in Section S.8.

S.2 WHAT DOES THE EIS ADDRESS?

S.2.1 What Is GTCC LLRW?

GTCC LLRW is waste that is not generally acceptable for near-surface disposal and for which the waste form and disposal methods must be different and, in general, more stringent than those specified for Class C LLRW. NRC regulations require GTCC LLRW to be disposed of in a geologic repository as defined in 10 CFR Parts 60 and 63, unless proposals for an alternative method are approved by NRC under 10 CFR 61.55(a)(2)(iv).[1]

The concentrations of radionuclides in Classes A, B, and C LLRW limit the length of time that these wastes are generally considered to be hazardous to about 500 to 1,000 years. 10 CFR 61.7(a)(2) notes that near-surface disposal site characteristics for these wastes should be considered in terms of the indefinite future and evaluated for a time frame of at least 500 years. Radioactive decay and the slow migration of radionuclides from the disposal units should reduce the hazard from the radionuclides to safe levels at that time. In contrast, some of the radionuclides in the GTCC LLRW and GTCC-like waste either have long half-lives (in excess of 10,000 years) or are present in high concentrations.

Class A LLRW has the lowest radionuclide concentration limits of the four classes of waste and is usually segregated from other LLRW at the disposal site. Class B LLRW has higher radionuclide concentration limits

NRC Classification System for LLRW

The NRC classification system for the four classes of LLRW (A, B, C, and GTCC) is established in 10 CFR 61.55 and is based on the concentrations of specific short- and long-lived radionuclides given in two tables. Classes A, B, and C LLRW are generally acceptable for disposal in near-surface land disposal facilities. GTCC LLRW is LLRW "that is not generally acceptable for near-surface disposal" as specified in 10 CFR 61.55(a)(2)(iv). As stated in 10 CFR 61.7(b)(5), there may be some instances in which waste with radionuclide concentrations greater than permitted for Class C would be acceptable for near-surface disposal with special processing or design.

GTCC LLRW and GTCC-Like Waste

GTCC LLRW refers to LLRW that has radionuclide concentrations that exceed the limits for Class C LLRW given in 10 CFR 61.55. This waste is generated by activities of NRC and Agreement State licensees, and it cannot be disposed of in currently licensed commercial LLRW disposal facilities. The federal government is responsible for the disposal of GTCC LLRW.

GTCC-like waste refers to radioactive waste that is owned or generated by DOE and has characteristics sufficiently similar to those of GTCC LLRW such that a common disposal approach may be appropriate. GTCC-like waste consists of LLRW and non-defense-generated TRU waste that has no identified path for disposal at the present time. The use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste.

[1] The GTCC LLRW inventory in the EIS includes GTCC LLRW from the decommissioning of commercial nuclear reactors that are covered by a Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste. A Federal Circuit Court panel ruled that for purposes of determining damages in the spent nuclear fuel litigation, GTCC LLRW waste is considered high-level radioactive waste under the terms of DOE's Standard Contract (*Yankee Atomic Electric Co. v. U.S.*, 536 F. 3d 1268 (Fed. Cir. 2008) and *Pacific Gas & Electric Co. v. U.S.*, 536 F. 3d 1282 (Fed. Cir. 2008)). The court's decision does not affect DOE's responsibility to evaluate reasonable alternatives for a disposal facility or facilities for GTCC LLRW – including GTCC LLRW covered by the Standard Contract – in accordance with applicable law.

than Class A and must meet more rigorous requirements with regard to waste form to ensure its stability after disposal. Class C LLRW is waste that represents a higher long-term risk than does Class A or Class B LLRW. Like Class B waste, Class C waste must meet the more rigorous requirements with regard to waste form to ensure its stability, and it also requires additional measures to be taken at the disposal facility to protect against inadvertent human intrusion.

S.2.2 What Is GTCC-Like Waste?

Consistent with NRC's and DOE's authorities under the Atomic Energy Act of 1954, amended (P.L. 83-703), the NRC LLRW classification system does not apply to radioactive waste that is owned or generated by DOE and disposed of in DOE facilities. However, DOE owns or generates both LLRW and non-defense-generated TRU waste,[2] which have characteristics similar to those of GTCC LLRW and for which there may be no path for disposal. DOE has included these wastes, otherwise known as "GTCC-like waste," for evaluation in the GTCC EIS because a common approach and/or facility could be used. For the purposes of the EIS, the use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste.

Three Waste Types

The wastes being addressed in this EIS are divided into three distinct types. These three waste types and their estimated total volumes and radionuclide activities are as follows:

- Activated metals: 2,000 m^3 (71,000 ft^3) and 160 MCi
- Sealed sources: 2,900 m^3 (100,000 ft^3) and 2.0 MCi
- Other Waste: 6,700 m^3 (240,000 ft^3) and 1.3 MCi

About three-fourths of the waste by volume is GTCC LLRW; GTCC-like waste accounts for the remainder.

S.2.3 How Much GTCC LLRW and GTCC-Like Waste Is Addressed in the EIS?

The combined GTCC LLRW and GTCC-like waste inventory addressed in this EIS has a packaged volume of about 12,000 m^3 (420,000 ft^3) and contains a total activity of about 160 million curies (MCi) (see Figure S-4).

For the purposes of analysis in this EIS, both GTCC LLRW and GTCC-like waste are comprised of three waste types: activated metals, sealed sources, and other waste. The waste inventory addressed in the EIS includes both stored inventory (wastes that were already generated and are in storage as of 2008) and projected inventory (wastes that are expected to be generated in the future through 2083). Waste quantity data obtained in 2008 had verification

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2 Defense-generated TRU waste is radioactive waste generated by atomic energy defense activities. "Atomic energy defense activity," as defined by the Nuclear Waste Policy Act of 1982, as amended, means "any activity of the Secretary of Energy performed in whole or in part in carrying out any of the following functions: naval reactors development; weapons activities including defense inertial confinement fusion; verification and control technology; defense nuclear materials production; defense nuclear waste and materials byproducts management; defense nuclear materials security and safeguards and security investigations; and defense research and development." TRU waste that is not generated by atomic energy defense activities is considered non-defense-generated TRU.

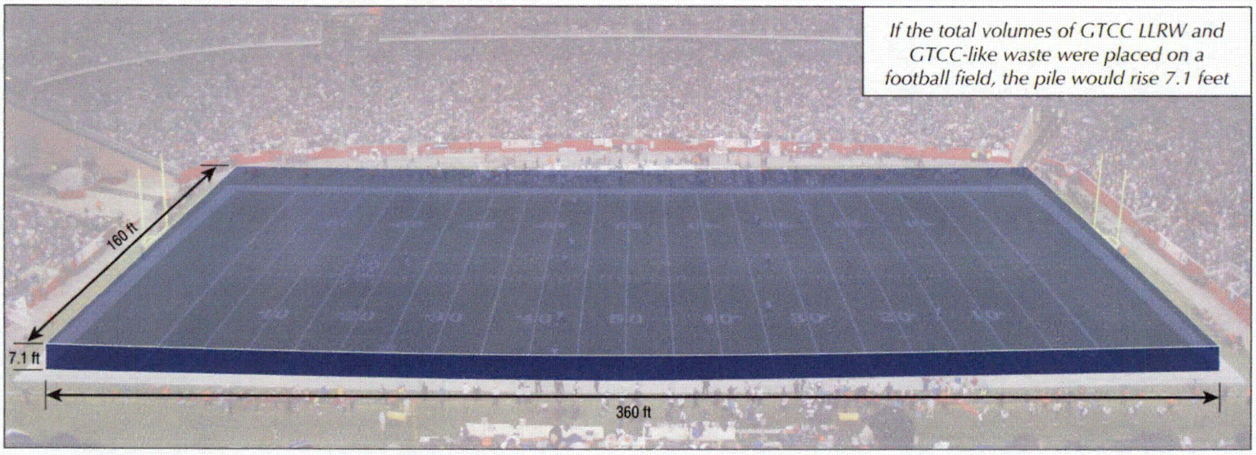
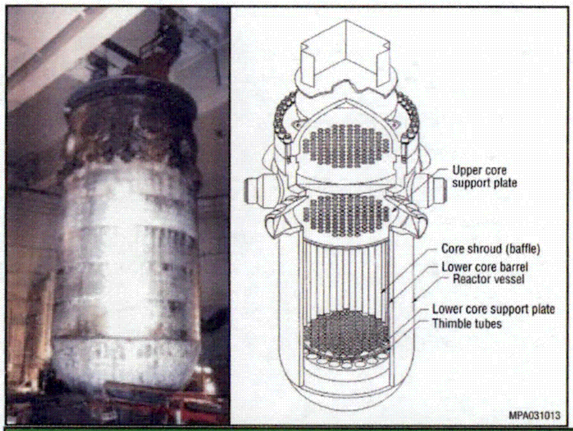


FIGURE S-4 Total Volume of GTCC LLRW and GTCC-Like Waste Addressed in the EIS



Activated Metals at a Glance
(2,000 m³ [71,000 ft³] containing 160 MCi)

- Largely generated from the decommissioning of nuclear reactors.
- Include portions of the nuclear reactor vessel, such as the core shroud and core support plate.
- Prevalent radionuclides in activated metals include C-14, Mn-54, Fe-55, Ni-59, Ni-63, Nb-94, and Co-60.
- In the United States, 104 commercial nuclear reactors are operating in 31 states, and more reactors are planned.
- Most reactors are not scheduled to undergo decommissioning for several decades.

