GTCC LLW ENVIRONMENTAL IMPACT STATEMENT: PRE-CLOSURE ASSESSMENT DATA PACKAGE

Waste Isolation Pilot Plant

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ACRONYMS AND ABBREVIATIONS

AMAD	active median aerodynamic diameter
AMC	Activated Metal Canister
ASERs	Annual Site Environmental Reports
ASTM	American Society for Testing and Materials
BEMR	Baseline Environmental Management Report
bgs	below ground surface
BLM	(U.S.) Bureau of Land Management
CFR	Code of Federal Regulations
CH	contact-handled
CNS	Chem-Nuclear Systems, Inc.
CO	carbon monoxide
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FTE	Full-Time Equivalent
FY	fiscal year
GNEP	Global Nuclear Energy Project
GPDD	General Plant Design Description
GTCC	Greater-Than-Class-C
HC	hydrocarbon
HEPA	High Efficiency Particulate Air (filter)
HP or hp	horsepower
hp-hour	horsepower-hour
h-SAMC	half-Shielded Activated Metal Canister
HVAC	Heating, Ventilation and Air-conditioning
IMC	International Minerals & Chemical Corporation
IPABS	Integrated Planning, Accounting, Budgeting System
K	thousand
KV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
LLRWPAA	Low-Level Radioactive Waste Policy Amendments Act
LLW	Low-Level Radioactive Waste
LMP	Land Management Plan
LWA	Land Withdrawal Act
M	million
NM	New Mexico
NMEMNRD	New Mexico Energy, Minerals, and Natural Resources Department
NNSA	National Nuclear Security Administration
NOI	Notice of Intent
NO_X	nitrogen oxides
NRC	U.S. Nuclear Regulatory Commission
PM	particulate matter
PM_{10}	particles with 10 micron AMAD

RH	remote-handled
SAMC	Shielded Activated Metal Canister
SAR	Safety Analysis Report
SEIS-II	Final Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant (U. S. DOE 1997a)
SNL	Sandia National Laboratories
SO_2	Sulfur dioxide
SSC	Structures, Systems, and Components
SWB	Standard Waste Box
TDOP	Ten-drum Overpack
TEDE	total effective dose equivalent
TRU	Transuranic Waste
TRUPACT	Transuranic Packaging Transporter
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WHB	Waste Handling Building
WHB Unit	Waste Handling Building Unit
WLWA	WIPP Land Withdrawal Area
WP	waste package

GLOSSARY

^{239}Pu gram equivalent – a normalized measure of radionuclide activity as described in Appendix B.

Allocated disposal room – an allocated disposal room is a single WIPP disposal room plus one seventh of the access drift for the panel that contains the disposal room.

Anticipated volume – the sum of the stored and projected volumes.

Design Class I – Design Class I applies to structures, systems, and components (SSCs) for the prevention or mitigation of the consequences of an accident or severe natural phenomena that could result in a 50-year commitment beyond the WIPP Exclusive Use Area in excess of 25 rem (0.25 Sv) Total Effective Dose Equivalent (TEDE).

Design Class II – Design Class II applies to SSCs that 1) provide permanent confinement, 2) provide permanent shielding, and 3) monitor and/or verify that radiological dose limits are not exceeded.

Design Class IIIA – Design Class III applies to SSCs that are not included in Design Class I or II and require a different level of quality, beyond that expected in commercial-industrial practice. These may include: Airborne radioactivity monitoring following accidental releases of radioactive materials; SSCs with design and fabrication complexity and uniqueness; SSCs with the potential for contamination due to component failure, and; equipment with unique subassemblies, when replaced, shall be identical in terms of function, form, and fit.

Disposal room – a room mined in WIPP for disposal radioactive waste.

Panel – ten regions in series in the waste disposal area of WIPP disposal rooms. Waste panels consist of seven rooms.

1. INTRODUCTION

The Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) assigned the United States Federal Government the responsibility for disposing of Greater-Than-Class-C (GTCC) low-level radioactive waste (LLW) generated by activities licensed by U.S. Nuclear Regulatory Commission (NRC) or Agreement States (42 USC 2021 as amended). The LLRWPAA requires that the Federal Government provide for the disposal of GTCC LLW in a facility that adequately protects the safety and health of the public and is licensed by NRC. As part of the responsibilities assigned to the U.S. Department of Energy (DOE) in the LLRWPAA, the DOE has begun the environmental impact statement (EIS) process for development of a disposal capability for GTCC LLW and DOE GTCC-like waste. This document presents data necessary to evaluate the suitability of the Waste Isolation Pilot Plant (WIPP) as a potential site in the GTCC LLW EIS.

1.1 BACKGROUND

The NRC classifies LLW in four categories, Class A, Class B, Class C and waste that is not generally acceptable for near-surface disposal, GTCC LLW, as defined in 10 CFR 61.55. LLW that exceeds the maximum concentration limits of radionuclides established by NRC for Class C waste is referred to as "Greater-Than-Class-C". In anticipation of the upcoming GTCC LLW EIS, the DOE has recently (U. S. DOE 2006a) prepared an update to their 1994 GTCC LLW inventory estimates, *Greater-Than-Class C Low-Level Radioactive Waste Characterization: Estimated Volumes, Radionuclides, Activities, and Other Characteristics* (DOE/LLW-114) (U. S. DOE 1994a). Further, the DOE has established an inventory basis for the GTCC LLW EIS evaluations in Task 3.2 of this project. That inventory basis is documented in *Basis Inventory for Greater-Than-Class-C Low-Level Radioactive Waste Environmental Impact Statement Evaluations* (SNL 2008).

The document, *Basis Inventory for Greater-Than-Class-C Low-Level Radioactive Waste Environmental Impact Statement Evaluations* (SNL 2008), provides information about volumes, radionuclide activities, chemical forms, packages, locations, and disposal rates for four waste streams as summarized in Table 1-1. The waste streams identified in Table 1-1 are comprised of waste types that are regulated by the NRC as GTCC LLW, as defined in 10 CFR 61.55 (nuclear utility activated metal, sealed sources, and other waste), or contain DOE waste with characteristics similar to GTCC LLW and which currently do not have an identified path to disposal (referred to in this report as DOE GTCC-like waste). This waste is not regulated by the NRC, but will be included in the EIS evaluations.

Therefore, for this analysis, these waste streams are as follows:

Waste stream 1 consists of GTCC LLW activated metal from nuclear utilities.

Waste stream 2 consists of sealed radioactive sources and has been broken down into four waste streams (2a through 2d), by container type and the presence/absence of ^{137}Cs (handling considerations).

Waste stream 3 represents GTCC-like activated metal from DOE sites.

Waste stream 4 contains other waste and is broken down by handling considerations (contact-handled [CH] versus remote-handled [RH]).

Table 1-1 Summary of GTCC LLW and DOE GTCC-like Waste Volumes[a]

Waste Stream	Source	Description	Volume (m^3)	Container Type	Number of Containers
1[b]	Com	GTCC LLW Activated Metal	882	h-SAMC	12,796
2a	Com	GTCC LLW Non-cesium Sealed Sources	652	55-gallon drum	3,133
2b	DOE	DOE GTCC-like Non-cesium Sealed Sources	0.84	55-gallon drum	4
2c	Com	GTCC LLW Cesium Sealed Sources	1019	Irradiator [c]	1,435
2d	DOE	DOE GTCC-like Cesium Sealed Sources	33	Irradiator [c]	46
3[b]	DOE	DOE GTCC-like Activated Metal	13	h-SAMC	68
4a	Com	GTCC LLW CH Other Waste	43	55-gallon drum	207
4b	DOE	DOE GTCC-like CH Other Waste-- excl West Valley	34	55-gallon drum	165
4b	DOE	DOE GTCC-like CH Other Waste-- West Valley	933	SWB	498
4c	Com	GTCC LLW RH Other Waste	34	h-SAMC	173
4d	DOE	DOE GTCC-like RH Other Waste	1475	h-SAMC	7,486

[a]All data taken from SNL (2008) and Argonne (2008); [b]SAMC and AMC packages are not suitable for WIPP disposal and will not be considered in this analysis; Activated metals will be disposed in WIPP in h-SAMCs; [c]CIS-US (2006).

The methods and assumptions used to formulate the information summarized in Table 1-1 are documented in SNL (2008) and Argonne (2008). For the GTCC LLW EIS analyses, it is assumed that waste stream 1, GTCC LLW activated metal, will be disposed in WIPP in canisters with outer dimensions of 28 inches diameter and 55 inches length (Section 2.4.1), (SNL 2008), henceforth referred to as half-Shielded Activated Metal Canisters (h-SAMCs).

Waste stream 2a, GTCC LLW sealed sources containing isotopes other than ^{137}Cs, will be disposed in WIPP in 3,133 55-gallon drums (SNL 2008). The outer dimensions of a 55-gallon drum are 24 inches diameter and 35 inches long (U. S. DOE 2006a). Waste stream 2b, DOE GTCC-like sealed sources containing isotopes other than ^{137}Cs, will also be disposed in four 55-gallon drums. Waste stream 2c, GTCC LLW sealed sources containing ^{137}Cs, is assumed to be disposed in WIPP in the original package, the Cs irradiator, and waste stream 2c consists of 1,435 irradiators. Waste stream 2d, consists of 46 DOE GTCC-like sealed sources containing ^{137}Cs and is assumed to be disposed in WIPP in the original package, the Cs irradiator. It is assumed for the GTCC LLW EIS analysis that the CIS-US Inc. Blood Irradiator Model IBL-437 is representative of the cesium irradiator sources. The

outer dimensions of the CIS-US blood irradiator are 26.4 inches wide by 25.6 inches long by 59.1 inches high (CIS-US 2006).

Waste stream 3 is comprised of DOE GTCC-like activated metal and will be disposed of in 68 h-SAMCs.

Waste stream 4 consists of other waste, which contains contaminated equipment, debris, trash, scrap metal and decontamination decommissioning waste. Waste stream 4 has been broken down into 4 sub-categories 4a through 4d. Waste stream 4a consists of CH GTCC LLW other waste and is assumed to be packaged in 208 55-gallon drums. Waste stream 4b contains DOE GTCC-like CH other waste and is assumed to be packaged in 165 55-gallon drums, except the waste stream 4b West Valley waste, which is assumed to be packaged in 498 standard waste boxes (SWBs) with the dimensions of 36.875 inches high, 54.5 inches wide, and 71 inches long. Waste stream 4c consists of RH GTCC LLW other waste and will be packaged in 173 h-SAMCs. Waste stream 4d is RH DOE GTCC-like other waste and will be packaged 7,486 h-SAMCs.

DOE has grouped waste into three categories to analyze the inventory in the GTCC EIS. Group 1, which is addressed in this report, is comparable to the inventory presented in the Notice of Intent (NOI), and consists of waste already in storage or expected to be generated from facilities already in operation. Group 2 represents the additional waste that was identified for inclusion in the EIS after the NOI was published, and consists of waste that may be generated from proposed actions. Group 2 will be addressed in an addendum to this report. Group 3 includes wastes from the proposed Global Nuclear Energy Project (GNEP) programmatic alternatives and from the previously proposed Advanced Fuel Cycle Facility (AFCF) and will be qualitatively addressed in the cumulative impacts section of the GTCC EIS.

1.2 PURPOSE

The focus of the upcoming EIS is to evaluate the potential environmental impacts from the construction, operation, closure and post-closure performance of a disposal facility for GTCC LLW and DOE GTCC-like waste. This document provides the technical basis for an evaluation of the environmental impacts from pre-closure activities including transportation, construction, and operation of the WIPP facility if the DOE were to decide to dispose of GTCC LLW and DOE GTCC-like waste at WIPP. It supplies pre-closure data identified in the data requirements document (Argonne 2006) and in planning efforts for this task (SNL 2007a) including: descriptions of the disposal facilities (disposal cells and major buildings), site maps and land usage requirements, resource requirements, personnel staffing estimates, and wastes and emissions estimates.

The pre-closure data for WIPP has been formulated solely for use in preparing the GTCC LLW EIS. Of necessity, a number of assumptions, which are identified in this report, have been made while developing this pre-closure data. The result is a pre-closure data set for the GTCC LLW EIS that adequately represents reasonable expectations for disposal of GTCC LLW and DOE GTCC-like waste at a level of detail commensurate with the data required for EIS evaluations.

1.3 APPROACH AND KEY ASSUMPTIONS

It is assumed that the disposal of GTCC LLW waste in the WIPP will receive regulatory approval and comply with appropriate Congressional mandates in place at the time of disposal. Currently, the WIPP Land Withdrawal Act (LWA) (Public Law 102-579) (U. S. Congress 1996) limits disposal in WIPP to 6.2 million cubic feet of defense-generated transuranic (TRU) waste. Under the current schedule, DOE expects to cease WIPP operations by 2035. However, a baseline change request is being processed that would change the end date for WIPP to 2045 (Johnson 2007). In addition, the baseline change request indicates that the plan is to transition WIPP operations to the National Nuclear Security Administration (NNSA) which provides a basis for assuming that WIPP operations will be funded beyond 2045 and that GTCC LLW would not bear the entire cost of those operations.

As detailed in (SNL 2008), projected GTCC LLW generation schedules show disposal periods that exceed WIPP's current closure date of 2035 by 30 years (the last of the GTCC LLW activated metal waste is projected to be generated in 2062). Therefore, it is assumed that other waste forms and/or decisions to expand the mission of WIPP occur such that the WIPP facility continues to operate during the GTCC LLW disposal campaign period. This assumption is predicated on the fact that keeping the WIPP underground tunnels safe and operable for the GTCC LLW disposal campaign will require constant maintenance and a fully staffed operational force will be needed. In keeping with the assumption of an extended WIPP mission, it is also assumed that personnel will be in place to support such activities, and as such, no additional staffing would be necessary. Only those resources used specifically for the construction of the necessary disposal areas for the disposal of GTCC LLW and DOE GTCC-like waste are considered in this analysis. Likewise, only the operational resources necessary for processing GTCC LLW and DOE GTCC-like waste for disposal have been included.

This document presents data and information that is specific to the WIPP and assumes that GTCC LLW and DOE GTCC-like wastes will be disposed using the same (or similar) technologies and methods currently in use at the WIPP for the disposal of defense-generated TRU waste. It is assumed that all above-ground facilities at WIPP are available for handling the GTCC LLW and DOE GTCC-like waste, and construction of additional above-ground facilities is not required.

Currently, the inventory of waste (both CH-TRU and RH-TRU) identified for disposal in WIPP is less than the legislated limits (U. S. DOE 2004b). However, due to the potential for generation of additional DOE cleanup wastes that may be suitable for disposal at WIPP, this document assumes that additional rooms, beyond the WIPP legislated limits, would need to be constructed to accommodate the disposal of GTCC LLW and DOE GTCC-like waste. It is assumed that RH GTCC LLW and DOE GTCC-like waste will be emplaced using shielded containers using floor space in WIPP.

Construction and operational data in support of the GTCC EIS analyses are developed in this document on either an "allocated disposal room" basis or a "waste hoist trip" basis. Costs, durations, and personnel information are based on shipments to WIPP.

An allocated disposal room is a WIPP disposal room plus one-seventh of the access drift for the panel that contains the disposal room. This is because a WIPP disposal room is not mined by itself but instead, it is mined as part of a panel which requires mining of an access drift. Therefore, an allocated disposal room is one-seventh of a panel plus its access drift. All WIPP data associated with construction are analyzed to obtain values on an allocated disposal room basis. By determining the room space required for each GTCC LLW and DOE GTCC-like waste stream, resources, equipment, wastes, emissions, costs, durations, and personnel associated with construction of room space for the GTCC LLW and DOE GTCC-like waste can be calculated by applying the allocated disposal room values from WIPP. The process flow diagram identifying the resources, equipment, wastes, and emissions associated with construction of room space in WIPP is shown Figure 1.1.