Sealed Sources at a Glance
(2,900 m³ [100,000 ft³] containing 2.0 MCi)

- Widely used in equipment to diagnose and treat illnesses (particularly cancer), sterilize medical devices, irradiate blood for transplant patients, nondestructively test structures and industrial equipment, and explore geologic formations to find oil and gas.
- Located in hospitals, universities, and industries throughout the United States.
- Unsecured or abandoned sealed sources are a national security concern because of their potential to be used by terrorists in a "dirty bomb."
- Commonly consist of concentrated radioactive materials encapsulated in small metal containers.
- Radionuclides commonly used in sealed sources include Cs-137, Am-241, and Pu-238.

Other Waste at a Glance
(6,700 m^3 [240,000 ft^3] containing 1.3 MCi)

- Other Waste primarily includes contaminated equipment, debris, scrap metal, filters, resins, soil, and solidified sludges. These wastes are associated with the:
  - Production of Mo-99, which is used in about 16 million medical procedures (e.g., to detect cancer) each year. The United States depends on aging foreign reactors to produce Mo-99, and shortages in recent years due to the unexpected shutdowns of the foreign facilities have highlighted the need to produce Mo-99 in the United States.
  - Production of radioisotope power systems in support of space exploration (e.g., from the plutonium-238 production project) and national security.
  - Environmental cleanup of radioactively contaminated sites including the West Valley Site in New York.
- A wide range of radionuclides may be present in Other Waste, including Tc-99, Cs-137, and a number of transuranic radionuclides including isotopes of plutonium, americium, and curium.

Transuranic (TRU) Waste

TRU waste is radioactive waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes 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 U.S. Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR 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 Part 61. Examples of TRU radionuclides include Pu-238, Pu-239, Pu-240, Am-241, and Am-243.

Contact-Handled and Remote-Handled Waste

As used in this EIS, contact-handled (CH) waste refers to GTCC LLRW and GTCC-like waste that has a dose rate of less than 200 mrem/h on the surface of the package. Remote-handled (RH) waste refers to GTCC LLRW and GTCC-like waste that has a surface dose rate of 200 mrem/h or more. These definitions are consistent with the way that these terms are defined for disposal of TRU waste at WIPP.

> **Two Waste Groups**
>
> For purposes of analysis in this EIS, wastes are considered to be in one of two groups.
>
> - Group 1 consists of wastes from currently operating facilities. Some of the Group 1 wastes have already been generated and are in storage awaiting disposal.
> - Group 2 consists of projected wastes from proposed actions or planned facilities not yet in operation.

updates made in 2010 as needed, see Argonne (2010). In performing its due diligence in the preparation of this final EIS, DOE reviewed the waste quantity data and has determined that the expected waste quantity estimates remain valid and are conservative and bounding. The stored inventory includes waste in storage at sites licensed by the NRC or Agreement States (GTCC LLRW) and at certain DOE sites (GTCC-like waste) and consists of all three waste types (activated metals, sealed sources, and Other Waste).

For analysis in this EIS, the three waste types fall into two groups on the basis of uncertainties associated with their generation. Group 1 consists of wastes from currently operating facilities that are either already in storage or are expected to be generated from these facilities (such as commercial nuclear power plants by 2083); all currently operational plants were assumed to have their license renewed for an additional 20 years of operation. All stored GTCC LLRW and GTCC-like wastes are included in Group 1.

Group 2 consists of projected wastes from proposed actions or planned facilities not yet in operation. These actions include those proposed by DOE and those to be conducted by commercial entities (including electric utilities) for an assumed number of new (i.e., still to be licensed or constructed) nuclear power plants. Some or all of the Group 2 waste may never be generated, depending on the outcome of the proposed actions that are independent of this EIS. Such actions include the potential exhumation of previously disposed-of wastes at the West Valley Site in New York, wastes from the production of Mo-99, and wastes from the planned plutonium-238 production project. No stored GTCC LLRW and GTCC-like wastes are included in Group 2. Any potential nuclear fuel cycles involving advanced reactors or recycling of used fuel and the GTCC LLRW and GTCC-like waste associated with these activities are uncertain at this time and therefore not estimated in this EIS. Either of these scenarios could have an impact on the volume of GTCC LLRW and GTCC-like waste generated and requiring disposal, which would be subject to future NEPA review including a review of the types and amount of waste generated and the need for disposal capacity.

The waste volumes and radionuclide activities of the wastes addressed in this EIS are summarized in Table S-1.

The total waste volume in Group 1 is estimated to be 5,300 m^3 (190,000 ft^3), and this waste contains a total of 110 MCi of activity. The radionuclide activity is mainly from the decommissioning of commercial nuclear power reactors currently in operation (see Figure S-5). Group 2 has an estimated waste volume of 6,400 m^3 (230,000 ft^3) and contains a total activity of 49 MCi. Some of this waste is associated with the environmental cleanup of the West Valley Site in New York (a former commercial facility for reprocessing of spent nuclear fuel that has two disposal areas for radioactive waste). The radionuclide activity in the Group 2 wastes would result mainly from the decommissioning of proposed new commercial nuclear power reactors.

TABLE S-1 Summary of Group 1 and Group 2 GTCC LLRW and GTCC-Like Waste Packaged Volumes and Radionuclide Activities[a]

Waste Type	In Storage		Projected		Total Stored and Projected	
	Volume (m^3)	Activity (MCi)[b]	Volume (m^3)	Activity (MCi)	Volume (m^3)	Activity (MCi)
Group 1						
GTCC LLRW						
Activated metals (BWRs)[c] – RH	7.1	0.22	200	30	210	31
Activated metals (PWRs) – RH	51	1.1	620	76	670	77
Sealed sources (Small)[d] – CH	–[e,f]	–	1,800	0.28	1,800	0.28
Sealed sources (Cs-137 irradiators) - CH	–	–	1,000	1.7	1,000	1.7
Other Waste[g] – CH	42	0.000011	–	–	42	0.000011
Other Waste – RH	33	0.0042	1.0	0.00013	34	0.0043
Total	130	1.4	3,700	110	3,800	110
GTCC-like waste						
Activated metals – RH	6.2	0.23	6.6	0.0049	13	0.24
Sealed sources (Small) – CH	0.21	0.0000060	0.62	0.000071	0.83	0.000077
Other Waste – CH	430	0.016	310	0.0062	740	0.022
Other Waste – RH	520	0.096	200	0.17	720	0.26
Total	960	0.34	510	0.18	1,500	0.52
Total Group 1	1,100	1.7	4,200	110	5,300	110
Group 2						
GTCC LLRW						
Activated metals (BWRs) – RH	–	–	73	11	73	11
Activated metals (PWRs) – RH	–	–	300	37	300	37
Activated metals (Other) – RH[h]	–	–	740	0.14	740	0.14
Sealed sources – CH[h]	–	–	23	0.000020	23	0.000020
Other Waste – CH[h]	–	–	1,600	0.024	1,600	0.024
Other Waste – RH[h]	–	–	2,300	0.51	2,300	0.51
Total	–	–	5,000	49	5,000	49
GTCC-like waste						
Activated metals – RH	–	–	–	–	–	–
Sealed sources – CH	–	–	–	–	–	–
Other Waste – CH	–	–	490	0.012	490	0.012
Other Waste – RH	–	–	870	0.48	870	0.48
Total	–	–	1,400	0.49	1,400	0.49
Total Group 2	–	–	6,400	49	6,400	49

TABLE S-1 (Cont.)

Waste Type	In Storage		Projected		Total Stored and Projected	
	Volume (m^3)	Activity (MCi)[b]	Volume (m^3)	Activity (MCi)	Volume (m^3)	Activity (MCi)
Groups 1 and 2						
GTCC LLRW						
Activated metals – RH	59	1.4	1,900	160	2,000	160
Sealed sources – CH	–	–	2,900	2.0	2,900	2.0
Other Waste – CH	42	0.00091	1,600	0.024	1,600	0.024
Other Waste – RH	33	0.0042	2,300	0.51	2,300	0.51
Total	130	1.4	8,700	160	8,800	160
GTCC-like waste						
Activated metals – RH	6.2	0.23	6.6	0.0049	13	0.24
Sealed sources – CH	0.21	0.0000060	0.62	0.000071	0.83	0.000077
Other Waste – CH	430	0.016	800	0.02	1,200	0.036
Other Waste – RH	520	0.096	1,100	0.65	1,600	0.75
Total	960	0.34	1,900	0.67	2,800	1.0
Total Groups 1 and 2	1,100	1.7	11,000	160	12,000	160

a All values have been rounded to two significant figures. Some totals may not equal sum of individual components because of independent rounding. BWR = boiling water reactor, CH = contact-handled (waste), PWR = pressurized water reactor, RH = remote-handled (waste). Includes waste in storage as of 2008 and projected through 2083. Waste quantity data obtained in 2008 had verification updates made in 2010 as needed, see Argonne (2010). In performing its due diligence in the preparation of this final EIS, DOE reviewed the waste quantity data and has determined that the expected waste quantity estimates remain valid and are conservative and bounding.

b MCi means megacurie or 1 million curies.

c There are two types of commercial nuclear reactors in operation in the United States, BWRs and PWRs. Different factors were used to estimate the volumes and activities of activated metal wastes for these two types of reactors.

d Sealed sources may be physically small but have high concentration of radionuclides.

e There are sealed sources currently possessed by NRC licensees that may become GTCC LLRW when no longer needed by the licensee. The current status of individual sources (i.e., whether they are in use, waste, etc.) is subject to change over time. Therefore, due to uncertainty of when the licensees will declare their sources a waste, an estimated volume and activity has been included in the projected inventory.

f A dash means that there is no value for that entry.

g Other Waste consists of those wastes that are not activated metals or sealed sources; it includes contaminated equipment, debris, scrap metals, filters, resins, soil, solidified sludges, and other materials.

h Wastes from the West Valley Site NDA and SDA are reflected in the inventories listed under Group 2 activated metals, sealed sources, and Other Waste - RH/CH. Of the 740 m^3 under activated metals, 210 m^3 is from the NDA and 525 m^3 is from the SDA; 23 m^3 of sealed sources is from the SDA; 1,600 m^3 of Other Waste - CH is from the SDA; and 1,950 m^3 of Other Waste - RH included 1,943 m^3 from the NDA and 7.34 m^3 from the SDA.

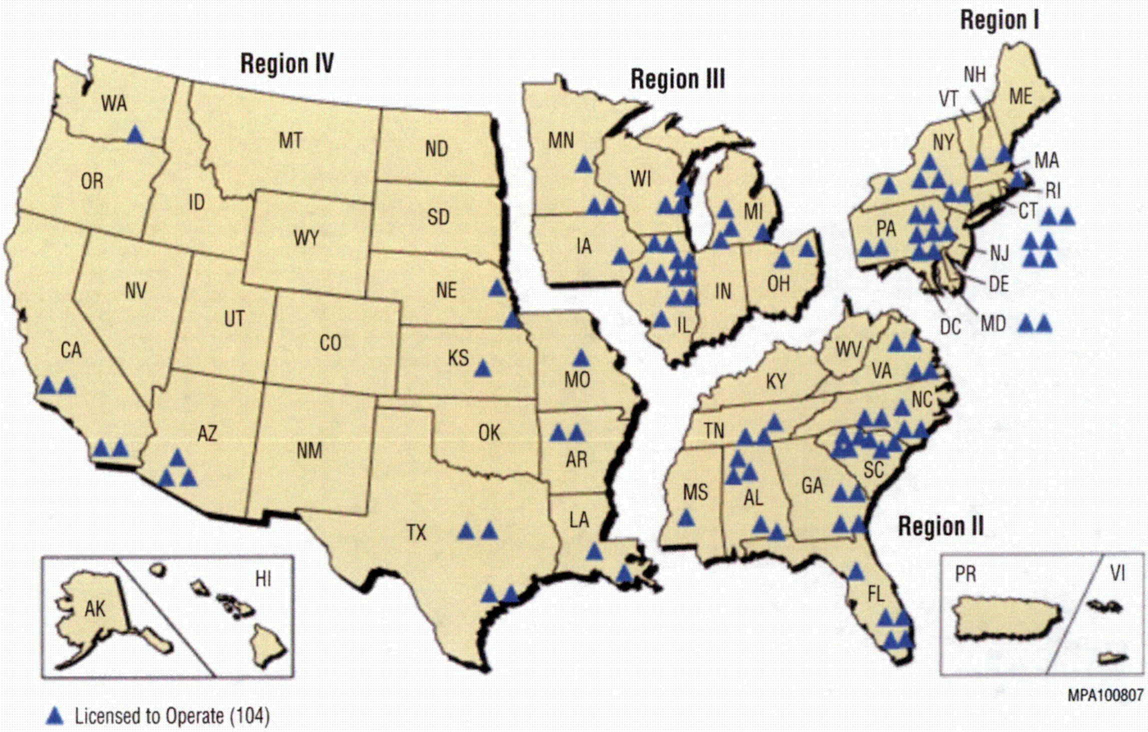


FIGURE S-5 Map Showing the Four NRC Regions and the Locations of Currently Operating Commercial Nuclear Power Plants

The total estimated volume of mixed waste (waste containing hazardous chemical constituents in addition to radionuclides) in Group 1 is about 170 m^3 (6,000 ft^3). Current information is insufficient to allow a reasonable estimate of the amount of Group 2 waste that could be mixed waste. Most of the Group 1 mixed waste is GTCC-like waste; only 4 m^3 (140 ft^3) is GTCC LLRW. Available information indicates that much of this waste is characteristic hazardous waste as regulated under the Resource Conservation and Recovery Act; therefore, this EIS assumes that for the land disposal methods, the generators will treat the waste to render it nonhazardous under federal and state laws and requirements. WIPP, however, can accept defense-generated TRU mixed waste as provided in the WIPP Land Withdrawal Act (LWA) of 1992 as amended (P.L. 102-579 as amended by P.L. 104-201).

S.2.4 What Is the Assumed Time Frame for GTCC LLRW and GTCC-Like Waste Disposal?

Waste would be received at the disposal facilities over an extended period of time. The actual start date for operations is uncertain at this time and dependent upon, among other things, the alternative or alternatives selected, additional NEPA review as required, characterization studies, and other actions necessary to initiate and complete construction and operation of a GTCC LLRW and GTCC-like waste disposal facility. For purposes of analysis in the GTCC EIS, DOE assumed a start date of disposal operations in 2019. However, given these uncertainties, the actual start date could vary. The receipt rate of the various waste types assumed for purposes of

analysis in the GTCC EIS is shown in Figure S-6. Approximately 8,500 m^3 (300,000 ft^3) of the total GTCC LLRW and GTCC-like waste inventory of 12,000 m^3 (420,000 ft^3) is projected to be available for disposal during the first 16 years of disposal operations (i.e., the years 2019–2035). Most of this waste consists of disused sealed sources, which present a national security concern and therefore have a greater near-term disposal need, and Other Waste (e.g., debris from DOE environmental cleanup activities, waste from the planned production of radioisotope power systems in support of space exploration and national security, and waste from the planned production of Mo-99 for cancer treatment and other important medical procedures). Beyond the year 2035, the primary waste volumes are projected to be disused sealed sources and GTCC LLRW activated metal waste from decommissioning nuclear reactors. This future activated metal waste accounts for approximately 98% of the total activity of the GTCC LLRW and GTCC-like waste inventory.

S.2.5 What Is the Range of Reasonable Alternatives Evaluated in the EIS?