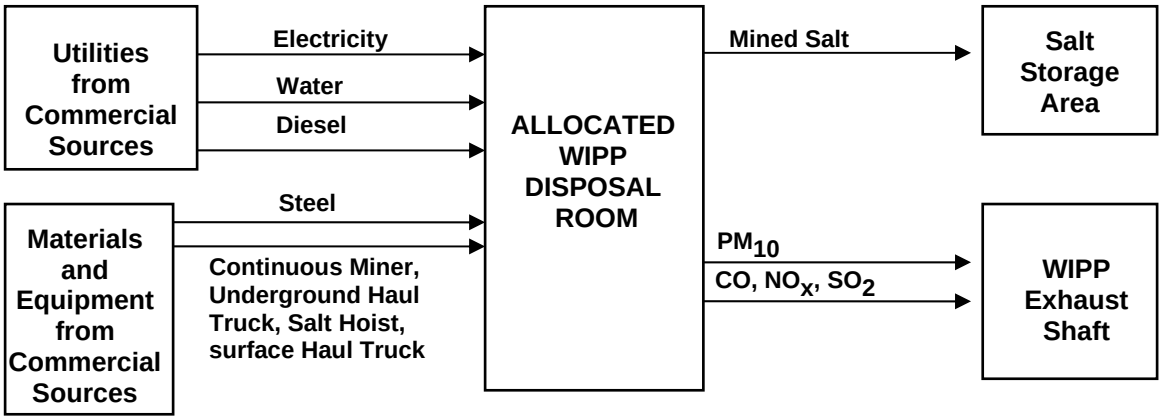


Figure 1.1. Flow Diagram for Construction of a WIPP Disposal Room[a]

[a](see Sections 5.1 and 6.1)

All WIPP data associated with operations are analyzed to obtain values for waste emplaced at WIPP. According to Bradley et al. (1993), the estimated exposure during normal CH waste handling at WIPP is as follows: Waste Handlers: 0.70 rem/yr, Radiation Control: 0.60 rem/yr, and Average Individual: 0.68 rem/yr. Based on actual operations information to date for WIPP (Gallagher 2008), no worker has received a measurable dose at WIPP from waste operations. The WIPP Waste Acceptance Criteria (WAC) limits contact dose rate to 200 mrem per hour for CH and 1000 rem per hour for RH. The DOE has a self-imposed limit of 1 rem/yr for worker exposure at WIPP, which is lower than the occupational exposure of 5 rem per year in DOE Order 5400.5. Because all GTCC RH waste is assumed to be managed in shielded containers such that it could be handled as CH in accordance with the 200 mrem per hour limit, remote handled equipment and worker shielding would not be required. It is expected that waste operations for GTCC waste emplacement at WIPP would be consistent with dose information for current operations, and therefore, estimated worker exposures are not further evaluated in this report.

The process flow diagram identifying the resources, equipment, wastes, and emissions associated with operations at WIPP is shown Figure 1.2. WIPP disposal room requirements for each of the GTCC LLW and DOE GTCC-like waste streams are shown in Table 1-2. The calculation of room space is described in Section 4.3.

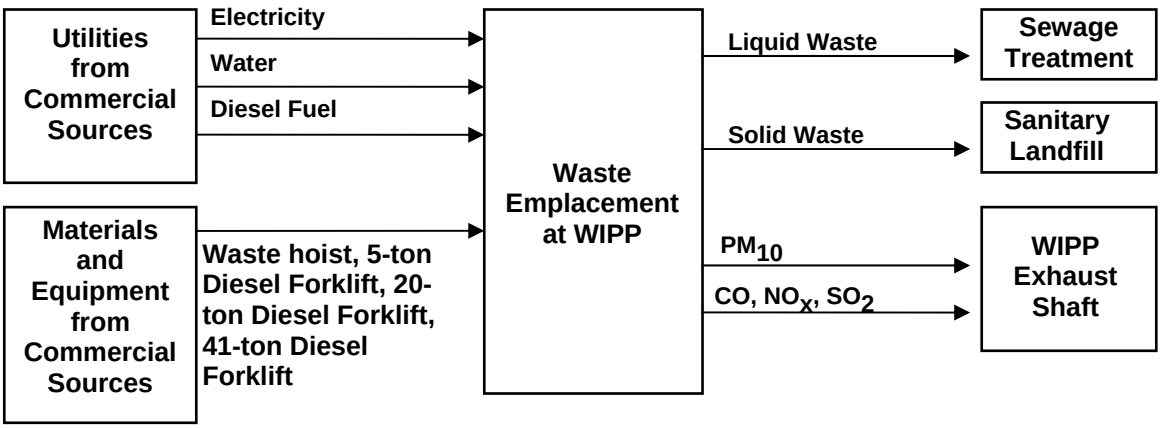


Figure 1.2. Flow Diagram for Operations at WIPP[a]

[a](see Sections 5.2 and 6.2)

Table 1-2. WIPP Room Space for GTCC LLW and DOE GTCC-like Waste Streams

Waste Stream	Description	Container	Room Space Required[a]
1[b]	GTCC LLW Activated Metal	h-SAMC	4.56
2a	GTCC LLW Non-cesium Sealed Sources	55-gallon drum	0.28
2b	DOE GTCC-like Non-cesium Sealed Sources	55-gallon drum	0.0019
2c	GTCC LLW Cesium Sealed Sources	Irradiator [c]	0.66
2d	DOE GTCC-like Cesium Sealed Sources	Irradiator [c]	0.022
3[b]	DOE GTCC-like Activated Metal	h-SAMC	0.025
4a	GTCC LLW CH Other Waste	55-gallon drum	0.0184
4b	DOE GTCC-like CH Other Waste-- excl West Valley	55-gallon drum	0.0147
4b	DOE GTCC-like CH Other Waste-- West Valley	SWB	0.31
4c	GTCC LLW RH Other Waste	h-SAMC	0.063
4d	DOE GTCC-like RH Other Waste	h-SAMC	2.67

[a]Calculated in Section 4.4; [b]SAMC and AMC packages are not suitable for WIPP disposal and will not be considered in this analysis; Activated metals will be disposed in WIPP in h-SAMCs; [c]CIS-US (2006).

The operations data in the following sections (namely Sections 5, 6, and 7) are presented as total values for each waste stream of GTCC LLW and DOE GTCC-like waste.

It is assumed for the purposes of these analyses that current CH-TRU handling and disposal information can be applied to GTCC LLW containers (e.g., h-SAMCs will be handled as CH waste and emplaced on the floor of the disposal room). Transporting GTCC LLW packages to the underground will assume similar WIPP handling techniques.

Additional assumptions used to prepare the information presented in this report are discussed separately below for each of the basic data types. Section 2 describes the climate, geology, and hydrology of the site. Section 3 describes the surface structures and infra-structure. Section 4 describes the WIPP underground and presents the calculation of disposal room space required for the GTCC LLW and DOE GTCC-like waste. Section 5 describes the resource and equipment needs if GTCC LLW and DOE GTCC-like waste were to be disposed at WIPP. Section 6 describes facility wastes and emissions. Section 7 describes costs, durations and personnel requirements. Section 8 provides information to be used in transportation analyses.

2. CLIMATE, GEOLOGY AND HYDROLOGY

2.1 GENERAL WIPP SITE INFORMATION

The information shown in Table 2-1 was taken from Attachment A, Page A-1 of *Waste Isolation Pilot Plant Hazardous Waste Facilities Permit, NM 4890139088-TSD* (HWFP) (U. S. DOE 2006b).

Table 2-1. General WIPP Site Information[a]

Facility Location:	32° 22’ 30” N 103° 47’ 30” W
Date Operation Began	November 26, 1999
Owner and Co-operator	U.S. Department of Energy P.O. Box 3090 Carlsbad, NM 88221
	Washington TRU Solutions LLC P.O. Box 2078 Carlsbad, NM 88221
Responsible Officials	David Moody, Manager DOE Carlsbad Field Office Farok Sharif, General Manager Washington TRU Solutions LLC
U.S. EPA I.D. Number	NM4890139088

[a]HWFP (U. S. DOE 2006b)

2.2 SITE DESCRIPTION

Located in Eddy County in the Chihuahuan Desert of southeastern New Mexico (Figure 2.1), the WIPP site encompasses approximately 41.1 square kilometers, or 16 square miles. This

part of New Mexico is relatively flat and is sparsely inhabited, with little surface water. The site is 42 kilometers (26 miles) east of Carlsbad in a region known as Los Medaños (the Dunes).

On October 30, 1992, the President signed into law the Waste Isolation Pilot Plant Land Withdrawal Act (LWA) (Public Law 102-579) (U. S. Congress 1996). This Act transferred responsibility for management of the WIPP withdrawal area from the Secretary of the Interior to the Secretary of Energy. The land is permanently withdrawn from all forms of entry, appropriation, and disposal under the public land laws and is reserved for uses associated with the purposes of WIPP (U. S. DOE 1993a). The WIPP site encompasses 16 sections (4,146 hectares [10,240 acres]) of federal land in Township 22 South, Range 31 East Figure 2.2. This boundary was delineated so as to extend at least 1.6 kilometers (1 mile) beyond any WIPP underground development.

The WIPP site has been divided into four areas under DOE control (Figure 2.2). A chain-link fence surrounds the innermost "Property Protection Area," which includes the surface facilities. Surrounding this inner area is the "Exclusive Use Area," set off by a barbed-wire fence. Enclosing these areas is the "Off-Limits Area," which is unfenced to allow livestock grazing but, like the other two, is patrolled and posted against trespass or other land uses. Beyond the "Off-Limits Area," but within the 16-section WIPP site, the land is managed under the traditional public land use concept of multiple use. Mining and drilling for purposes other than support of the WIPP project, however, are restricted (U. S. DOE 1995).

2.3 LAND USE IN THE VICINTIY OF WIPP

The dominant use of the land within 16 kilometers (10 miles) of the site is grazing, with lesser amounts used for oil and gas extraction and potash mining. Bureau of Land Management (BLM) owns most of this land. Two ranches are located within 16 kilometers (10 miles) of the WIPP site while the closest town, Loving, New Mexico, is 29 kilometers (18 miles) away. The federal government or the State of New Mexico owns most of the land within 50 kilometers (30 miles) of the site. Within 80 kilometers (50 miles) of the site, there is dryland farming, irrigated farming along the Pecos River, and some forest, wetland, and urban land.

A Land Management Plan for the WIPP site was published in 1993 (U. S. DOE 1993a). This plan establishes management objectives and planned actions for the use of the withdrawn land until the end of the decommissioning phase. The Land Management Plan lists 13 areas of concern: wildlife, cultural resources, grazing management, recreation, mining and oil and gas production, rights-of-way, access, emergency and facility security, fire management, water service, groundwater surveillance, salt tailings, and reclamation.

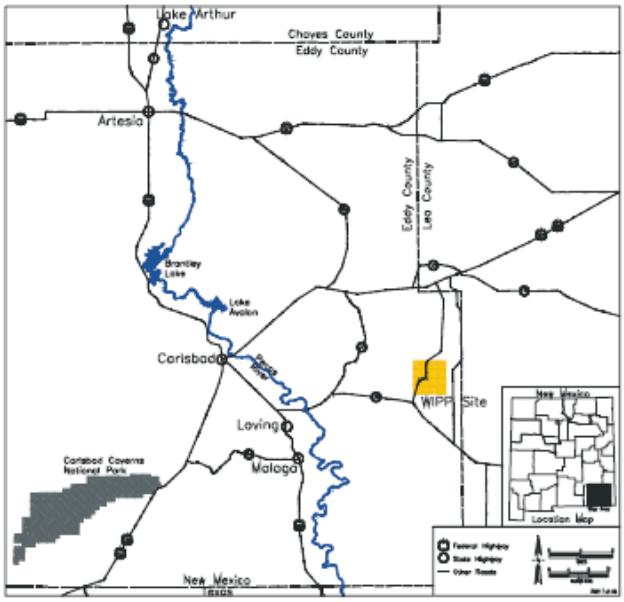


Figure 1.2 - WIPP Location

Figure 2.1. Location of the WIPP in Eddy County, NM (U. S. DOE 2006c)

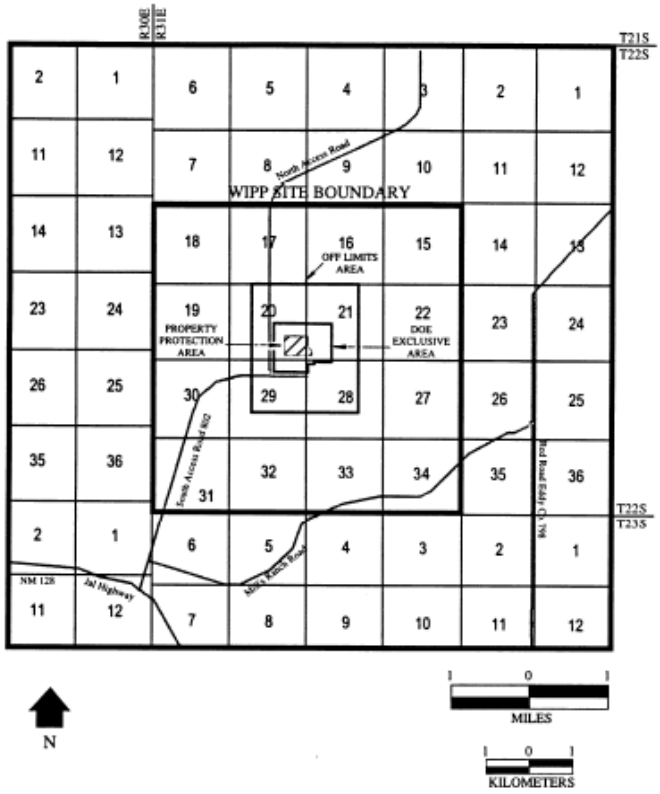


Figure 2.2. WIPP Area Boundary (U. S. DOE 1997a)

2.4 CLIMATE

The regional climate is semiarid, with low precipitation and humidity and a high rate of evaporation. More than 90 percent of the mean annual precipitation at the site is lost by evapotranspiration. Precipitation is unevenly distributed throughout the year, with most occurring during summer thunderstorms. On a mean monthly basis, evapotranspiration at the site greatly exceeds the available rainfall; however, intense local thunderstorms produce runoff and some percolation. Thunderstorms are frequent from June through September, and are often accompanied by hail. Rains are brief but occasionally intense and can result in flash flooding in arroyos and along floodplains. In late winter and spring, there are strong west winds and dust storms. Tornadoes do occur throughout the region and from 1955 through 1967, 15 tornadoes were reported in the WIPP vicinity covered by one degree of latitude and longitude (U. S. DOE 1980).

The Carlsbad Air Terminal is the closest off-site meteorological monitoring station and is located approximately 50 kilometers (30 miles) west of WIPP. Because of the relatively flat terrain, meteorological measurements at the airport are considered to be representative of the region. The mean annual temperature is 16 degrees Celsius (60 degrees Fahrenheit), and the mean annual precipitation is approximately 33 centimeters (13 inches).

The WIPP meteorological station is located at the WIPP site approximately 600 m (1,970 ft) northeast of the Waste Handling Building (WHB). The main function of the station is to provide site-specific data for atmospheric dispersion modeling. The station measures and records wind speed, wind direction, and temperature at elevations of 2, 10, and 50 m (6.5, 33, and 165 ft). The station also records ground-level measurements of barometric pressure, relative humidity, precipitation, and solar radiation. The mean temperature at the WIPP site in 2005 was 16.8 degrees Celsius (62.2 Fahrenheit). The mean monthly temperatures for the WIPP area ranged from 27.0 Celsius (80.6 Fahrenheit) during July to 8.2 Celsius (46.8 Fahrenheit) in December. The lowest recorded temperature was -13.0 Celsius (8.6 Fahrenheit) in December. The maximum recorded temperature was 39.8 Celsius (103.6 Fahrenheit) in July. The precipitation at the WIPP site for 2005 was 417.4 mm (16.4 in.), most of which occurred during the months of August, May, October, and February (U. S. DOE 2006c).

2.5 AIR QUALITY

Air quality monitoring data collected since 1990 are summarized in the WIPP Annual Site Environmental Reports (ASERs) (U. S. DOE 1991; 1992; 1993b; 1994b; 1995; 1996d; 1997c; 1998; 1999b; 2000; 2001; 2002c; 2003; 2004b; 2005b; 2006c). These reports provide a suitable air quality baseline prior to the possible disposal of GTCC LLW and DOE GTCC-like waste at WIPP. Air emissions due to the possible disposal of GTCC LLW and DOE GTCC-like waste is discussed later in this document (Section 6.2).

2.6 Geology

The following sections describe the regional setting, stratigraphy and structure, seismic activity, and mineral resources.

2.6.1 Regional Setting

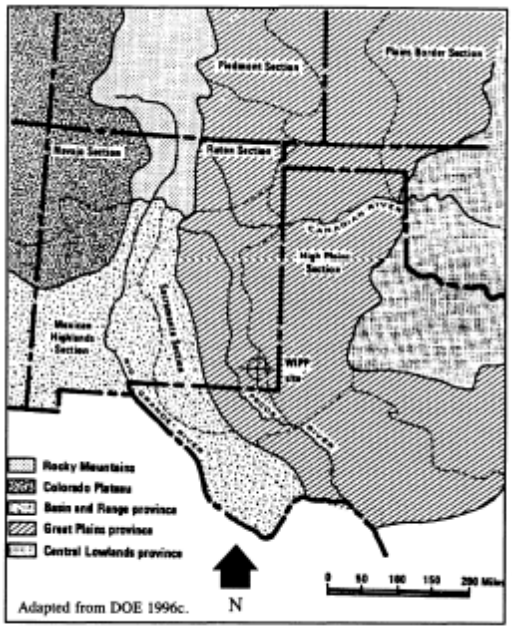
WIPP is located in southeastern New Mexico, in the Pecos Valley Section of the Great Plains Physiographic Province (Figure 2.3). The terrain throughout the province varies from plains and lowlands to rugged canyons. In the immediate vicinity of WIPP, numerous small mounds formed by wind-blown sand characterize the land surface. A 410,000 to 510,000 year-old layer enriched in calcium carbonate material, the Mescalero caliche, is typically present beneath the surface layer of sand. The caliche layer overlies a 600,000-year old volcanic ash layer (U. S. DOE 1996b). The Mescalero caliche can be found over large portions of the Pecos River drainage area and is generally considered to be an indicator of surface stability (U. S. DOE 1980). The site slopes gently from east to west, from an elevation of 1,088 meters (3,570 feet) above sea level at its eastern boundary to 990 meters (3,250 feet) above sea level along its western boundary.