DOE evaluated the following five alternatives in the EIS:

- Alternative 1: No Action,

- Alternative 2: Disposal at the WIPP geologic repository,

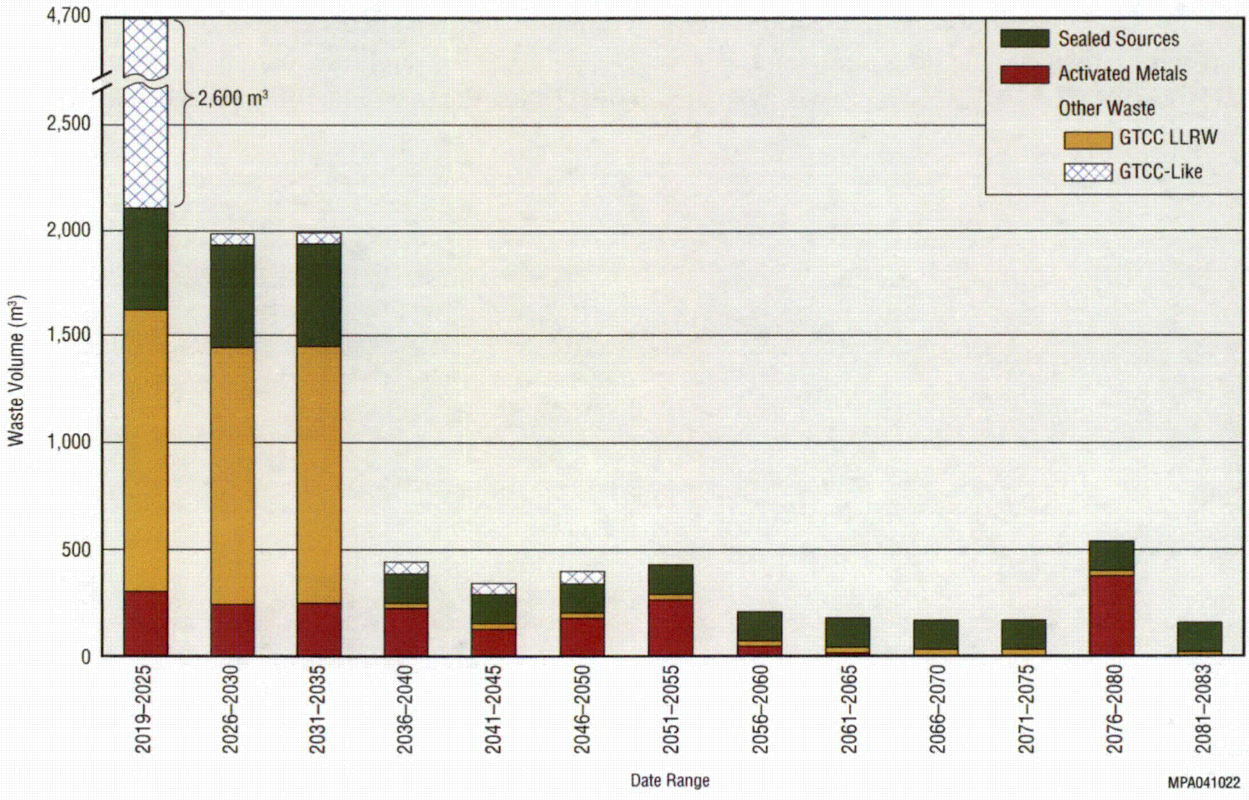


FIGURE S-6 Assumed Timeline for Receipt of GTCC LLRW and GTCC-Like Waste for Disposal

- Alternative 3: Disposal in a new borehole disposal facility,
- Alternative 4: Disposal in a new trench disposal facility, and
- Alternative 5: Disposal in a new vault disposal facility.

For the purposes of the analysis, DOE assumed construction of a new borehole, trench, or vault at all sites analyzed. This assumption provided conservatism in the evaluation methodology. However, an existing borehole, trench, or above-grade vault that meets the conceptual designs discussed in the EIS could be used.

Figure S-7 illustrates the disposal depths associated with the four action alternatives (Alternatives 2 through 5). DOE evaluated the use of an existing geologic repository (WIPP in New Mexico) and/or the construction of a new borehole, trench, or vault facility or facilities to safely dispose of the GTCC LLRW and GTCC-like waste. Combinations of disposal alternatives may be appropriate based on the characteristics of the waste type and other considerations (e.g., waste volumes, physical and radiological characteristics, and operational considerations). The new facility or facilities could be located at DOE sites having waste disposal missions, including the Hanford Site in Washington, the INL Site in Idaho, LANL in New Mexico, NNSS (formerly NTS) in Nevada, and SRS in South Carolina. In addition, such a disposal facility could be located on lands in the vicinity of WIPP (within or outside the land withdrawal boundaries of WIPP) or on generic nonfederal (commercial or private) lands.

DOE developed the four action alternatives after careful consideration of the waste inventory, disposal methods, and comments received during the public scoping period for the GTCC EIS. The WIPP repository is evaluated to determine the feasibility of the disposal of GTCC

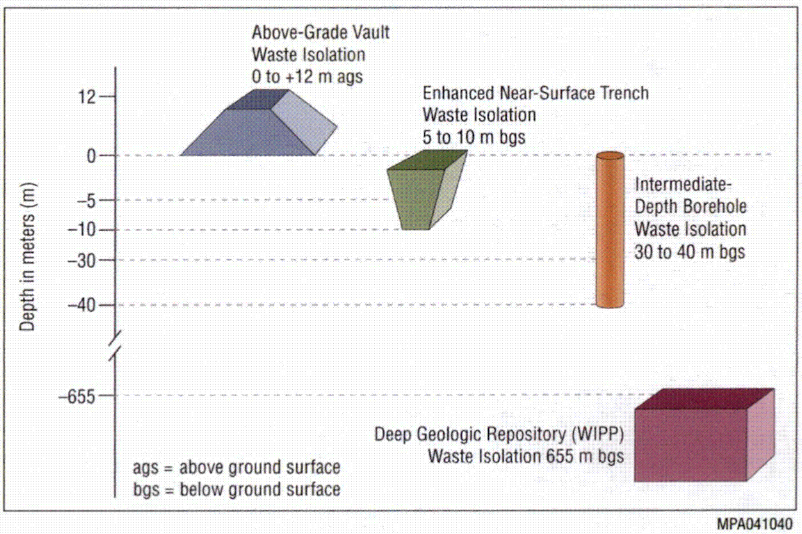


FIGURE S-7 Waste Isolation Depths for Proposed GTCC LLRW and GTCC-Like Waste Disposal Methods

LLRW and GTCC-like waste at a geologic repository. The designs for the land disposal facilities that are evaluated in this EIS are conceptual and generic in nature so that the performance of the sites with regard to employing the disposal methods considered in this EIS can be compared. These land disposal conceptual designs could be altered or enhanced, as necessary, to provide the optimal application at a given location.

Reference locations are identified for evaluating Alternatives 3 to 5 (borehole, trench, and vault) since these alternatives involve the construction of new disposal facilities. The reference locations, which have characteristics representative of the actual location that could be used for waste disposal purposes, are used in this EIS to compare disposal methodologies and sites. These reference locations at the DOE sites are generally in areas of these sites that have been used for other waste disposal activities or in which other disposal facilities or activities are also planned. If a site or sites were selected for possible implementation of a land disposal method or methods, a follow-on site-specific NEPA evaluation and documentation, as appropriate, along with a further optimization by a selection study, would be conducted to identify the location or locations within a given site that would be considered the best ones to accommodate the land disposal method(s). Figures indicating the reference locations of the land disposal facilities are given in this Summary. Reference locations have not been identified for the generic commercial disposal facilities, and these facilities are evaluated for potential human health impacts in this EIS on a regional basis (coinciding with the four NRC regions) by using input parameters assumed to be representative of each of the regions as a whole.

The five alternatives are described here.

S.2.5.1 Alternative 1: No Action

Under the No Action Alternative, current practices for storing GTCC LLRW and GTCC-like waste would continue in accordance with current requirements (e.g., NRC, state, DOE). The GTCC LLRW generated by the operation of commercial nuclear reactors (mainly activated metal waste) would continue to be stored at the various nuclear reactor sites that generated this waste or at other reactors owned by the same utility. Sealed sources would continue to be stored at interim storage and generator sites. Other Waste would also remain stored and managed at the generator or interim storage sites. In a similar manner, all stored and projected GTCC-like waste would remain at current DOE storage and generator locations (these wastes are being stored at several DOE sites as identified in Table S-2). Under this alternative, DOE would take no further action to develop disposal capability for these wastes, and current practices for managing these wastes would continue into the future. It is further assumed that for the short term, management of the stored wastes would continue for 100 years (a time period typically assumed for active institutional controls), and long-term impacts are analyzed for the period beyond 100 years and up to 10,000 years to be consistent with the time frame analyzed for the proposed disposal alternatives (i.e., Alternatives 2 to 5). National security concerns over the lack of a disposal capability for sealed sources that are GTCC LLRW would not be addressed.