A high plains desert environment characterizes the area. Due to the seasonal nature of the rainfall, most surface drainage is intermittent. The Pecos River, 20 kilometers (12 miles) southwest of the WIPP boundary, is a perennial river and the master drainage for the region. A natural divide lies between the Pecos River and WIPP. As a result, the Pecos drainage system does not currently affect the site. Local surface drainage features include Nash Draw and the San Simon Swale (Figure 2.3).

2.6.2 Stratigraphy and Structure

WIPP is located in the northern portion of the Delaware Basin, a structural basin underlying present-day southeastern New Mexico and western Texas and containing a thick sequence of sandstones, shales, carbonates, and evaporites. The WIPP repository is located at a depth of approximately 655 meters (2,150 feet) in rocks of Permian age. The sediments accumulated during the Permian period represent the thickest portion of the sequence in the northern Delaware Basin and are divided into four series. From oldest to youngest, these series are: the Wolfcampian, Leonardian, Guadalupian, and Ochoan. The Ochoan series is divided into four formations. From oldest to youngest, these formations are: Castile, Salado (the lower part of which contains the WIPP repository), Rustler, and Dewey Lake (Figure 2.4).

The discussion below presents the geologic formations important to understanding the long-term performance of WIPP starting with the host rock for the WIPP repository (the Salado Formation), the formations below the Salado (the Castile and Bell Canyon Formations), and the formations above the Salado (the Rustler, Dewey Lake, Santa Rosa, and Gatuña Formations).



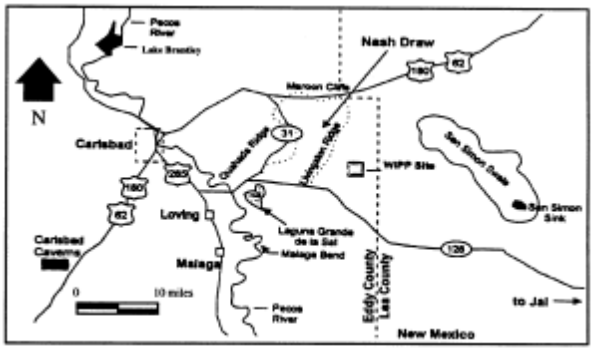


Figure 2.3. WIPP Site Location in Southeastern New Mexico (U. S. DOE 1997a)

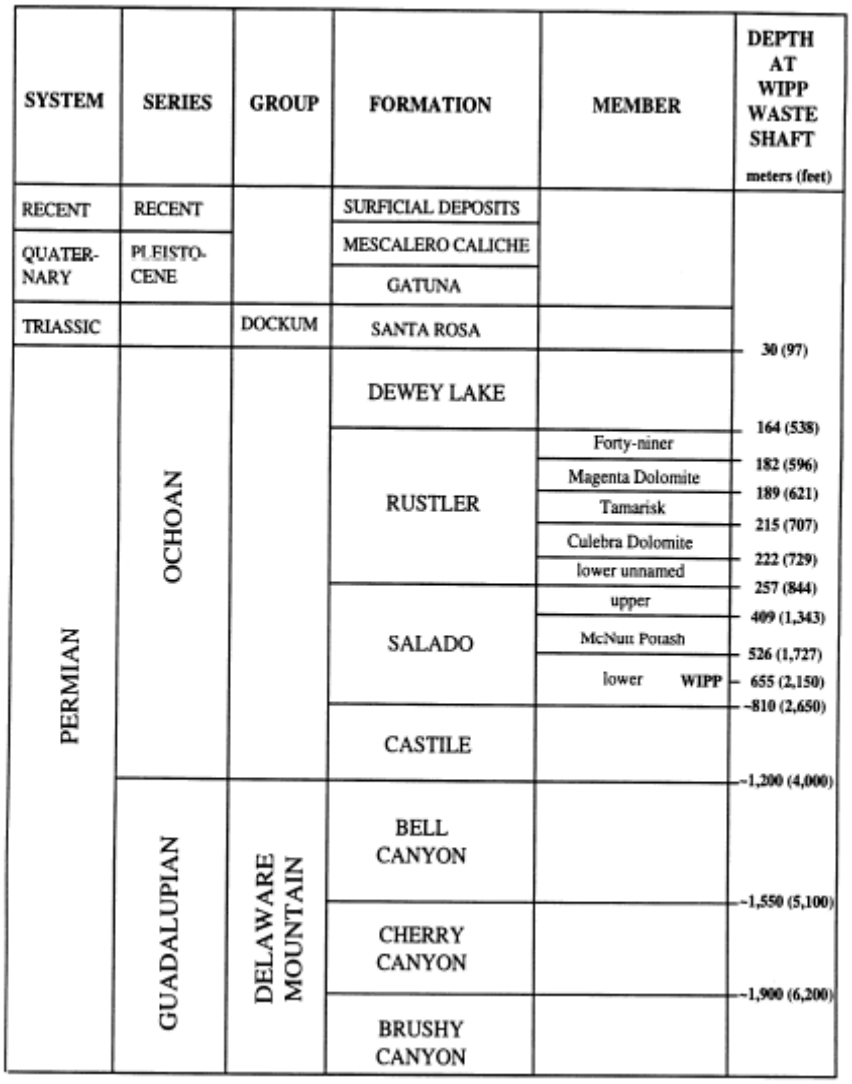


Figure 2.4. WIPP Regional Geologic Column (U. S. DOE 1997a)

2.6.2.1 Salado Formation

The Permian Salado Formation is a massive bedded salt formation, predominantly halite (sodium chloride), and is thick and laterally extensive. DOE selected the Salado Formation as the site of the WIPP repository for several geologic reasons (U. S. DOE 1980; 1990): (1) the Salado halite units have very low permeability to fluid flow, which impedes groundwater flow into and out of the repository; (2) the Salado is regionally widespread; (3) the Salado includes continuous halite beds without complicated structure; (4) the Salado is deep with little potential for dissolution; (5) the Salado is near enough to the surface that access is reasonable; and (6) the Salado is largely free of mobile groundwater, as compared to existing mines and other potential repository sites.

The Salado Formation is approximately 553 meters (1814 feet) thick, and is present from approximately 257 to 810 meters (843 to 2,658 feet) below ground surface (bgs) at the site

(Figure 2.4). The Salado is comprised of three members. From oldest to youngest, these are: the Lower Member, the McNutt Potash Member, and the Upper Member. The WIPP repository is located in the Lower Member, and in the thickest part of the Salado formation.

2.6.2.2 Castile Formation

The Permian Castile Formation directly underlies the Salado Formation and typically consists of three relatively thick anhydrite/carbonate units and two thick halite units in the WIPP area. It is approximately 390 meters (1,279 feet) thick, and is present from approximately 810 to 1,200 meters (2,658 to 3,937 feet) bgs at the site, which is approximately 155 meters (509 feet) below the level of the repository (Figure 2.4). The more brittle anhydrite units of the Castile are probably fractured, and the fracture zones are relatively permeable and act as zones for accumulation of brine originating in the Castile (U. S. DOE 1997b).

2.6.2.3 Bell Canyon Formation

The Permian Bell Canyon Formation underlies the Castile Formation and is comprised of a layered sequence of sandstones, shales, siltstones, and limestones near WIPP. It is also the uppermost target of hydrocarbon exploration in the local area. It is approximately 350 meters (1,148 feet) thick, and is present from approximately 1,200 to 1,550 meters (3,937 to 5,086 feet) bgs at the site. The top of the Bell Canyon is approximately 545 meters (1,788 feet) below the level of the repository.

2.6.2.4 Rustler Formation

The upper Permian Rustler Formation lies above the WIPP repository, and directly overlies the Salado Formation (Figure 2.4). It consists primarily of evaporate deposits and is divided into five members. From the base of the Rustler, these members are: the Unnamed Lower Member (renamed the Los Medaños Member in later documents), the Culebra Dolomite, the Tamarisk, the Magenta Dolomite, and the Forty-niner. The Culebra and Magenta Dolomites are gypsum-bearing dolomites containing numerous cavities (vugs), fractures, and silty zones. The other three members contain various amounts of anhydrite, siltstone, claystone, and halite. The Rustler Formation is approximately 305 meters (1,001 feet) thick and is present from approximately 164 to 257 meters (538 to 843 feet) bgs at the WIPP site. The base of the Rustler is approximately 398 meters (1,306 feet) above the level of the repository.

2.6.2.5 Dewey Lake Formation

The Dewey Lake Formation overlies the Rustler Formation at WIPP, and is the youngest Permian formation in the WIPP area. It consists largely of reddish-brown siltstones and claystones with lesser amounts of sandstone. It is approximately 134 meters (440 feet) thick and is present from approximately 30 to 164 meters (98 to 538 feet) bgs at the WIPP site. The base of the Dewey Lake is approximately 491 meters (1,611 feet) above the level of the repository.

2.6.2.6 Santa Rosa Formation

The Triassic Santa Rosa Formation, also called the Dockum Group, overlies the Dewey Lake Formation and consists of light reddish-brown sandstones and conglomerates. The Santa Rosa Formation is thin to absent above the WIPP site (U. S. DOE 1996b).

2.6.2.7 Gatuña Formation

The Pleistocene Gatuña Formation overlies the Santa Rosa Formation and is somewhat similar in lithology and color, although the Gatuña is also characterized by a wide range of lithologies (coarse conglomerates to gypsum-bearing claystones). The upper Gatuña contains a 600,000 year-old volcanic ash layer (U. S. DOE 1996b). The Gatuña is in turn overlain by the Mescalero caliche and surficial sand deposits described above.

2.7 FAULTING

No surface displacement or faulting younger than early Permian has been reported, indicating that tectonic movement since then, if any, has not been noteworthy. No mapped Quaternary (last 1.9 million years) or Holocene (last 10,000 years) faults exist closer to the site than the western escarpment of the Guadalupe Mountains, about 100 kilometers (60 miles) to the west-southwest (U. S. DOE 1997b).

2.7.1 Seismic Activity

The strongest earthquake on record within 290 kilometers (180 miles) of the site was the Valentine, Texas, earthquake of August 16, 1931 (U. S. DOE 1997b), with an estimated Richter magnitude of 6.4. A Modified Mercalli Intensity V was estimated for this earthquake's groundshaking at WIPP. At Intensity V, groundshaking is felt by nearly everyone, a few instances of cracked plaster occur, and unstable objects are overturned. This is the strongest groundshaking intensity known for the WIPP site.

From November 1974 to August 2006, the largest earthquake within 300 kilometers of the WIPP site occurred on April 14, 1995 based upon a search of the United States Geological Survey National Earthquake Information Center earthquake on January 9, 2007. It was located 32 kilometers (20 miles) east-southeast of Alpine, Texas (approximately 240 kilometers [150 miles] south of the site) and was assigned a Richter magnitude of 5.7. It was the largest event within 300 kilometers of the site since the Valentine, Texas, earthquake, and had no effect on any structures at WIPP (Sanford et al. 1995). From 1974 to 2006, recorded earthquakes within the 300 kilometer radius of WIPP have ranged from magnitude 2.3 to 5.7 (U. S. G. S. 2007)

2.8 MINERAL RESOURCES

2.8.1 Hydrocarbons

Prior to 1970, most commercially related drilling in the WIPP area targeted shallow oil (1,200 to 1,400 meters [3,937 to 4,593 feet] in depth) in the Bell Canyon Formation. From

1970 to the mid-1980s, most drilling near WIPP focused on gas exploration in the deeper Morrow and Atoka Formations (approximately 4,000 meters [13,124 feet]). During the late 1980s and early 1990s, commercial oil was discovered in the Permian Cherry Canyon and Brushy Canyon Formations, which lie below the Bell Canyon formation described above. These discoveries were made at locations adjacent to the eastern and northeastern boundary of WIPP, at a depth of approximately 2,100 to 2,400 meters (6,890 to 7,874 feet). As of 1997, these formations were the primary exploration and development targets in the Permian Basin, one of the most actively explored areas in the United States (Broadhead et al. 1995).

Oil and gas exploration drilling activities in the New Mexico portion of the Permian basin (in which the WIPP site is located) have fluctuated considerably since 1997. As many as approximately 57 rigs were working in the basin in late 1997, but the maximum number dropped to about 15 in 2000. The maximum rig count increased to approximately 65 in 2001, dropped to the low 30s in 2002, and then steadily increased to approximately 60 in 2005. It is assumed that hydrocarbon exploration drilling activities in the WIPP vicinity will continue for the foreseeable future {Crossroads, 2005 #1272}.

Within and immediately around the WIPP land withdrawal area, significant reserves of recoverable oil and gas may be present in the Morrow and Atoka formations, and in shallower Bell Canyon and Cherry Canyon formation reservoirs (Broadhead et al. 1995).

2.8.2 Potash

Bedded potash (a mixture of several soluble oxide, sulfate, and chloride compounds containing potassium, used chiefly in fertilizers) was discovered in Eddy County, New Mexico, in 1925. By 1944, New Mexico was the largest domestic potash producer, representing 85 percent of consumption. Development continued through the 1950s and 1960s, reversed in the 1970s and had declined by the mid 1990s. As of the mid 1990s, commercial potash mining had approached the southwestern side of the WIPP Land Withdrawal Area, and future mining was expected to take place there, or on the north side of the WIPP site. No active potash mining leases existed in the WIPP controlled area at that time (Barker et al. 1995).

Since 1997, potash mining activities in the WIPP vicinity have continued. Approximately 1,500,000 short tons of potash were produced in 1997, and production has slowly declined since that time. In 2005, approximately 1,000,000 short tons were produced (NMEMNRD 2006).

The majority of actively mined and potential resources of potash ore are found in the 37 meter (121 feet) thick McNutt Member of the Salado Formation, which is the host for 11 ore zones. In the vicinity of the withdrawal area, the McNutt Member is found at depths ranging from 400 to 525 meters (1,312 to 1,722 feet) above the repository horizon. An additional ore zone is found in the Upper Member of the Salado.

2.9 HYDROLOGY AND WATER RESOURCES

This section provides a summary of the surface hydrology of the WIPP region, followed by the hydraulic and hydrogeologic characteristics of the geologic formations relevant to WIPP.

2.9.1 Surface Water

WIPP is located approximately 25 kilometers (15 miles) east of the Pecos River and within the Pecos River Basin (Figure 2.3). The drainage area of the Pecos River at this location is 49,200 square kilometers (19,000 square miles). The Pecos River is the main surface water resource in the WIPP vicinity, but river water is not used for human consumption. Irrigation and livestock watering are the primary uses of the water from the Pecos.

The WIPP site has a few small intermittent westward-flowing tributaries of the Pecos River. More than 90 percent of the mean annual precipitation at the site is lost by evapotranspiration. On a mean monthly basis, evapotranspiration at the site greatly exceeds the available rainfall; however, intense local thunderstorms produce temporary runoff and some percolation.

2.9.2 Groundwater

The WIPP repository is situated in the thick, relatively impermeable Salado Formation salt beds 655 meters (2,150 feet) below the ground surface. Generally, groundwater in the Rustler and Dewey Lake Formations and the units overlying them are essentially isolated from the Salado Formation.

The Rustler Formation includes the Culebra and Magenta Dolomites, two units containing water of low quality (brine to brackish) (U. S. DOE 1996b). The Culebra Dolomite is the first notable water-bearing unit above the Salado Formation. Flow in the Culebra is generally from north to south. The Dewey Lake Formation overlies the Rustler Formation and in some areas is relatively transmissive, particularly in the south central and southwestern part of the WIPP site (U. S. DOE 1996b). The location of the water table is generally considered to be within the Dewey Lake Formation (Figure 2.4).

The following sections discuss the hydraulic and hydrogeologic characteristics of the individual geologic formations underlying, overlying, and laterally bounding the WIPP underground facility.