TABLE S-2 Current Storage and Generator Locations of the GTCC LLRW and GTCC-Like Waste Addressed in the GTCC EIS[a]

Waste Type	GTCC LLRW	GTCC-Like Waste
Group 1		
Activated metals - RH	Various states (see Figure S-5)	INL Site (Idaho) ORR (Tennessee)
Sealed sources - CH	Various states	LANL (New Mexico)
Other Waste - CH	Babcock and Wilcox (Virginia) Waste Control Specialists (Texas)	West Valley Site (New York) INL Site (Idaho) Babcock and Wilcox (Virginia)
Other Waste - RH	Virginia and Texas	West Valley Site (New York) INL Site (Idaho) ORR (Tennessee) Babcock and Wilcox (Virginia)
Group 2		
Activated metals - RH	Various states	–
Sealed sources - CH	West Valley Site (New York)	–
Other Waste - CH	West Valley Site (New York)	West Valley Site (New York) ORR (Tennessee)
Other Waste - RH	West Valley Site (New York) Missouri University Research Reactor (Missouri) Babcock and Wilcox (Virginia)	West Valley Site (New York) ORR (Tennessee)

[a] Other Waste consists of those wastes that are not activated metals or sealed sources; it includes contaminated equipment, debris, scrap metal, filters, resins, soil, solidified sludges, and other materials. A dash means no volume for that waste type. INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, ORR = Oak Ridge Reservation.

S.2.5.2 Alternative 2: Disposal at WIPP

This alternative involves the disposal of GTCC LLRW and GTCC-like waste at WIPP. The operation at WIPP involves disposal of TRU waste generated by atomic energy defense activities by emplacement in underground disposal rooms that are mined as part of a panel and an access drift. Each mined panel consists of seven rooms. Contact-handled (CH) TRU waste containers are emplaced on disposal room floors, and remote-handled (RH) TRU waste containers are currently emplaced in horizontal boreholes in disposal room wall spaces. However, the EPA and New Mexico Environment Department have approved DOE use of shielded containers for safe emplacement of selected RH TRU waste streams with lower activity levels on the floor of the repository. The use of the shielded containers will enable DOE to significantly increase the efficiency of transportation and disposal operations for RH TRU waste at WIPP. For RH TRU waste streams with higher activity levels, such as those levels exhibited in the near term by activated metals removed from recently shutdown nuclear reactors, a similar, more heavily shielded container could be used. Consistent with the approval for the shielded container and the potential extension to a more heavily shielded container, this EIS assumes all activated metal waste and Other Waste - RH would be packaged in shielded containers that would be emplaced on the floor of the mined panel rooms in a manner similar to that used for the emplacement of CH waste.

The analysis discussed in this EIS assumes that disposal procedures and practices at WIPP would continue, except for the emplacement of activated metals and Other Waste - RH on room floors (not in wall spaces, as is the current procedure). It is also assumed that all aboveground support facilities would be available for the disposal of GTCC LLRW and GTCC-like waste and that construction of additional aboveground facilities would not be required to dispose of the entire inventory of GTCC LLRW and GTCC-like waste. However, the construction of up to 26 additional underground rooms would be required. Underground rooms are constructed by conventional mining techniques that use an electric-powered continuous miner rather than blasting. The mined salt is transported underground by haul trucks; once there, the salt is placed on the salt hoist and lifted to the surface. The exact locations and orientations of these rooms would be determined on the basis of mining engineering, safety, and other factors. Refer to Section 4.1.4.1 and Figure 4.1.4 1 in the EIS for additional information on construction. Figure S-8 shows the current WIPP layout including underground shafts.

Prior to implementation of this alternative, further evaluation and analysis of alternative technologies and methods to optimize the transport, handling, and emplacement of the wastes would be conducted to identify those technologies and methods that would minimize to the extent possible any potential impacts to human health or the environment. Follow-on WIPP-specific NEPA review would be conducted to examine in greater detail the potential impacts associated with the disposal of GTCC LLRW and GTCC-like waste at WIPP, as appropriate. DOE acknowledges that only defense-generated TRU waste is currently authorized for

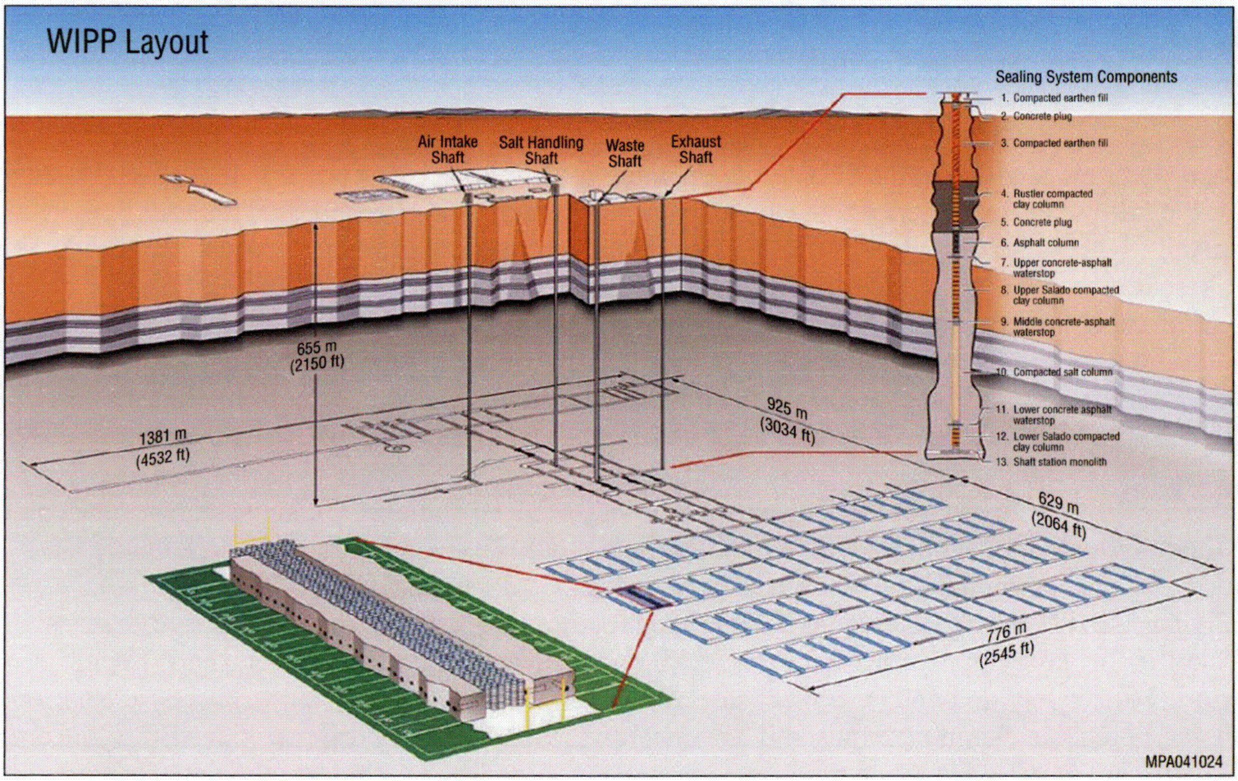


FIGURE S-8 Current WIPP Layout

disposal at the WIPP geologic repository under the WIPP LWA as amended (P.L. 102-579 as amended by P.L. 104-201), and that legislation would be required to allow disposal of waste other than TRU waste generated by atomic energy defense activities at WIPP and/or for siting a new facility within the land withdrawal area.

It should be noted that waste disposal operations at WIPP were suspended on February 5, 2014, following a fire involving an underground vehicle. Nine days later, on February 14, 2014, a radiological event occurred underground at WIPP, contaminating a portion of the mine primarily along the ventilation path from the location of the incident and releasing a small amount of contamination into the environment.

DOE will resume disposal operations at WIPP when it is safe to do so. The schedule for restart of limited operations is currently under review. DOE is continuing to characterize and certify TRU waste at the Idaho National Laboratory, Oak Ridge National Laboratory, Savannah River Site, and Argonne National Laboratory for eventual shipment to WIPP. TRU waste continues to be generated at the Hanford site and Lawrence Livermore National Laboratory. DOE is carefully evaluating and analyzing the impacts on storage requirements and commitments with state regulators at the generator sites. These efforts will inform decisions related to the availability of storage for certified TRU waste until waste shipments to WIPP can resume. Detailed information on the status of recovery activities at WIPP can be found at http://www.wipp.energy.gov/wipprecovery/recovery.html.

S.2.5.3 Alternative 3: Disposal in a New Intermediate-Depth Borehole Disposal Facility

Alternative 3 involves the construction, operations, and post-closure performance of a new borehole facility for the GTCC LLRW and GTCC-like waste inventory. Reference locations at the following five sites are evaluated for this alternative: the Hanford Site, the INL Site, LANL, NNSS, and the WIPP Vicinity. Because of the shallow depth to groundwater at SRS, this alternative is not evaluated for this site. Of the four NRC regions considered for the generic commercial facility, only NRC Region IV was evaluated for this alternative, since the depth to groundwater at the other three regions is considered too shallow for application of the borehole method. A cross section of a conceptual borehole design is shown in Figure S-9. For purposes of the EIS analysis, a borehole with a depth of 40 m (130 ft) was evaluated.

To dispose of the entire inventory of GTCC LLRW and GTCC-like waste, the conceptual design indicates that about 44 ha (110 ac) of land would be required for the 930 boreholes needed to accommodate the waste packages of GTCC LLRW and GTCC-like waste (see Figure S-10). This acreage would include land required for supporting infrastructure, such as facilities or buildings for receiving and handling waste packages or containers, and space for a stormwater retention pond (to collect stormwater runoff and truck washdown). Less acreage and fewer boreholes would be required if a decision were made to only dispose of certain GTCC LLRW and GTCC-like waste types in a borehole facility. The borehole method entails borehole designs constructed at depths below 30 m (100 ft) but above 300 m (1,000 ft) below ground surface (bgs). Boreholes can vary widely in diameter (from 0.3 to 3.7 m [1 to 12 ft]), and the

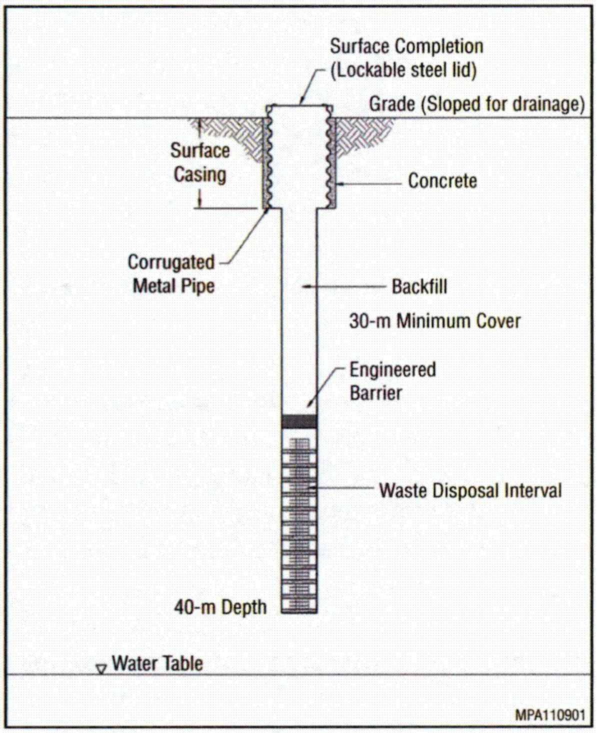


FIGURE S-9 Cross Section of the Conceptual Design for an Intermediate-Depth Borehole

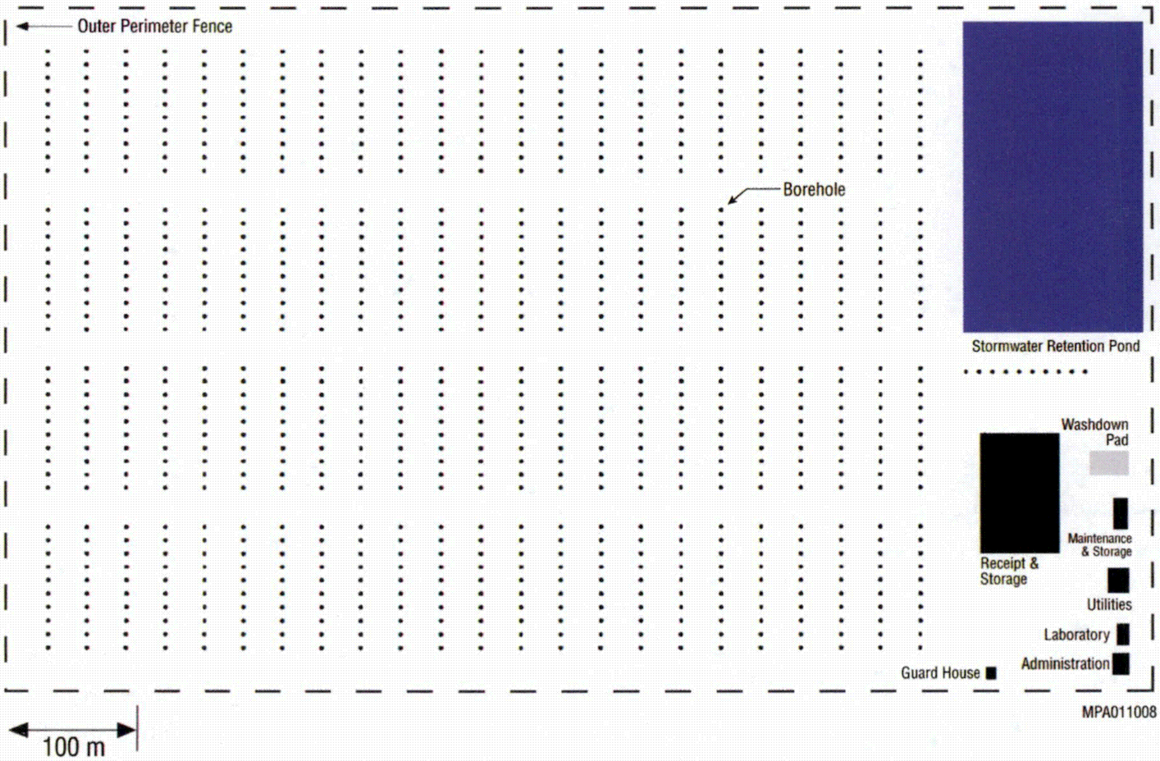


FIGURE S-10 Layout of Conceptual Borehole Facility

proximity of one borehole to another can vary depending on the design of the facility. GTCC LLRW and GTCC-like waste disposal placement is assumed to be about 30 to 40 m (100 to 130 ft) bgs. After placement of the wastes in the borehole, an engineered barrier (reinforced concrete) would be added above the disposal containers to deter inadvertent drilling into the isolated waste during the post-closure period, and backfill would be added to the surface level.

S.2.5.4 Alternative 4: Disposal in a New Enhanced Near-Surface Trench Disposal Facility

Alternative 4 involves the construction, operations, and post-closure performance of a new trench disposal facility. This alternative is evaluated for the Hanford Site, the INL Site, LANL, NNSS, SRS, and the WIPP Vicinity. The conceptual design of the trench is shown in Figure S-11. Alternative 4 is evaluated for the generic commercial sites in NRC Regions II and IV in order to allow for a comparison with the federal sites in these two regions.

To dispose of the entire inventory of GTCC LLRW and GTCC-like waste, the conceptual design for the trench method includes 29 trenches occupying a footprint of about 20 ha (50 ac) (see Figure S-12). This acreage includes land required for supporting infrastructure, such as facilities or buildings for receiving and handling waste packages or containers, and space for a stormwater retention pond (to collect stormwater runoff and truck washdown). Each trench would be approximately 3-m (10-ft) wide, 11-m (36-ft) deep, and 100-m (330-ft) long. GTCC LLRW and GTCC-like waste disposal placement is assumed to be about 5 to 10 m (15 to 30 ft) bgs. After wastes were placed in the trench, an engineered barrier (a reinforced concrete layer)