2.9.2.1 Salado Formation Hydrology

As described above, the Salado Formation has several characteristics which make it a favorable host medium for a repository, including its low permeability to fluids and its relatively low water content. Hydraulic tests from which permeabilities have been derived indicate that the Salado halite has either extremely low or no permeability (no measurable flow occurred during some of the tests) (U. S. DOE 1996c).

Inflow of brine into the repository excavation has been observed in boreholes and from "weeps," which are localized brine seeps issuing from cracks in the disturbed surfaces of the repository walls, floors, and roofs. The volumes of brine observed from these occurrences have been small, and flow into the repository has ceased within three years of initial observation (U. S. DOE 1996b). Nevertheless, for the long-term, it is reasonable and conservative to consider that there may be brine near the repository that would flow toward and into the repository, albeit at a low rate.

Brine inflow is a concern in that the brine would provide necessary moisture for the degradation of certain waste material components and gas generation. The Salado salt has such a low permeability that it is difficult to measure with existing technology. Studies of the Salado indicate that the impure halite (greater than 0.5 percent impurities) may exhibit brine flow through pore spaces and along grain boundaries, but measurements on continuous layers of pure halite indicate that vertical flow through the Salado does not occur (U. S. DOE 1996b).

2.9.2.2 Castile Formation Hydrology

The Castile Formation is dominated by anhydrite and halite zones of low permeability (U. S. DOE 1996b); however, fracturing in the anhydrite zone of the upper portion of the Castile has generated isolated regions with much greater permeability than the surrounding intact anhydrite. These regions, referred to as brine reservoirs, contain brine at greater than hydrostatic pressure.

Results of hydraulic tests performed in boreholes suggest that the extent of the highly permeable portions of the Castile is limited. The vast majority of brine is thought to be stored in low-permeability microfractures, with about 5 percent of the overall brine volume stored in large, open fractures. Geostatistical analyses conducted at the site determined that there is an 8 percent probability that a hole drilled into the waste panel region would encounter brine in the Castile (U. S. DOE 1996b).

Geochemical investigations of the brine in the Castile concluded that these fluids originated from ancient seawater and that no evidence exists for fluid contribution from present meteoric waters. The geochemical data indicate that the brine in reservoirs has not mixed to any significant extent with other bodies of water and has not circulated (U. S. DOE 1996b).

2.9.2.3 Bell Canyon Formation Hydrology

The Bell Canyon Formation is considered to form a single hydrostratigraphic unit about 300 meters (984 feet) thick. The low-permeability of the Castile Formation that overlies it effectively isolates the fluid flow in the Bell Canyon (U. S. DOE 1996b).

2.9.2.4 Rustler Formation Hydrology

The Rustler Formation is the most significant hydrogeologic unit above WIPP because it contains the Culebra Dolomite, the first laterally continuous water-bearing unit above the Salado Formation. As stated in above, the Rustler Formation consists of five units, starting at

the base of the formation: 1) the Unnamed Lower Member (Los Medaños Member), 2) the Culebra Dolomite Member, 3) the Tamarisk Member, 4) the Magenta Dolomite Member, and 5) the Forty-Niner Member. The following is a summary of the understanding of the hydrology of these five units (U. S. DOE 1996b).

2.9.2.4.1 Unnamed Lower Member (Los Medaños Member)

The Unnamed Lower Member makes up a single hydrostratigraphic unit in WIPP models of the Rustler Formation, although its composition varies somewhat (U. S. DOE 1996b). Overall, it acts as a confining layer. The basal interval of the Unnamed Lower Member is composed of relatively low hydraulic conductivity siltstone, mudstone, and claystone, and contains the water-producing zones of the lowermost Rustler. The remainder of the Unnamed Lower Member contains extremely low hydraulic conductivity mudstones, anhydrite, and variable amounts of halite.

2.9.2.4.2 Culebra Member

The Culebra Dolomite Member is the most transmissive unit at the WIPP site and is considered the most likely pathway for radionuclide releases from the repository to the accessible environment.

Culebra flow patterns have been recognized as moving predominantly north to south on the WIPP site. Groundwater flow in the Culebra is considered to be a confined system, complicated by contributions of vertical leakage and regional groundwater recharge (Corbet 1997). The majority of fluid movement in the Culebra occurs within fractures and within vugs connected by fractures (U. S. DOE 1996b).

2.9.2.4.3 Tamarisk Member

The Tamarisk Member consists of layers of claystone, mudstone, and siltstone sandwiched between layers of anhydrite. These rock types have very low permeability and transmissivity, and function as a confining layer (U. S. DOE 1996b).

2.9.2.4.4 Magenta Member

The Magenta Dolomite Member is a conductive, saturated, hydrostratigraphic unit at WIPP. However, in most locations the hydraulic conductivity of the Magenta is one to two orders of magnitude less than that of the Culebra (U. S. DOE 1996b).

2.9.2.4.5 Forty-Niner Member

The Forty-Niner Member is the uppermost member of the Rustler formation, and is a confining hydrostratigraphic layer consisting of low-permeability anhydrite and siltstone (U. S. DOE 1996b).

2.9.2.5 Dewey Lake and Santa Rosa Formations

The upper Dewey Lake consists of a thick, generally unsaturated section. The middle Dewey Lake is the interval immediately above a cementation change, from carbonate (above) to sulfate (below), where saturated conditions and a natural water table have been identified in limited areas. The average saturated thickness is 5.1 meters (16.6 feet). An anthropogenic saturated zone has been observed in the overlying Santa Rosa Formation and in the upper part of the Dewey Lake Redbeds since 1995. The lower Dewey Lake is below the sulfate cementation change, with much lower permeabilities (U. S. DOE 2006c).

2.10 POTENTIAL IMPACTS ON HYDROLOGY FROM DRILLING AND MINING

The following is a brief description of the potential future impacts of hydrocarbon exploration and development and potash mining in the WIPP area.

2.10.1 Potential Impacts from Oil and Gas Development

Hydrocarbon exploration and development involves the injection of brine into boreholes that are used for brine disposal and enhanced oil recovery. Without proper management, brine injection activities can have significant hydraulic impact on surrounding geologic media. In several cases, brine injected at depth at locations south of WIPP migrated out of the injection zone and into the overlying Salado Formation, or to the surface (Silva 1996). The potential for this type of incident to occur at WIPP was evaluated by DOE and was viewed as highly unlikely because of differences in geology between WIPP and the nearby injection site, changes in oil-well completion practices since the 1940s, and improved reservoir management practices (Kirkes 2005).

2.10.2 Potential Impacts of Potash Mining

Potash mining has the potential to impact the hydrology of the area near the WIPP site in two ways. One impact involves the potential for mining operations to cause weakening and collapse of overlying strata and subsequent subsidence. This may result in the propagation of fractures through the overlying water-bearing unit (e.g., the Culebra Dolomite), thereby creating potential contaminant pathways (Neill et al. 1996). The other potential impact comes from the need of potash mining operations to dispose of brine generated during mining operations. As in the case of oil and gas drilling operations, potash mining requires the use of salt water disposal wells, and the potential exists for out-of-zone migration of brine injected through improperly sealed wells and deteriorating casing could have a potential impact on hydrologic conditions near the WIPP site.

Current restrictions do not allow any drilling or mining activities within the WIPP controlled area. Routine field inspections are conducted to ensure that there are no direct impacts to WIPP from drilling or mining activities. Planned active controls at WIPP (U. S. DOE 1996b) will ensure that the prohibition on the drilling of hydrocarbon wells and on potash mining is enforced during the active institutional control period (100 Years). Following that period, DOE intends to implement passive institutional controls (U. S. DOE 1996b) that are

expected to significantly deter the possibility of human intrusion for an additional 700 years. Beyond that time, the potential exists for drilling or mining activities to encroach into the area of the WIPP site.

2.11 WATER SUPPLY

As stated above, the Pecos River is the main surface water resource in the WIPP vicinity, but river water is not used for human consumption. Irrigation and livestock watering are the primary uses of the water from the Pecos.

The water wells nearest the WIPP site that are using the naturally-occurring shallow groundwater for domestic use are the Barn Well and Ranch Well located on the J. C. Mills Ranch. These wells are located approximately three miles south-southwest of the WIPP surface facilities.

Water service for WIPP is provided by a water line from the city of Carlsbad water supply system. The main Carlsbad water supply is the Sheeps Draw well field, located approximately 50 kilometers (31 miles) west of WIPP. The Loving/Malaga supply wells are located approximately 25 kilometers (15.5 miles) southwest of the site, and draw from deposits that are hydraulically linked to the Pecos River (U. S. DOE 2006c).

3. WIPP SITE LAND USE

This section provides site maps and an overview of land use within the WIPP site area. The WIPP site comprises four distinct regions of increasingly restricted use to the public. The largest of these areas is the "Land Withdrawal Area" (WIPP LWA or WLWA) which consists of 16-sections (41.4 square kilometers) of federal land under jurisdiction of the DOE and bounded by the WIPP site boundary. Within this boundary are, in decreasing size: 1) The "off-limits area," which consists of approximately 1,454 acres (5.9 square kilometers) posted and managed as off limits by the DOE; 2) The exclusive use area, which is approximately 277 acres (112 hectares) restricted exclusively for the use of the DOE, its contractors, and subcontractors in support of the project and posted against trespass and use by the general public; and 3) The property protection area, which is surrounded by a chain-link security fence that encloses approximately 34 acres (13.7 hectares) and provides security and protection for all major surface structures (U. S. DOE 1996b). These property areas are shown in Figure 3.1.

In general, the inclusion of GTCC LLW and DOE GTCC-like waste will not require modifications to any WIPP surface facilities or the above-ground infrastructure. The existing facilities are assumed to be adequate to facilitate waste handling, storage and transport to the underground. WIPP can receive standard truck shipments and has a rail spur adjacent to the WHB, although rail shipments have never been received and are not planned for the current WIPP mission. Current parking areas may be used for temporary storage or overflow of transport trailers within the property protection area. Additional paved areas, not currently used for parking areas, exist within the property protection area. There are above-ground waste container storage areas within the WIPP CH and RH waste handling facilities. Based

on the presence and type of existing facilities, it is assumed that no additional construction is necessary to accept, handle, store and transport to the underground GTCC LLW and DOE GTCC-like waste.

3.1 ABOVE-GROUND INFRASTRUCTURE

3.1.1 Rights-of-Way, Rights-of-Way Corridors, and Realty Components

The *Waste Isolation Pilot Plant Land Management Plan*, DOE/WIPP-93-004 (LMP) gives information about the above-ground infrastructure at WIPP. Realty components originally constructed, currently maintained, and/or utilized in the operation of WIPP, under custodial right-of-way reservations include, but are not limited to, the following (U. S. DOE 2002b). The rights-of-way, rights-of-way corridors, and realty components are shown in Figure 3.2.

3.1.1.1 North Access Road

The North Access Road is a private road granted, for perpetuity, under right-of-way reservation NM 55676 on August 24, 1983. The North Access Road is approximately 13 miles in length with an easement width of 120 feet. This road is restricted for use by the personnel, agents, and contractors of the DOE on official business related to the WIPP project, or to personnel, permittees, licensees, or lessees of the BLM. Signs are placed and will be maintained at the turnout of Highway 62/180 stating the restrictions on access. Persons desiring access to Highway 128 should use the Lea County Line Road immediately to the east. Right-of-way NM 55676 was amended on April 22, 1988, to facilitate the construction of livestock fencing along either side of the subject road.

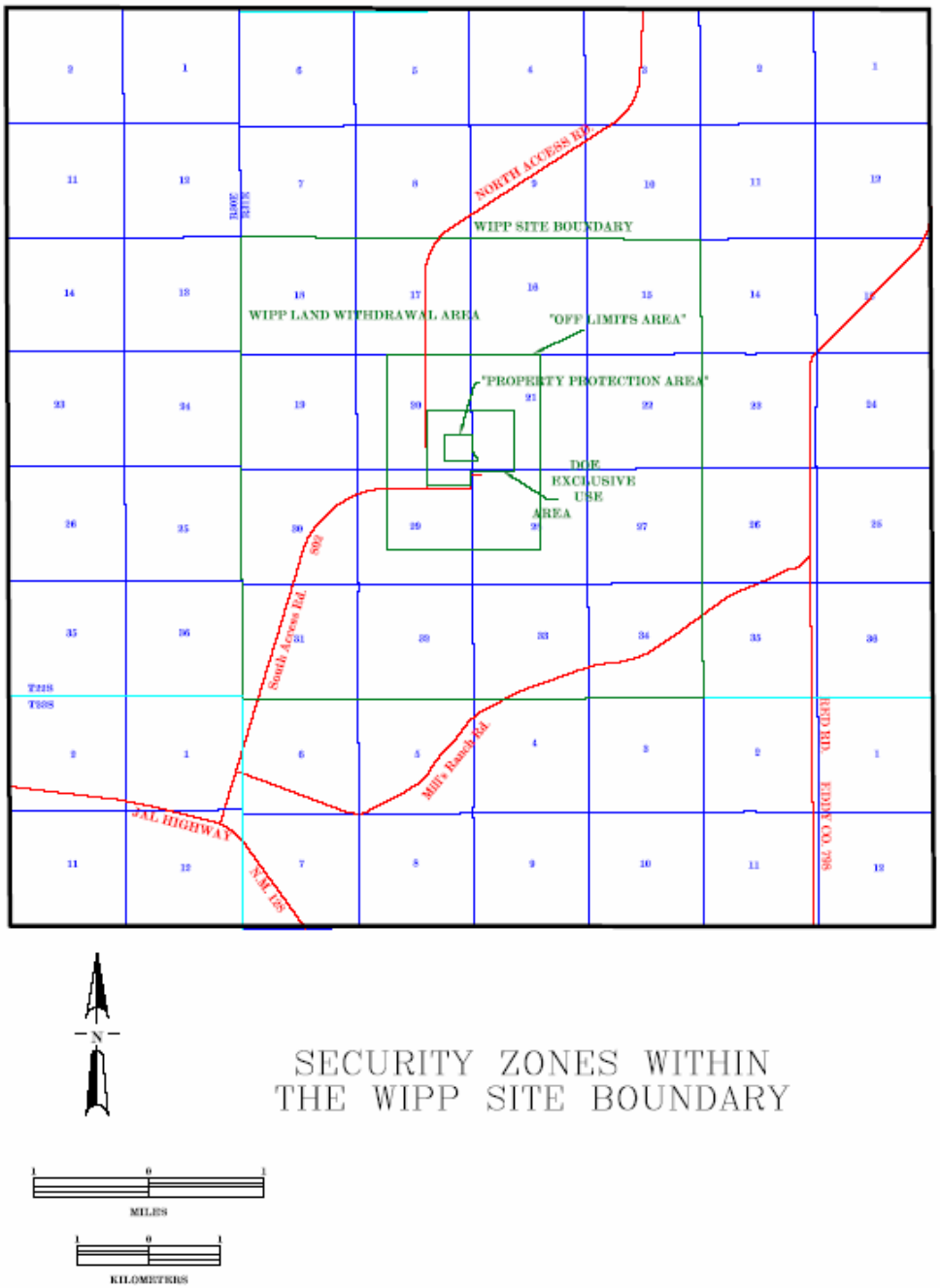


Figure 3.1: WIPP Site Property Areas (U. S. DOE 2002b)

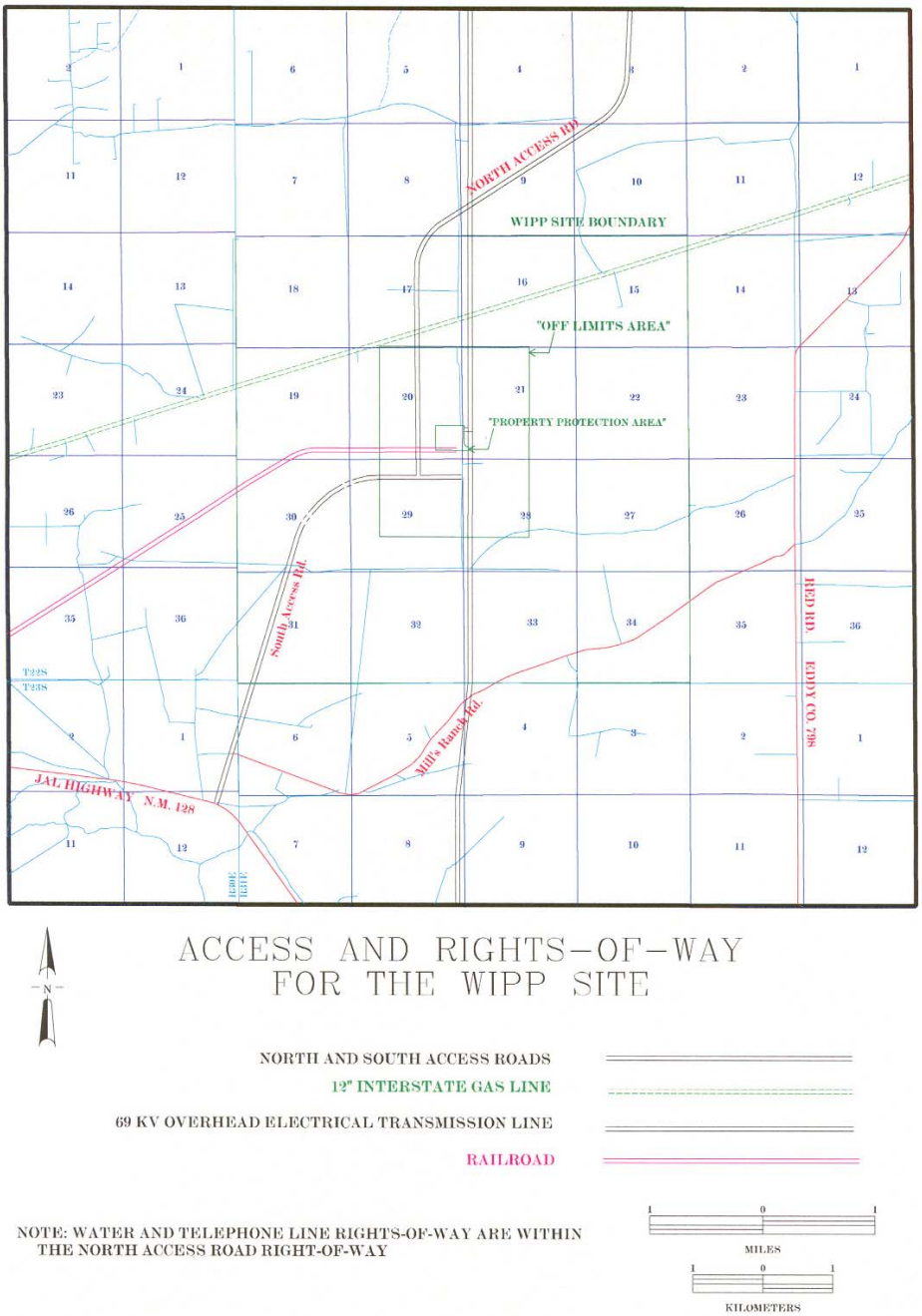


Figure 3.2. Access and Rights-of-Way for the WIPP Site (U. S. DOE 2002b)

3.1.1.2 South Access Road

Eddy County Road 802 is designated as the South Access Road. This road originates at the turnout of Highway 128 and terminates as the pavement ends at the confluence of Sections 28 and 29 in T.22 South, R.31 East. This is a county road constructed in accordance with BLM right-of-way permit NM 46130. Terms for the right-of-way are for ". . . 50 years after the date of grant." The road configuration consists of a right-of-way width of 80 feet, two 12 foot driving lanes, two-to-four foot shoulders, and parallel "bar" ditches. Multiple-use access will be allowed unless it is determined that access by industry or the general public represents a significant safety risk to WIPP personnel. Upon determination, general access on Eddy County Road 802 may be restricted at the boundary of the 1,454-acre Off-Limits Area in accordance with DOE Order 5632.6, "Physical Protection of DOE Property and Unclassified Facilities."

3.1.1.3 Access Railroad

Rail access to the WIPP site is provided by a rail line connecting with a spur of the Atchison, Topeka, and Santa Fe railroad near the IMC Kalium Nash Draw Mine six miles southwest of the site. This section of rail was constructed under the auspices of right-of-way reservation NM 55699 granted on September 27, 1983, is approximately five miles in length and consists of an adjacent frontage road, in addition to the rail. Both railroad and service road were constructed on an easement width of 150 feet.

3.1.2 Utilities

3.1.2.1 Water Service Pipeline

Water service for the WIPP facility is furnished by a water line that originates 31 miles north of the facility. Maintenance and operation of the water line is performed in accordance with the conditions of Contract DE-AC04-86AL24138-M002 between the city of Carlsbad and the DOE under right-of-way reservation NM 53809 issued to the U.S. Army Corps of Engineers acting on behalf of the DOE. The volume capacity of the water line is such that it meets all water requirements for the operation of the WIPP facility, as well as provides the city of Carlsbad with untreated water.

The initial 16-mile segment of the line is a 24-inch-diameter line that accommodates the city of Carlsbad deliveries in excess of that required by the WIPP facility. The city of Carlsbad is authorized to use capacity in the initial 16-mile segment that is in excess of 500 gallons per minute, provided that:

- Any such use of the excess capacity by the city of Carlsbad will be without any cost or liability to the DOE.
- The city of Carlsbad will notify the DOE not less than 30 days in advance of the installation of each new tap and/or service capacity commitment which the city of Carlsbad intends to serve from the DOE's line.

- Upon request by the DOE Contracting Officer, the city of Carlsbad will provide a monthly tabulation of deliveries by tap point for the preceding 24 months.

In the final 15-mile (10 inch diameter) segment, the DOE has authorized the 3/4 inch water tap lines to supply water to livestock drinking tanks. Additional tap points may be added from time to time with advance approval of the DOE. Water delivered at such tap points will be metered and billed by the city of Carlsbad consistent with the city of Carlsbad's rates and procedures for providing service to its regular customers.

Future use of the water pipeline within the WLWA will be determined at the time of decommissioning of the WIPP facility.

As specified in Contract DE-AC04-86AL24138-M002, the city of Carlsbad will provide the DOE's water requirements free of consumption charge and maintain the water line, at its expense, during the initial term of the contract and any optional extension terms thereafter. Single maintenance projects involving repairs or replacements that cost in excess of $10,000 will be considered abnormal and will be funded by the DOE, provided that such repairs or replacements are not the result of the fault or negligence of the city of Carlsbad or its customers, and provided further that the city of Carlsbad will first obtain the advance approval of the Contracting Officer (DOE) for any maintenance project requiring the DOE funding. This contract will be renegotiated between the DOE and the city of Carlsbad every five years.

An operating committee, comprised of (no fewer than) two representatives from the DOE and other affected city, county, state, and federal agencies, will be formed. The responsibilities of the operating committee will be:

- To establish standard procedures and practices for the operation and maintenance of the water line.

- To review any technical studies that may be conducted during the term of the contract and keep the Contracting Officer (DOE) and the city of Carlsbad currently advised as to matters needing attention.

3.1.2.2 Transmission Line

WIPP is serviced by an overhead electrical transmission line [69 KV] that traverses the WLWA for two miles to the north (right-of-way reservation NM 43203) and an additional two miles to the south (right-of-way reservation NM 91163). The southern terminal of the line is approximately five miles south of WIPP at a location identified as the Southwest Public Service Company's Sand Dune Substation. Access to the power line easement is restricted to WIPP employees and SPS employees. Unauthorized access to the easement is prohibited and will result in DOE response commensurate with property protection [see Chapter 10 of DOE (1993a)].

3.1.2.3 High-Pressure Gas Line

A twelve-inch, high-pressure, interstate gas line with a corresponding easement road traverses portions of Sections 15, 16, 17, 19, and 20 of the WLWA. Maintenance and operation of the line and the easement road are the proprietary responsibility of the El Paso Natural Gas Company (the owner/operator of the line) under right-of-way reservation LC 060762. WIPP periodically uses the easement road for access to the east and, therefore, will conduct maintenance activities (as needed and in accordance with WIPP maintenance protocol) [see Chapter 13 of DOE (1993a)] to the road in order to provide adequate and safe access for WIPP vehicles (e.g., emergency response vehicles).

3.2 MAJOR SURFACE STRUCTURES

The HWFP (U. S. DOE 2006b) identifies three basic groups of structures associated with the WIPP facility: 1) surface structures, 2) shafts, and 3) underground structures. Shafts and underground structures are discussed in Section 4. The surface structures are shown in Figure 3.3.

The surface structures accommodate the personnel, equipment, and support services required for the receipt, preparation, and transfer of TRU waste from the surface to the underground. There are two surface locations where TRU waste will be managed and stored as shown in Figure 3.4. The first area is the WHB Container Storage Unit (WHB Unit) for TRU radioactive mixed waste management and storage. The WHB Unit consists of the WHB CH Bay and the RH Complex. The second area designated for managing and storing TRU waste is the Parking Area Container Storage Unit (Parking Area Unit), an outside container storage area which extends south from the WHB to the rail siding. The Parking Area Unit provides storage space for up to 50 loaded CH packages and 14 loaded RH packages on an asphalt and concrete surface. It is assumed that the surface structures currently at the WIPP will be used for the disposal of GTCC LLW and DOE GTCC-like waste and that construction of new surface structures will not be needed.

Figure 3.5 shows the major WIPP buildings. As discussed in the *General Plant Design Description* (GPDD) (U. S. DOE 1999a), no Design Class I structures, systems, and components (SSCs) exist at the WIPP. Design information is provided for those SSCs that have been designated as Design Class II, and IIIA in the GPDD.

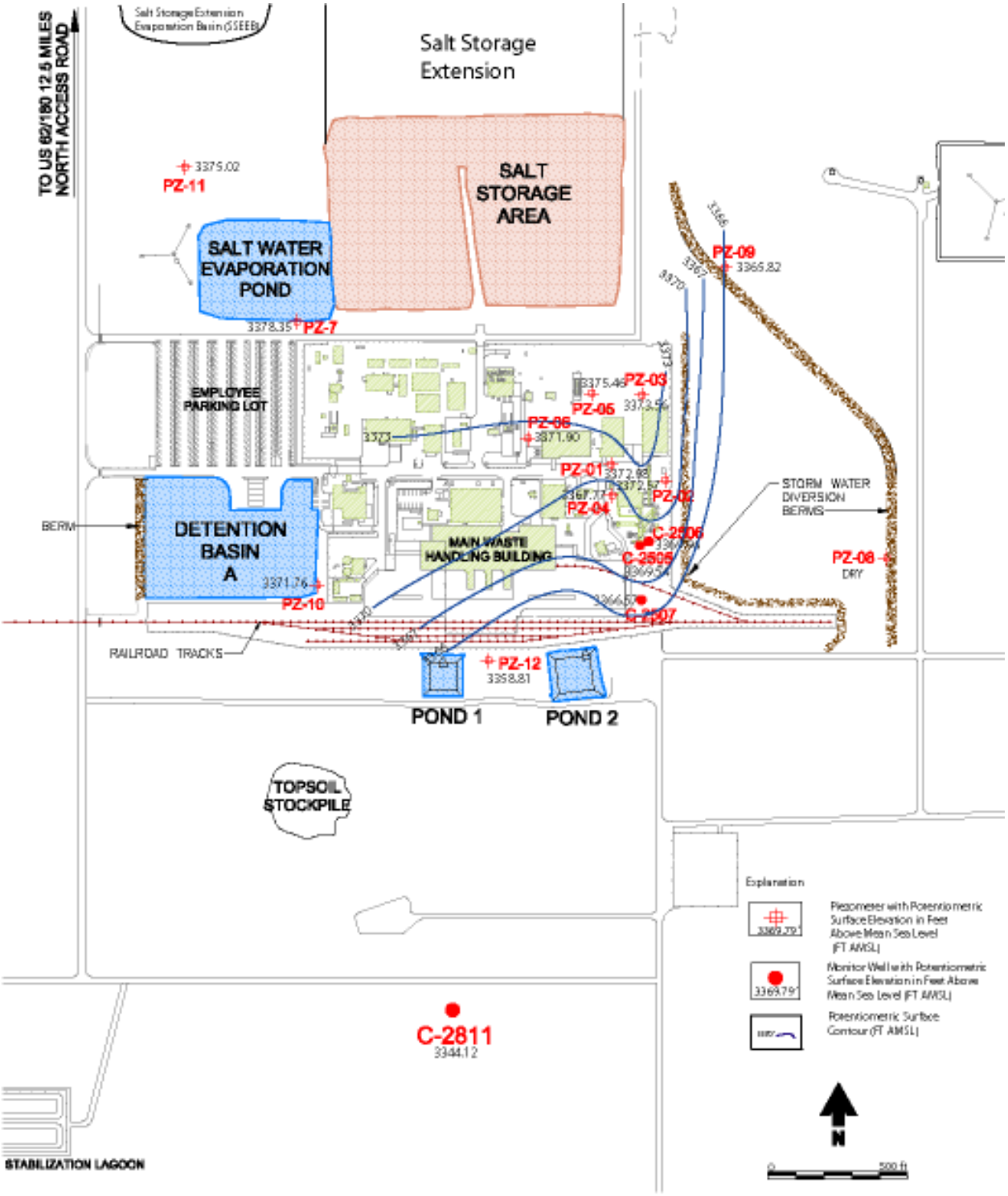


Figure 3.3. Map of Above-ground Infrastructure and Major Surface Structures at WIPP (U. S. DOE 2006b)

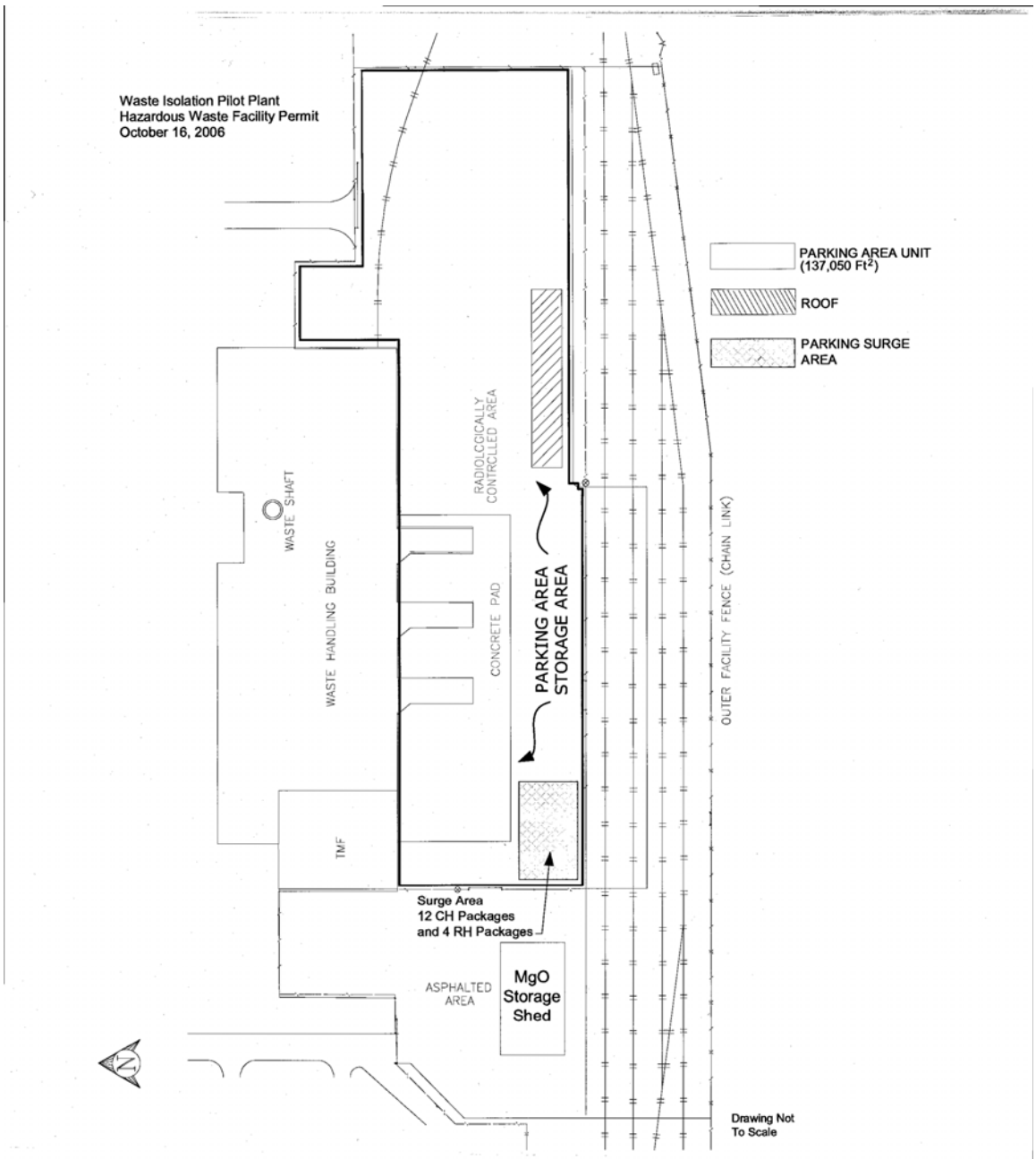


Figure O3-4
Parking Area-Container Storage and Surge Areas

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Figure 3.4. Parking Area-Container Storage and Surge Areas (U. S. DOE 2006b)