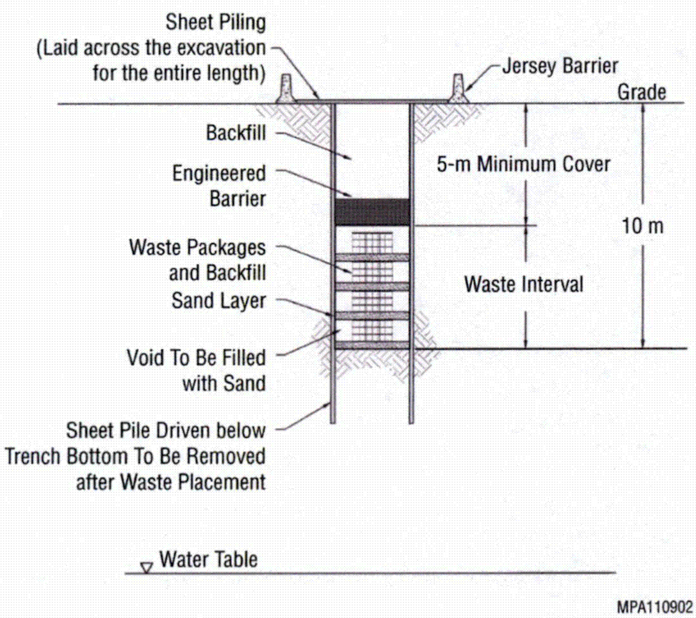


FIGURE S-11 Cross Section of the Conceptual Design for a Trench

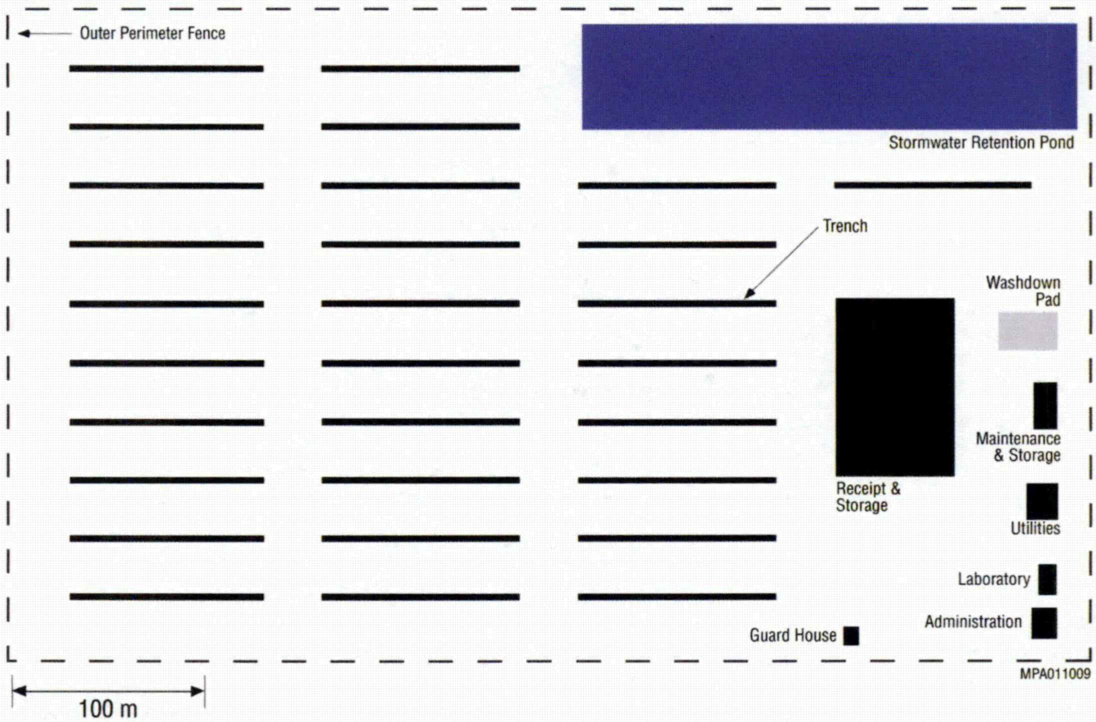


FIGURE S-12 Layout of a Conceptual Trench Facility

would be placed on top, and backfill would be added to the surface level. The additional concrete layer would provide additional shielding during the operational period, and at some sites where the material through which drilling would be done is typically soft (e.g., sand or clay), the layer could deter inadvertent drilling into the buried waste during the post-closure period. Measures would be included in the designs of the facilities to reduce the likelihood for future inadvertent human intrusion. In addition to the concrete cover noted above, the conceptual design for the trench is deeper and narrower than conventional near-surface LLRW disposal facilities to minimize this potential intrusion during the post-closure period. Additional intruder barriers would also be adopted for those sites in hard rock settings. Protecting against an inadvertent human intruder would be a key feature of the final facility design.

S.2.5.5 Alternative 5: Disposal in a New Above-Grade Vault Disposal Facility

Alternative 5 involves the construction, operations, and post-closure performance of a new vault disposal facility at the Hanford Site, the INL Site, LANL, NNSS, SRS, and the WIPP Vicinity. The conceptual design of the vault is shown in Figure S-13. Alternative 5 is evaluated for the generic commercial site in all four NRC regions. The conceptual design for the vault disposal employs a reinforced concrete vault constructed near grade level, with the footings and floors of the vault situated in a slight excavation just below grade.

The vault disposal facility to emplace the entire GTCC LLRW and GTCC-like waste inventory would consist of 12 vaults (each with 11 vault cells) and occupy a footprint of about 24 ha (60 ac) (see Figure S-14). This acreage would include land required for supporting