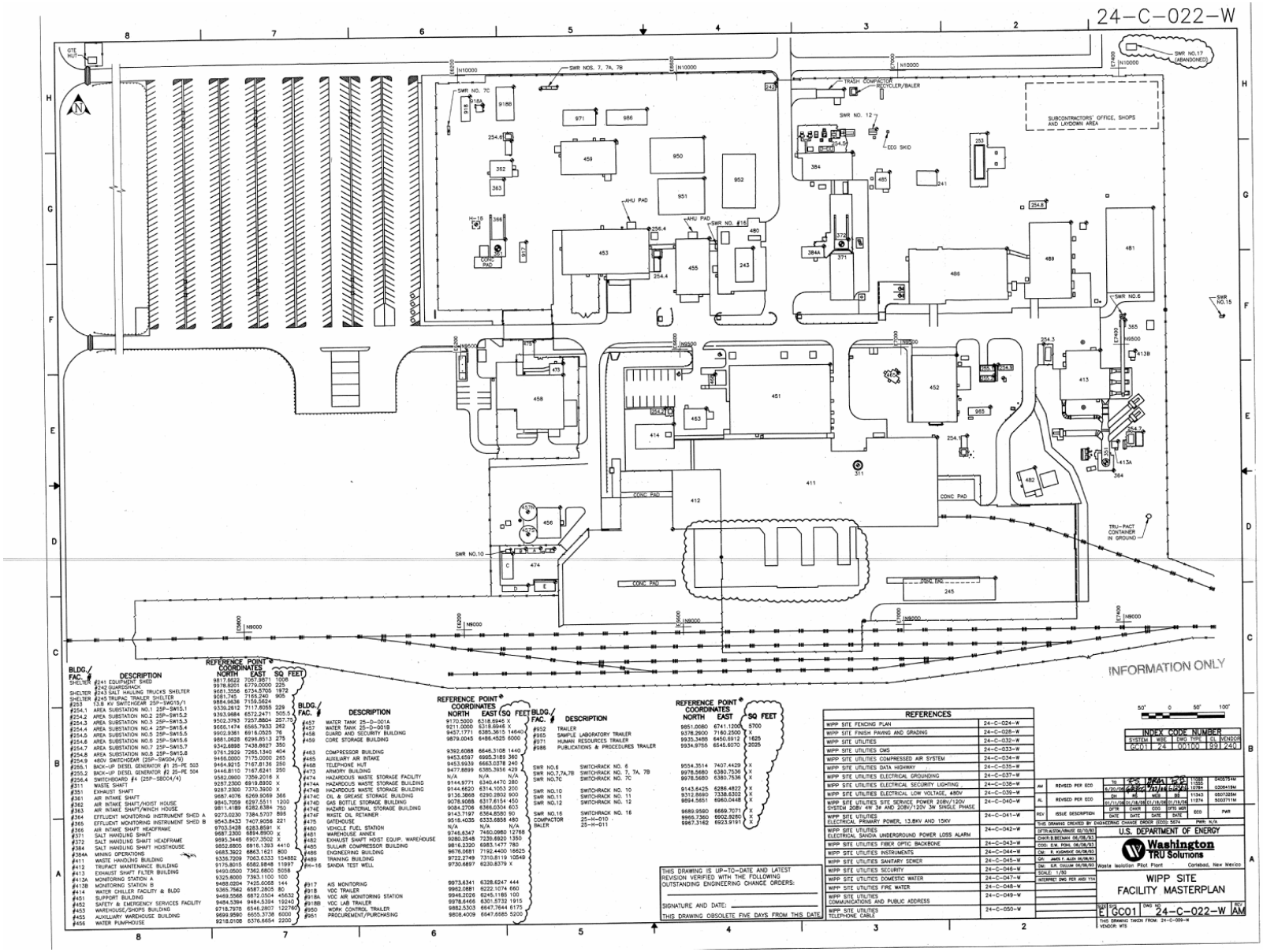

Figure 3.5. WIPP Surface Structures (U. S. DOE 2006b)

3.2.1 Waste Handling Building

The WHB is a steel frame structure with insulated steel siding, and includes portions of the building that are constructed of concrete for shielding and structural purposes and is classified as Design Class II (U. S. DOE 1999a). The WHB is 230 feet wide, 575 feet long and 50 feet high (except for a 125 foot high bay area) (U. S. DOE 1980). The building has separate areas for the receipt, inventory, inspection, and transfer of wastes through separate airlocks to a common waste shaft. It also contains offices, change rooms, a health-physics laboratory, and equipment for ventilation and filtration. Safety equipment and measures for controlling radiation exposures are included in the design of the WHB.

Building 412 (designed as the TRUPACT maintenance facility) is Design Class IIIA; however, the structural portions of the building are Design Class II because of its interface with the WHB. Building 412 provides space and equipment for minor scheduled and unscheduled maintenance activities and includes a 25-ton overhead crane (U. S. DOE 1999a).

WHB support areas include the waste hoist support areas and the main mechanical equipment room containing the heating, ventilation, and air conditioning (HVAC) equipment. Air locks are located on both sides of the waste hoist (U. S. DOE 1999a).

3.2.2 Exhaust Filter Building

The Exhaust Filter Building structure is classified as Design Class IIIA, and the high-efficiency particulate air (HEPA) filters and isolation dampers are Design Class II. The major areas with in the Exhaust Filter Building are the filter room and support area. The filter room houses the HEPA filtration units. The support area includes two mechanical equipment rooms housing the building filtration units, the exhaust fans, the supply-air handling units, the motor control centers, and the air lock (U. S. DOE 1999a).

3.2.3 Water Pumphouse

The Water Pumphouse contains two fire water pumps, three electric domestic water pumps, and space for water chlorination equipment and chemical storage. The Water Pumphouse is an above-ground steel frame and siding building classified as Design Class IIB (U. S. DOE 1999a).

3.2.4 Support Building

The Support Building houses general support services for activities at the WIPP facility. The Support Building is constructed of steel framing and sandwich panel siding, and is classified as Design Class IIIA (U. S. DOE 1999a).

3.2.5 Other Buildings

The following support structures are designed to the Uniform Building Code and are classified as Design class IIIB support structures (U. S. DOE 1999a):

- Salt Handling Shaft Headframe and Hoist House
- Air Intake Shaft Headframe and Hoist House
- Main Warehouse Building
- Guard and Security building
- Main Gatehouse
- Safety and Emergency Services building
- Compressor Building
- Engineering Building
- Training Building

3.2.6 Salt Storage Area

The salt storage area or "salt pile" consists of a 30-acre area north of the property protection area that contains the rock, principally salt, excavated from the repository (U. S. DOE 1980).

3.2.7 Detention Basin

The detention basin is to catch parking lot run-off. Storm water runoff from paved areas will be collected by storm sewers, which may also collect a very small amount of runoff from landscape irrigation; the remainder of the irrigation water will seep into the soil (U. S. DOE 1980).

Rainfall-intensity data allow an estimate of the maximum volume of runoff water from the developed areas at the site: 466,000 cubic feet during a 30-minute storm (U. S. DOE 1980). This estimate assumes a water-infiltration rate of 50% and a surface area of 150 acres. Runoff will be collected in ditches, carried away from the developed area, and discharged into drainage swales.

3.2.8 Sewage Treatment Ponds

The WIPP sewage treatment system is a zero-discharge facility consisting of two primary settling lagoons, two polishing lagoons, a chlorination system, and four evaporation basins. The entire facility is lined with 30 mil synthetic liners. The facility is designed to dispose of domestic sewage and site-generated brine waters from observation well pumping and from underground dewatering activities at the site.

The WIPP sewage facility is operated under the New Mexico Discharge Plan (DP-831) and managed in accordance with the EPA sewage sludge regulations (40 CFR 503), the New Mexico Water Quality Control Regulations {20 NMAC, Chapter 6), and the Sewage Lagoon Sampling Procedure (WIPP Procedure [WP] 02-EM 1001). These requirements provide

guidance for disposal of domestic sewage, site generated brine waters, and site generated non hazardous waste waters.

A determination is made on a case-by-case basis to determine regulatory requirements for onsite or offsite disposal of sewage sludge. Small quantities of sludges generated at the WIPP site have been used as fertilizer and soil stabilizers for WIPP reclamation projects. All sludges are analyzed in accordance with regulatory requirements of 40 CFR 503 before they are applied to the reclamation areas.

The sewage-treatment plant consists of two parallel aerobic lagoons connected to a common effluent-holding pond {U. S. DOE 1980 #271}. The effluent may be used for site landscape watering and dust control at the mined-rock pile. Provisions for hypo-chlorinating the effluent, as required, are made. Sludge dredged from the lagoons will be disposed of in the sanitary landfill or trucked away from the site for disposal. The plan effluent will meet all applicable New Mexico water-quality-control regulations. A chain-link fence 8 feet high will enclose the plant area to prevent the intrusion of any grazing animals or unauthorized persons (U. S. DOE 1980).

Other liquid effluents processed with the sanitary waste will be water used for washing miners' boots (U. S. DOE 1980).

4. THE WIPP UNDERGROUND

This section provides information about the WIPP underground including the shafts and underground structures. The section identifies potential underground facility modifications that would be caused by disposal of GTCC LLW and DOE GTCC-like waste in WIPP. While Section 3 concludes that the GTCC LLW and DOE GTCC-like waste will be handled using existing surface facilities (e.g., waste unloading areas, waste handling buildings, and staging areas), and no other surface facilities are necessary, additional underground excavations will be necessary to accommodate the GTCC LLW and DOE GTCC-like waste volume. It is assumed that the GTCC LLW and DOE GTCC-like waste will be disposed in underground waste disposal rooms similar (if not identical) to those currently used for the disposal of TRU waste.

4.1 WIPP SHAFT LAYOUT

Four vertical shafts connect the surface facility to the underground. These are the Waste Shaft, the Salt Handling Shaft, the Exhaust Shaft and the Air Intake Shaft. The Waste Shaft is the shaft used to transport TRU waste to the underground. The Salt Handling Shaft is the shaft used to transport mined salt from the underground to the surface. It is assumed that no other shafts (waste, salt, exhaust, or air intake) will be constructed to support the disposal of GTCC LLW and DOE GTCC–like waste at the WIPP. These shafts are illustrated in Figure 4.1.

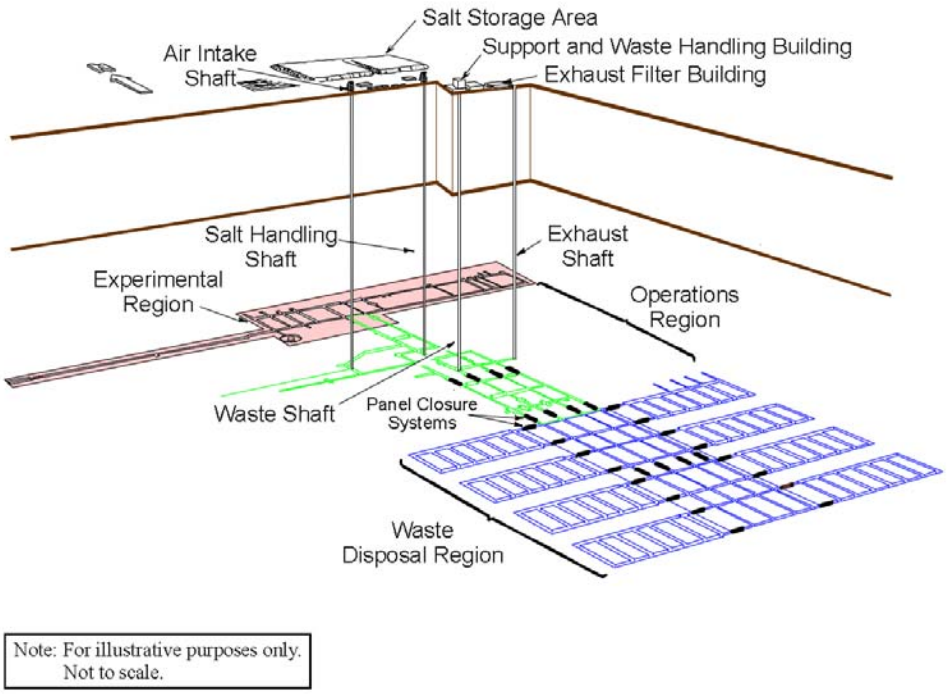

Figure 4.1. Spatial View of the WIPP Facility (U. S. DOE 1996b)

4.1.1 The Exhaust Shaft

There are two potential sources of contaminated airborne emissions from the WIPP operations: releases generated above-ground in WHB operations, and those generated underground that are released through the Exhaust Shaft (U. S. DOE 1996b) Appendix EMP). Two effluent monitoring stations, A and B, sample exhaust from the underground operations. Sample extraction probes sample the unfiltered exhaust stream in the Exhaust Shaft (Station A), the filtered exhaust down stream of the Exhaust Filter Building (Station B), and the filtered exhaust of the WHB (Station C). The exhaust air from the WHB is continuously routed through a set of pre-filters and two stages of HEPA filters. The air from the Exhaust Shaft is switch from the normal mode which is not filtered to a HEPA filtered mode if upstream air exceeds predetermined sampling set points. Separate exhaust fans are used for these modes (see Figure 4.2).

Above-ground waste operations are not expected to be a potential source of significant contamination because the volume of waste is small compared to that underground. Previous air dispersion modeling used the exhaust shaft (normal mode) as the discharge point. This model used two exhaust stacks spaced 23.6 feet (7.2 m) apart and 26.9 ft (8.2 m) above the ground surface. These stacks exit the mine air at a 45 degree angle upward. The standard ventilation rate is 425,000 ft^3 (12,000 m^3) per minute (U. S. DOE 1996b; Crawford 2005).

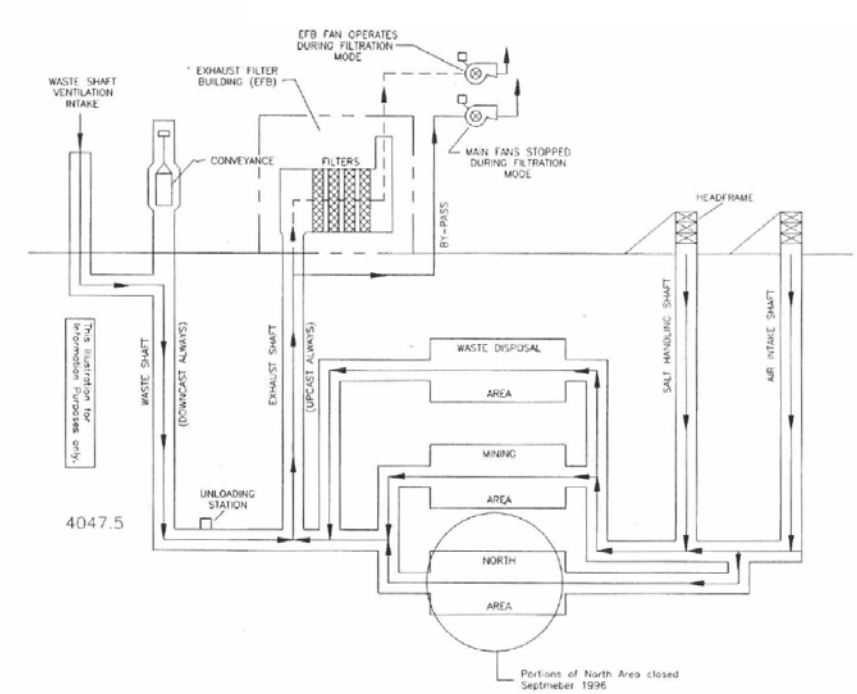

Figure 4.2. Diagram of the Exhaust Flow at WIPP (U. S. DOE 2006b)

4.2 UNDERGROUND LAYOUT AND GENERAL DESIGN

The waste disposal region of the WIPP is shown in Figure 4.3. This is the blue area from Figure 4.1. The green area in Figure 4.1 is the operations and experimental area which are not discussed further in this document. The waste disposal region is comprised of a series of panels containing disposal rooms. Waste panels consist of seven rooms. Each room has nominal dimensions of 91 m long, 10.1 m wide and 4.0 m high. Pillars between rooms are 30 m thick. Eight waste panels will be separated from each other and the main entries by nominally six 61-m pillars. In addition to the eight panels, the main north-south and east-west access drifts in the waste regions are available for waste disposal. These have been designated as Panels 9 and 10 for permitting and modeling purposes. Panels shown in Figure 4.3 with solid lines have been excavated[1]. Panels shown in Figure 4.3 with dotted lines are planned excavations. It is assumed that the only new construction at the WIPP facility required for the disposal of GTCC LLW and DOE GTCC-like waste would be the creation of new disposal rooms/panels for waste emplacement. Figure 4.4 shows the layout and dimensions of a panel.

[1]Other panels may have been excavated by the release of this document.

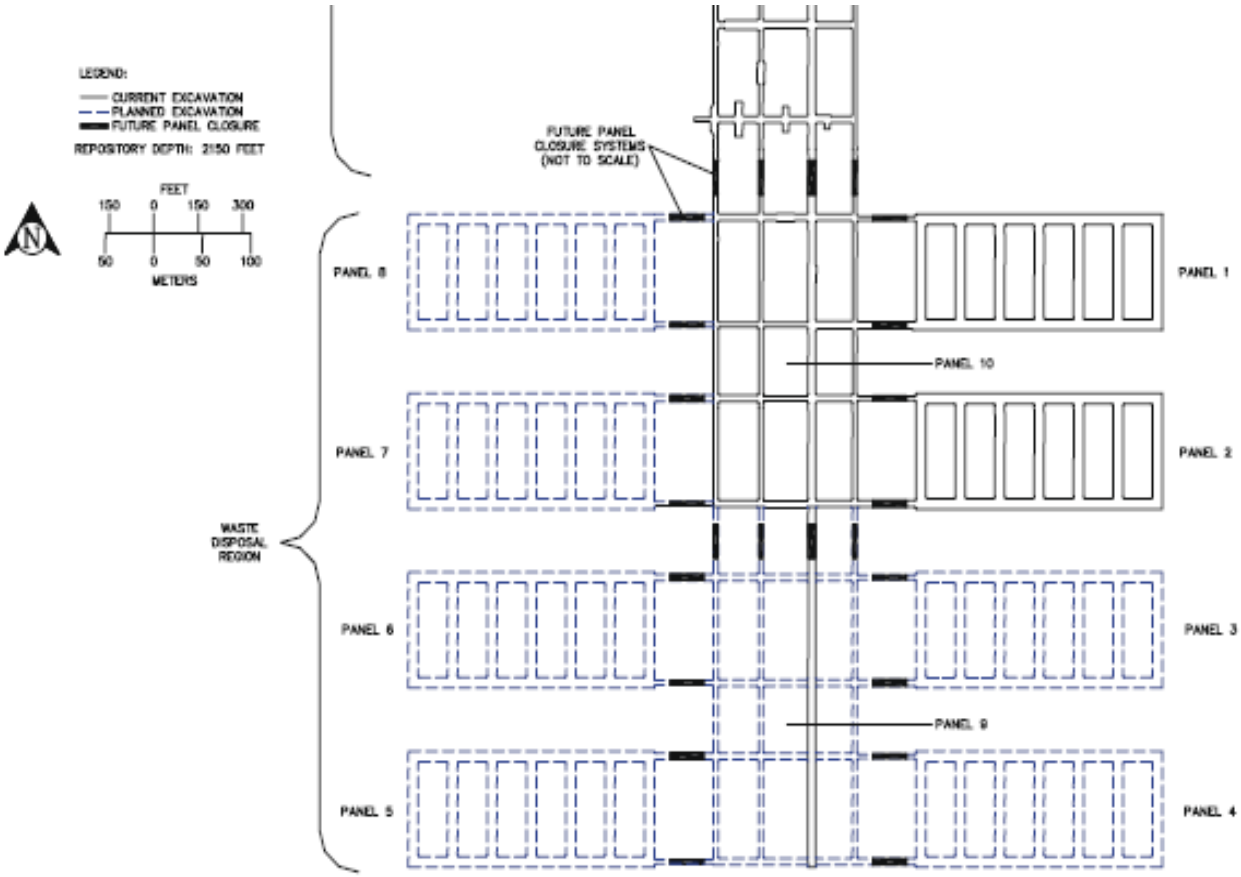

Figure 4.3. Layout of Waste Disposal Region for the WIPP (U. S. DOE 2004a)

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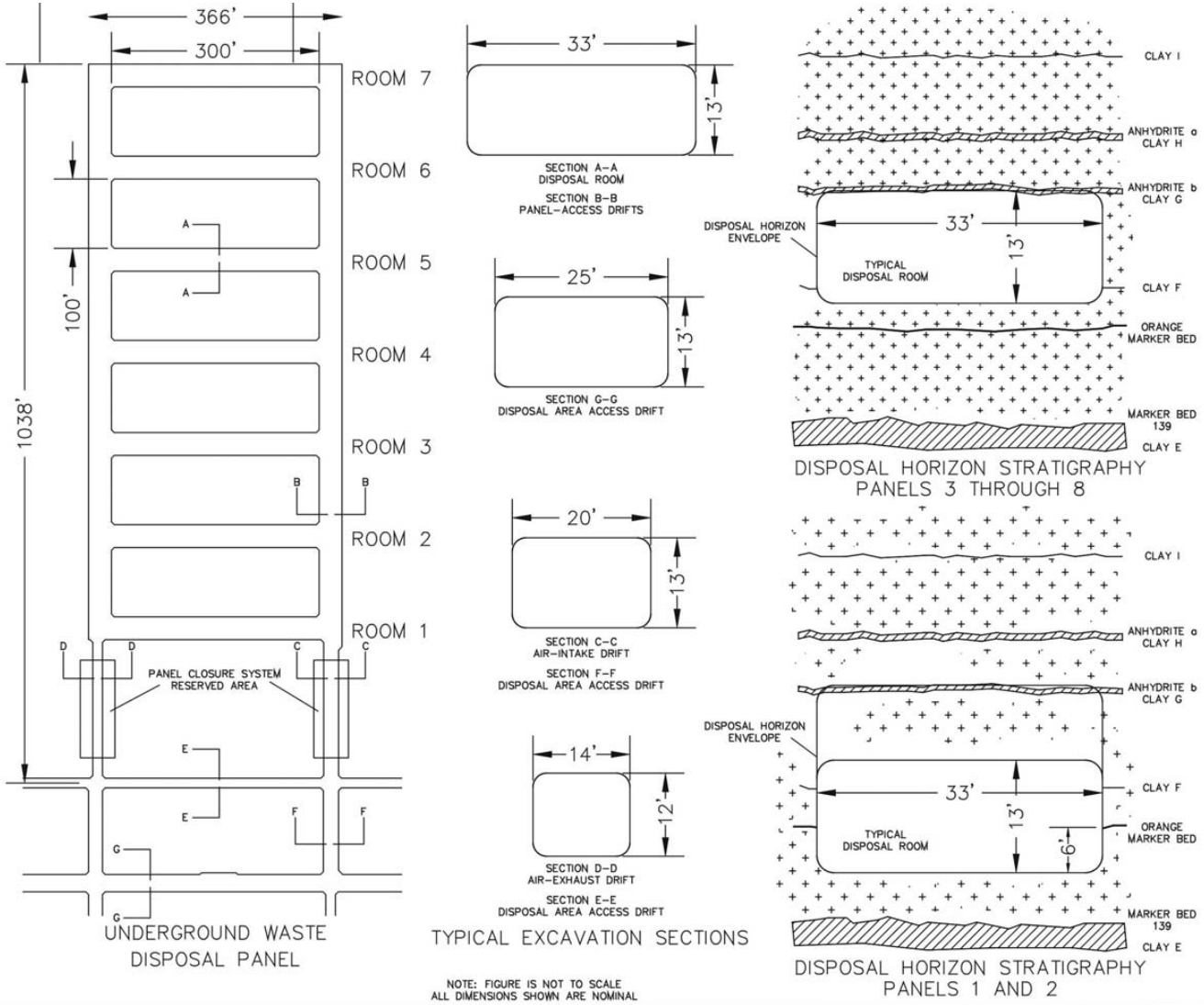


Figure 4.4. Individual Panel Layout and Dimensions (U. S. DOE 2004a)

4.3 AVERAGE WIPP DISPOSAL ROOM UNDERGROUND AREA USE

Salt excavated for a GTCC LLW and DOE GTCC-like waste panel would be stored and disposed in the same above-ground salt storage area shown in Figure 3.3. No additional below ground excavations or infrastructure is assumed to be necessary for GTCC LLW and DOE GTCC-like waste disposal (other than that described above).

Table 4-1. Average WIPP Disposal Room Underground Area

Underground Site Land Area (assuming a 10 panel repository)[a]	Area for CH waste	1.12×10^5 m^2
	Area for RH waste	1.58×10^4 m^2
	Area in waste panel not used for disposal	4.13×10^3 m^2
Disturbed Land Area (surface)	The total disturbed area is within the 34.12 acre property protection area	
Total Fenced Area[b]	Property Protection Area	34.12 acres within chain link security fencing
	DOE Exclusive Use Area	277.14 acres within five-strand barbed wire fencing
Total Excavated Material[c,d]	Room	3.64×10^3 m^3
	Panel	4.61×10^4 m^3
	Access Drifts for 1 Panel	2.29×10^4 m^3

[a]Table PAR-45, (U. S. DOE 2004a); [b]LMP (U. S. DOE 2002b);[c]Table PAR-45, (U. S. DOE 2004a), [d]The values for an access drift.

The disposal panels are connected by access drifts that are used to transport waste and mining equipment and to provide ventilation throughout the underground. These access drifts are shown in Figure 4.3. To accommodate additional panels the four access drifts would be extended to the south an additional 570 ft. Two 470 ft cross drifts would also be required. This extension would accommodate one or two additional panels south of panels 4 and 5. Two of the 570 ft access drifts are 25 ft wide by 13 ft tall. The other two are 14 ft wide and 12 ft tall. The cross drifts are 20 ft wide by 13 ft tall (Figure 4.4). Calculation of the access drift volume associated with a panel is shown in Table 4-2.

Table 4-2. Access Drift Excavated Material Volume[a]

Drift	Length (ft)	Width (ft)	Height (ft)	Volume (ft^3)
E-300	570	14	12	95,760
E-140	570	25	13	185,250
W-30	570	25	13	185,250
W-170	570	14	12	95,760
S-3540	470	20	13	122,200
S-3880	470	20	13	122,200
			Total excavated volume (ft^3)	806,420
			Total excavated volume (m^3)	22,840

[a]Volume calculations allow no adjustments for intersections.

4.4 CURRENT WASTE EMPLACMENT IN THE WIPP UNDERGROUND

Emplacement of waste in WIPP is described in *Appendix Data Attachment H: WIPP Waste Containers and Emplacement* (U. S. DOE 2004a). Figure 4.5 shows the typical position for waste emplacement containers in a room of a panel.

The hexagonal groupings shown in Figure 4.5 represent seven-packs of 55-gallon drums. The triangular groupings shown in Figure 4.5 represent three-packs of 100-gallon drums. The square groupings represent four-packs of 85-gallon drums. The oblong items shown represent standard waste boxes (SWBs), and the large circles shown in Figure 4.5 represent ten-drum overpacks (TDOPs).

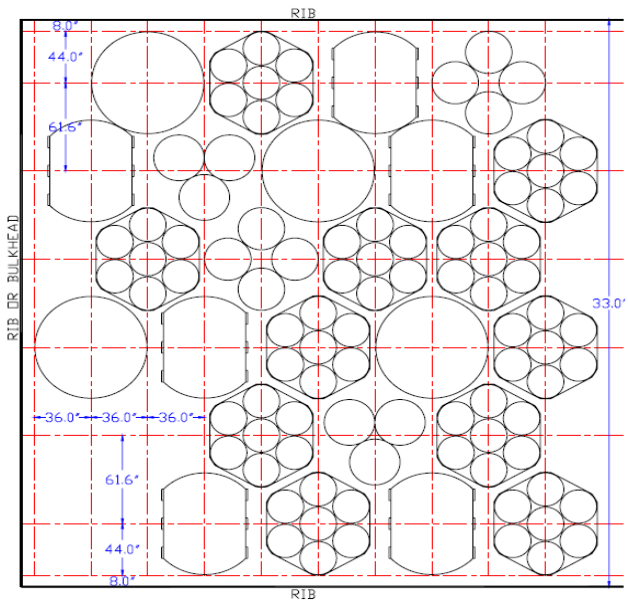


Figure 4.5. Example Current WIPP Room Emplacement Configuration (U. S. DOE 2004a)

Most of the assemblies shown in Figure 4.5 are stacked three high when they are emplaced in WIPP. A stack of waste in WIPP would be comprised of three assemblies in almost any combination: three-seven-packs in a stack, one SWB and two seven-packs in a stack and so forth. When an assembly is too large for stacking (for example, nothing is stacked on top of TDOPs in WIPP), a single assembly constitutes a stack. Waste packages are placed in WIPP disposal rooms in random fashion, with no specific load management or emplacement sequence.

Figure 4.6 shows the position of assemblies (called payloads in the figure) in rooms seven, five, four, three, and two of a typical WIPP panel. The figure indicates that an average WIPP room houses 1,638 assemblies if they are stacked three high, or 546 stacks. A typical WIPP panel will house 10,908 assemblies if they are stacked three high (3,636 stacks).

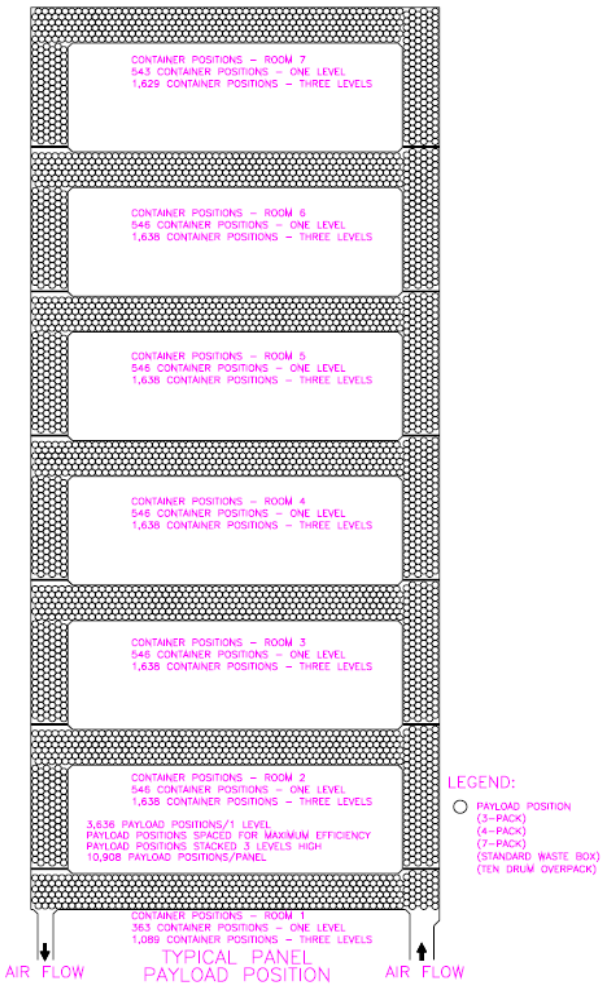


Figure 4.6. Planned CH Waste Emplacement in The Rooms of a Panel (U. S. DOE)

4.4.1 GTCC LLW Activated Metal from Nuclear Utilities and DOE GTCC-like Activated Metal

GTCC LLW activated metal from nuclear utilities (waste stream 1) and DOE GTCC-like activated metal (waste stream 3) will be handled as CH waste and will be packaged and emplaced in the h-SAMC, which will provide sufficient radiation shielding. Waste stream 1 has a volume of 882 m^3 and will require 12,796 h-SAMCs (SNL 2008). Assuming a 7-pack arrangement as shown in Figure 4.7, 1,828 waste stacks of h-SAMCs will be required for emplacement of this waste stream in the WIPP. Since this assembly is too heavy for stacking, it is assumed no waste is placed on the top of an h-SAMC 7-pack assembly.[2] Therefore, an h-SAMC 7-pack is considered to be a waste "stack." Waste stream 3 consists of 13 m^3 and will require 68 h-SAMCs and would occupy 10 waste stacks. This assembly would have outer dimensions of 84 inches diameter and 55 inches high.