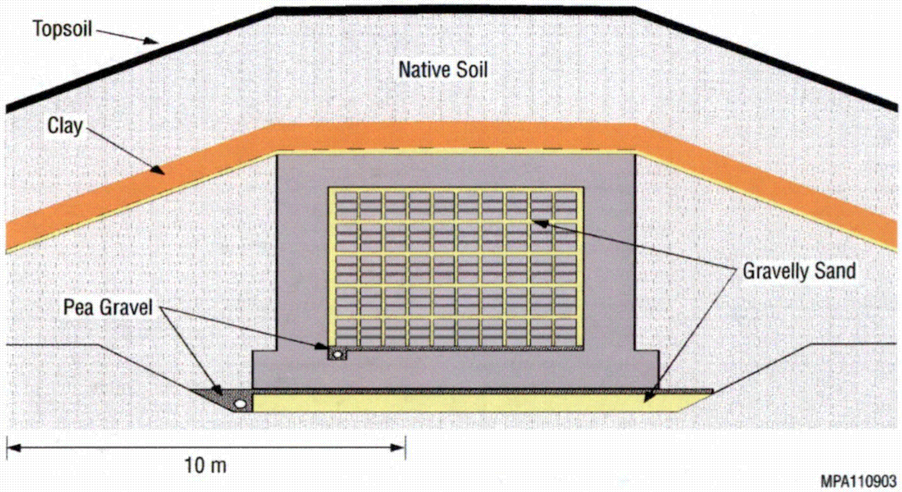


FIGURE S-13 Schematic Cross Section of the Conceptual Design for a Vault Cell

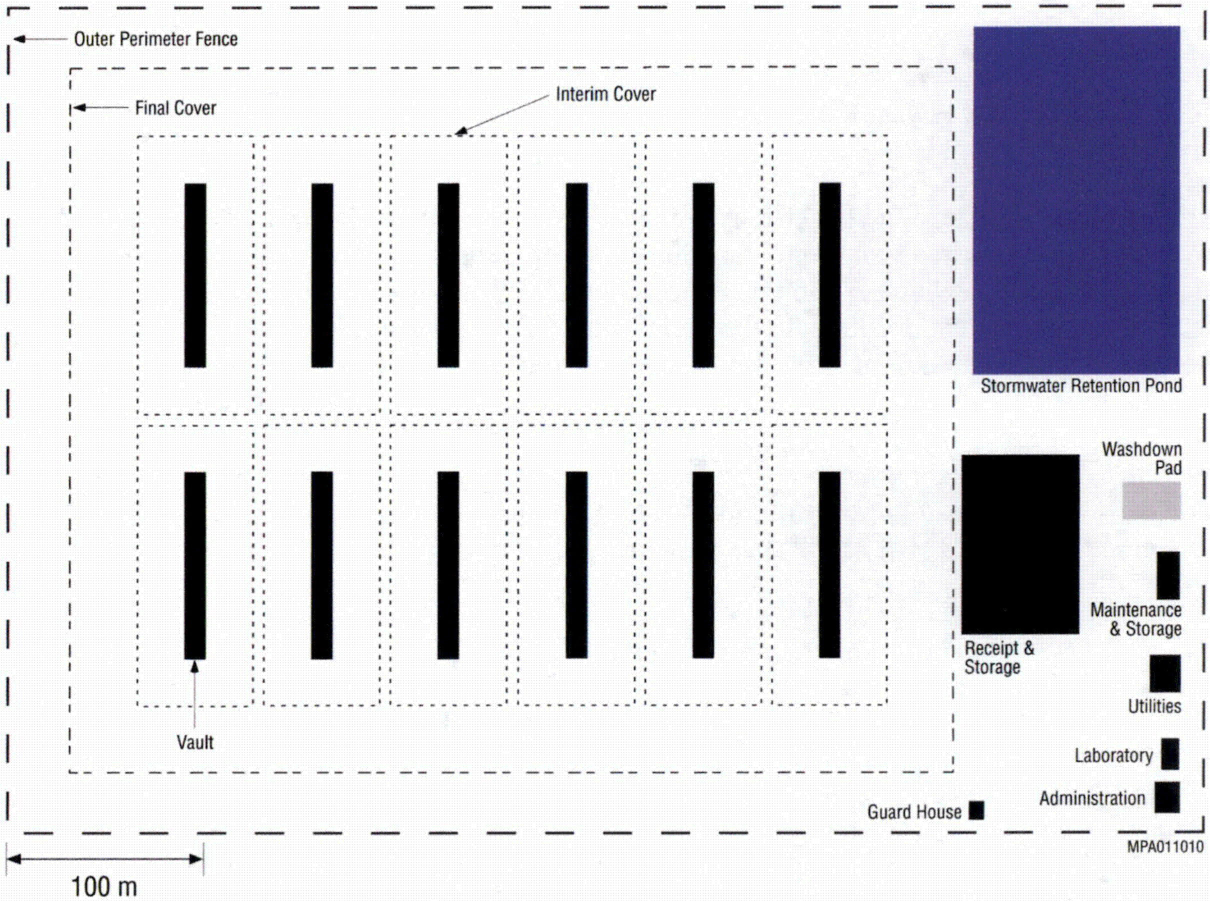


FIGURE S-14 Layout of a Conceptual Vault Disposal Facility

infrastructure, such as facilities or buildings for receiving and handling waste packages or containers, and space for a stormwater retention pond (to collect stormwater runoff and truck washdown). Each vault would be about 11-m (36-ft) wide, 94-m (310-ft) long, and 7.9-m (26-ft) tall, with 12 vaults situated in a linear array. The interior cell would be 8.2-m (27-ft) wide, 7.5-m (25-ft) long, and 5.5-m (18-ft) high, with an internal volume of 340 m^3 (12,000 ft^3) per cell. Double interior walls with an expansion joint would be included after every second cell. The thick concrete walls and earthen cover would minimize inadvertent intrusion into the vault. GTCC LLRW and GTCC-like waste disposal placement is assumed to be about 4.3 to 5.5 m (14 to 18 ft) above ground surface.

S.2.6 Which Sites Are Evaluated for a GTCC LLRW and GTCC-Like Waste Disposal Facility?

For deep geologic disposal, DOE evaluated WIPP in New Mexico because of its characteristics as a geologic repository. For the borehole method, DOE evaluated reference locations at five federally owned sites: Hanford Site, INL, LANL, NNSS, and the WIPP Vicinity. For the trench, and vault disposal methods, DOE evaluated reference locations at six federally owned sites: Hanford Site, INL, LANL, NNSS, SRS, and the WIPP Vicinity. In addition, the three land disposal methods were evaluated for generic commercial sites in the four regions that make up the United States (coinciding with NRC's four regions), as shown in Figure S-3. The evaluations of the reference locations are intended to serve as a starting point for each of the sites being considered, and if a site was selected for possible implementation of any of the three land disposal methods, follow-on-site-specific NEPA evaluation and documentation, as appropriate, along with further optimization by a selection study, would be conducted to identify the location or locations within a given site that would be considered the best ones to accommodate a borehole, trench, or vault disposal facility.

S.2.6.1 Waste Isolation Pilot Plant (WIPP)

WIPP is a DOE facility and is the first deep underground geologic repository in the United States. It is permitted by the EPA and the State of New Mexico to safely and permanently dispose of defense-generated TRU waste (WIPP LWA as amended [P.L. 102-579 as amended by P.L. 104-201]). The facility began disposal operations in 1999. WIPP is located 42 km (26 mi) east of Carlsbad, New Mexico, in the Chihuahuan Desert in the southeast corner of the state (see Figure S-15). The WIPP facility sits in the approximate center of a 41-km^2 (16-mi^2) area that was withdrawn from public domain and transferred to DOE (see Figure S-16). Project facilities include disposal rooms that are mined 655 m (2,150 ft) under the ground in a salt formation (the Salado Formation) that is 610-m (2,000-ft) thick and has been stable for more than 200 million years.

The facility footprint itself encompasses 14 fenced ha (35 fenced ac) of surface space and about 12 km (7.5 mi) of underground excavations in the Salado Formation. There are four shafts to the underground: the waste shaft, salt handling shaft, air intake shaft, and exhaust shaft (see Figure S-8). There are several miles of paved and unpaved roads in and around the WIPP site, and an 18-km-long (11-mi-long) access road runs north from the site to U.S. Highway 62-180.

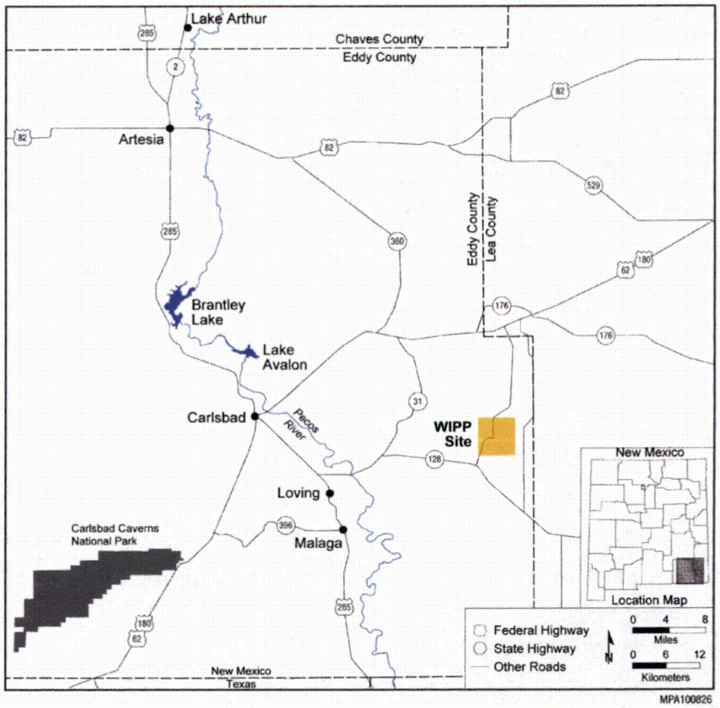


FIGURE S-15 General Location of WIPP in Eddy County, New Mexico

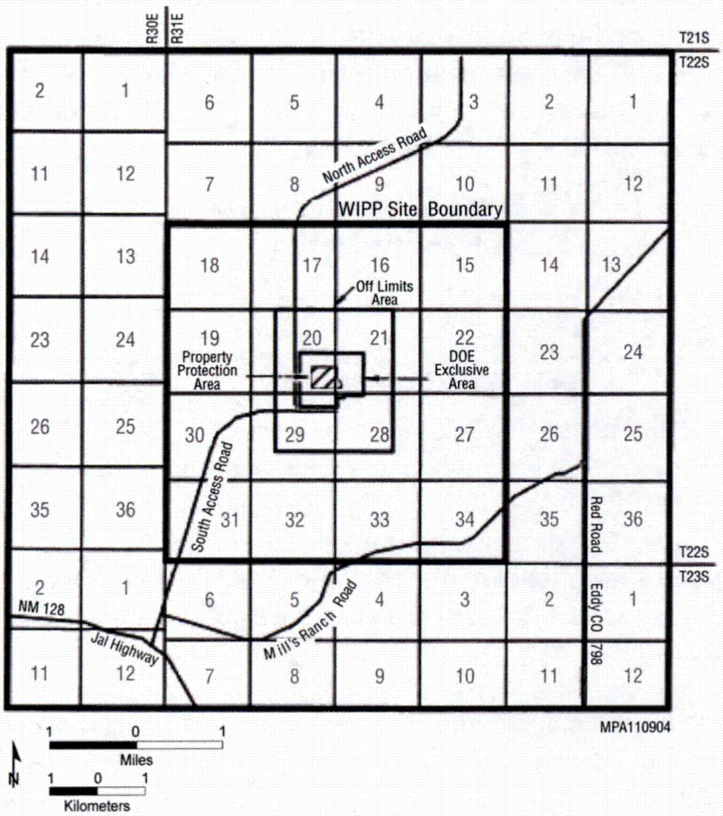


FIGURE S-16 Land Withdrawal Area Boundary at WIPP