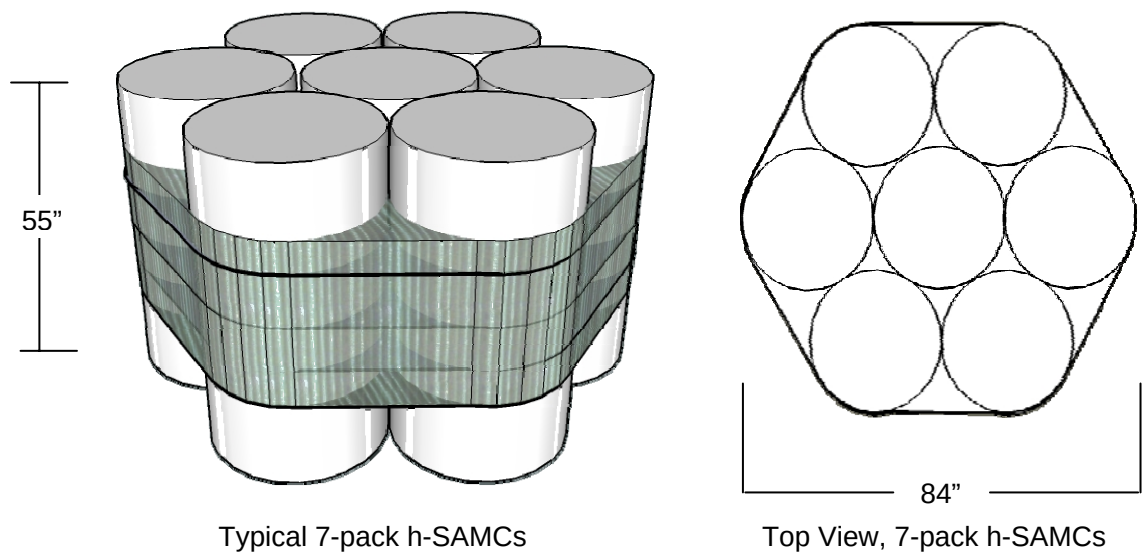


Figure 4.7. Conceptual Drawing of a Seven-Pack of h-SAMCs for Disposal in WIPP

(Not to Scale)

[2] While 55-gallon drums could be placed on top of heavy GTCC LLW container types such as Cs irradiators (waste streams 2c and 2d) and h-SAMCs (waste streams 1 and 3) this analysis does not assume this occurs. Such load management would require staging waste on the surface in temporary storage areas until opportunities for such emplacement arrangements occur. WIPP operations do not employ load management techniques for many reasons. Therefore, drums are not assumed to be stacked on top of heavy waste packages such as the Cs irradiator and the h-SAMC.

4.4.2 55-Gallon Drums and Standard Waste Boxes Containing Sealed Sources and CH Other Waste

It is assumed that the 55-gallon drums containing GTCC LLW and DOE GTCC-like sealed sources containing isotopes other than ^{137}Cs (waste streams 2a and 2b) and CH other waste (waste streams 4a and 4b) will be emplaced in WIPP as seven-packs (SNL 2008) as shown in Figure 4.8. This assembly would have outer dimensions of 72 inches diameter and 35 inches high and would be placed in WIPP in stacks of three (three seven-packs per stack). Figure 4.9 shows typical three-high seven-pack waste emplacement in the repository. Therefore, a waste stack of 55-gallon drums will contain 21 drums.

Assuming emplacement in WIPP as seven-packs and three seven-packs constitutes a stack, the 55-gallon drums containing GTCC LLW and DOE GTCC-like sealed sources containing isotopes other than ^{137}Cs (449 seven-packs of 55-gallon drums) would constitute 151 stacks in WIPP. The 55-gallon drums containing GTCC LLW and DOE GTCC-like CH other waste (excluding West Valley) consists of 54 seven-packs of 55-gallon drums and would constitute 18 stacks in WIPP.

It is assumed that DOE GTCC-like CH other waste from West Valley will be disposed of in 498 three-packs of SWBs. The SWB 3-packs will be stacked 3 high in the repository would constitute 166 stacks in WIPP. The SWB has the dimensions of 36.875 inches high, 54.5 inches wide, and 71 inches long as shown in Figure 4.11.

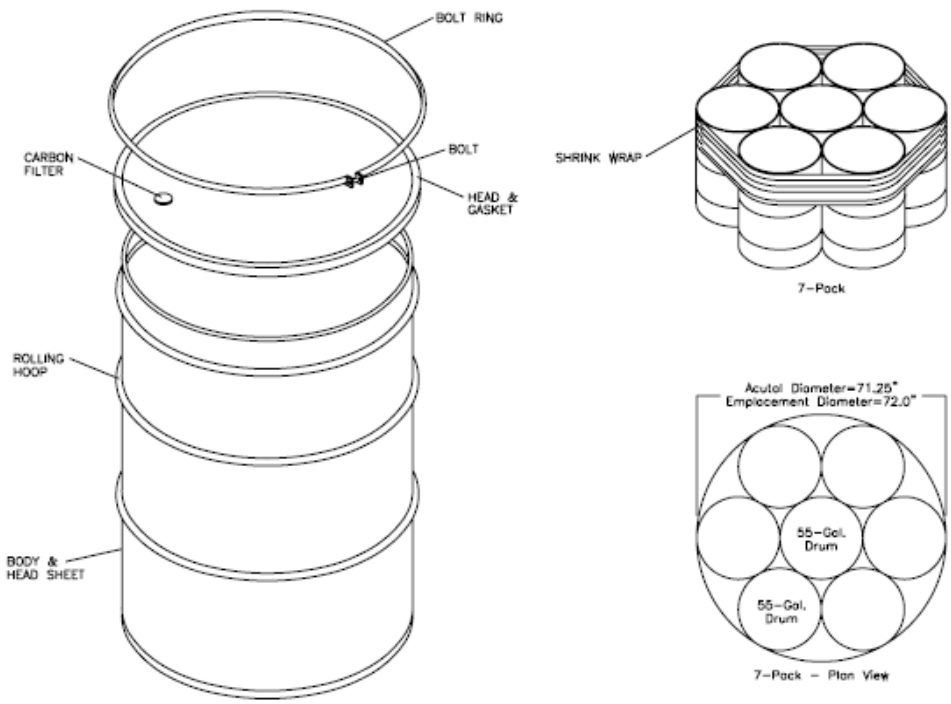


Figure 4.8. Conceptual Drawing of a Seven-Pack of 55-gallon drums for Disposal in WIPP (U. S. DOE 2004a)

Figure 4.9. Typical 55-gallon drum seven-pack waste emplacement (with bagged magnesium oxide chemical buffer on top of stack) in WIPP (U. S. DOE 2007)

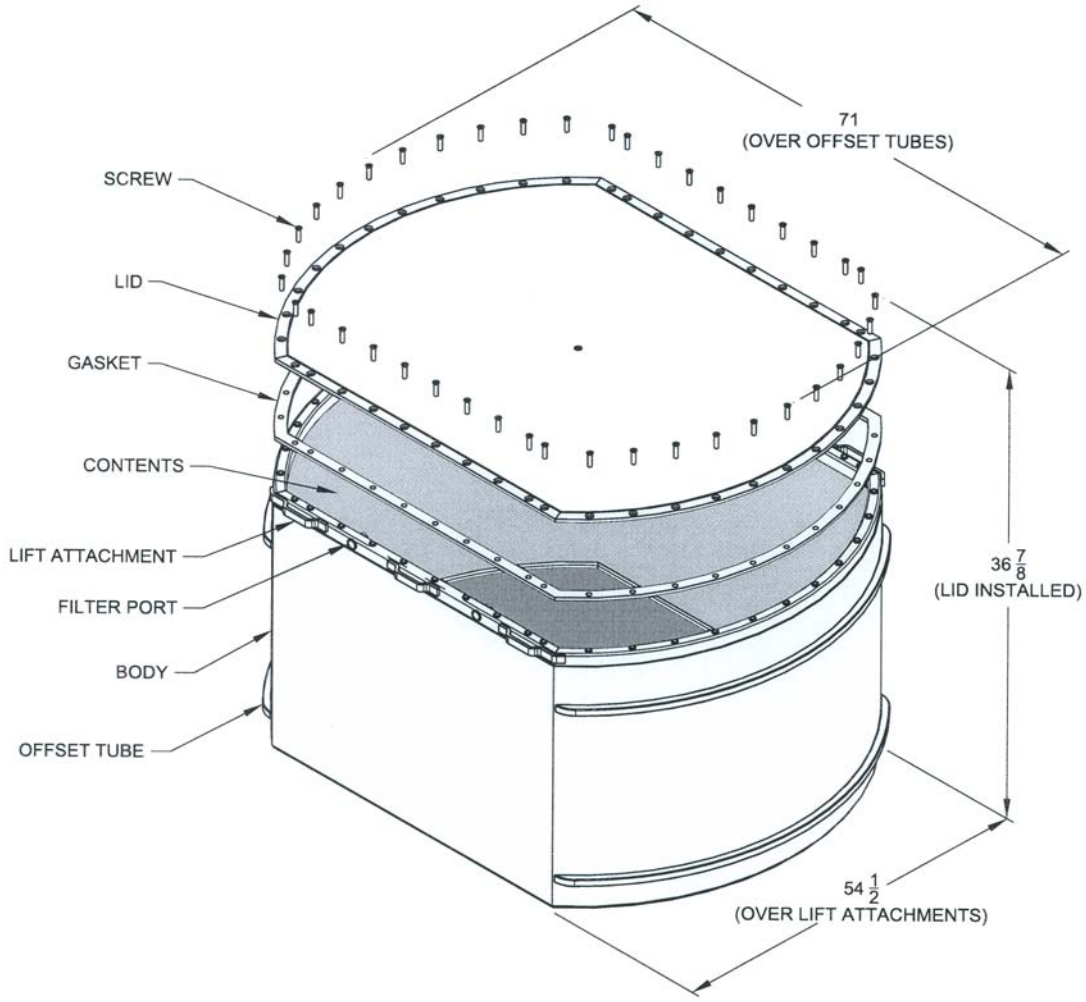
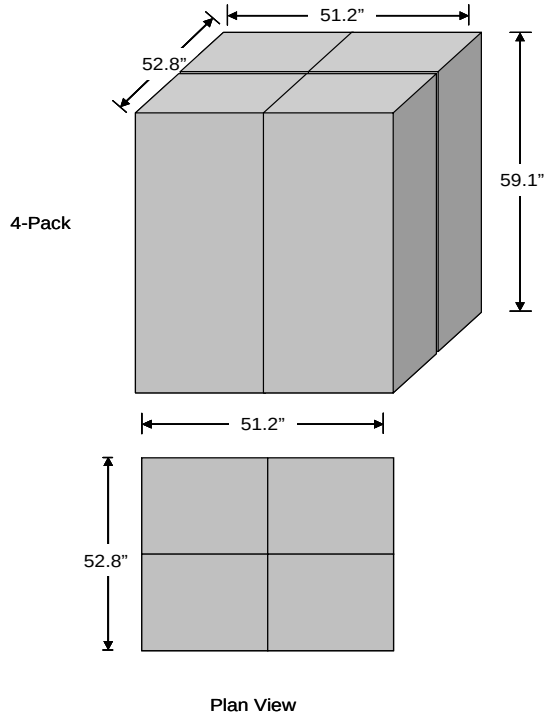


Figure 4.10. Conceptual Drawing of a Standard Waste Box (SWB) for Disposal in WIPP (U. S. DOE 1996b)

4.4.3 Sealed Sources Containing Cesium

As identified in Section 1.1, waste steams 2c and 2d consist of Cs sealed sources. It is assumed that these waste streams will be disposed in the Cs irradiator containing these sources. It is also assumed that the GTCC LLW and DOE GTCC-like Cs irradiators will be emplaced in WIPP in bundles of four as "four-packs" (SNL 2008) as shown in Figure 4.11. This assembly would have approximate outer dimensions of 53 by 52 inches and 60 inches high. A payload pallet will be necessary to facilitate emplacement similar to that used for four-packs of 85-gallon drum CH-TRU waste. Because Cs irradiators are very heavy (4,700 lbs each) (CIS-US 2006), they will not be placed on top of other waste assemblies. Furthermore, because of their small footprint (relative to seven-packs) it is assumed that other waste assemblies will not be placed on top of these four packs due to stability concerns. Therefore, the four-packs of Cs irradiators will be considered a waste "stack." Given this assumption, the 1,481 Cs irradiators would become 371 stacks of cesium irradiators (371 four-packs of cesium irradiators) emplaced in WIPP.



Cesium Irradiator Dimensions: 26.4" W x 25.6" L x 59.1" H
Unit weight: 4700 lbs {CIS-US, 2006}

Figure 4.11. Conceptual Drawing of a Four-Pack of Cesium Irradiators for Disposal in WIPP

4.5 TOTAL ROOM REQUIREMENTS FOR EMPLACEMENT OF GTCC LLW AND DOE GTCC-LIKE WASTE IN WIPP

Figure 4.12 shows an example emplacement scheme for GTCC LLW and DOE GTCC-like waste in WIPP. The smaller hexagonal groupings shown in Figure 4.12 represent seven-packs of 55-gallon drums. The larger hexagonal groupings shown in Figure 4.12 represent seven-packs of h-SAMCs. The square groupings represent four-packs of Cs irradiators.

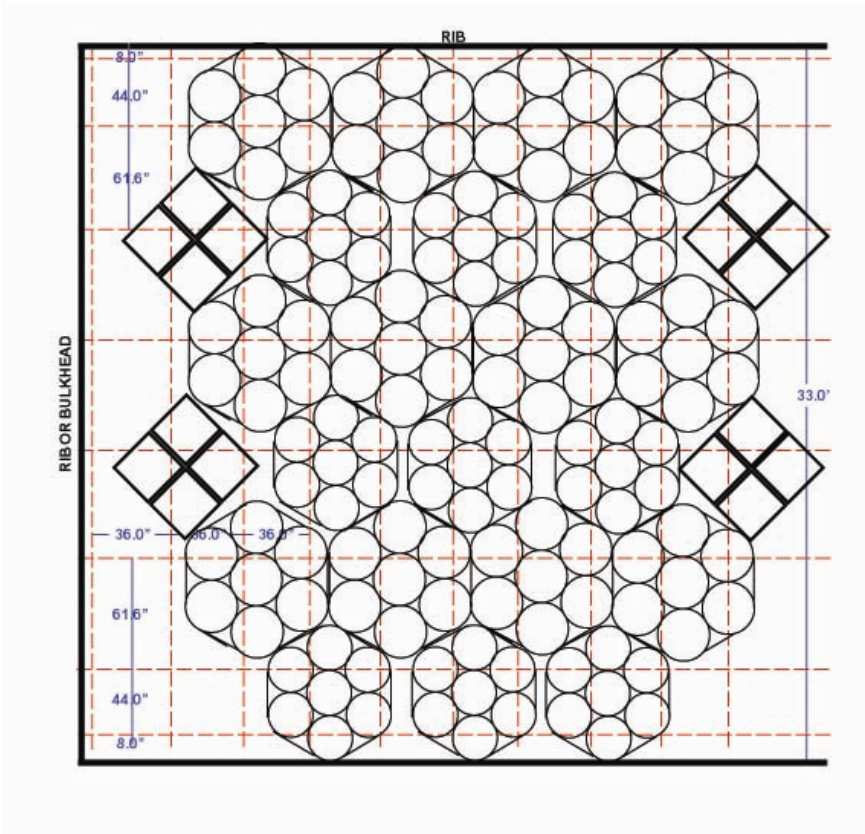


Figure 4.12. Example Emplacement Scheme For GTCC LLW and DOE GTCC-like Waste In WIPP

Table 4-3 shows the number of stacks required for each of the wastes discussed above. Since h-SAMCs are used for waste streams 1 and 3, and other contact handled GTCC LLW and DOE GTCC-like waste were placed in the WIPP rooms, 3,638 waste stacks would be required, or 8.6 WIPP rooms.

Table 4-3 below provides the waste stack and room requirements for each waste stream. The number of WIPP disposal rooms required for 55-gallon drum, irradiator or SWB waste streams is calculated by dividing the number of stacks by 546, which is the number of stacks per average WIPP room. However, h-SAMCs are 26.5%, larger than the largest WIPP disposal package, the TDOP, and therefore, the number of stacks per room for h-SAMC waste streams is 401 (i.e., 73.5% of 546). The number of WIPP disposal rooms required for h-SAMC waste streams is calculated by dividing the number of stacks per h-SAMC waste stream by 401 (the number of h-SAMC stacks per average WIPP room). Table 4-4 shows the number of trips required for the waste hoist because it is required in later sections of this document. The waste hoist, which is similar to a large elevator, transports waste from the surface storage building to the underground disposal rooms.

Table 4-3. Number of Stacks Required for Disposal of GTCC LLW and DOE GTCC-like Waste in WIPP

Waste Stream	Description	Number of Stacks[a]	WIPP Disposal Rooms Required[b]
1	GTCC LLW Activated Metal	1828	4.56[c]
2a	GTCC LLW Non-cesium Sealed Sources	150	0.28
2b	DOE GTCC-like Non-cesium Sealed Sources	1	0.0019
2c	GTCC LLW Cesium Sealed Sources	359	0.66
2d	DOE GTCC-like Cesium Sealed Sources	12	0.022
3	DOE GTCC-like Activated Metal	10	0.025[c]
4a	GTCC LLW CH Other Waste	10	0.0184
4b	DOE GTCC-like CH Other Waste-- excl West Valley	8	0.0147
4b	DOE GTCC-like CH Other Waste-- West Valley	166	0.31
4c	GTCC LLW RH Other Waste	25	0.063[c]
4d	DOE GTCC-like RH Other Waste	1070	2.67[c]
	Total	**3,638**	**8.6**

[a]The number of stacks are calculated in Sections 4.4.1 through 4.4.4; [b]There are 546 stacks per average WIPP disposal room (U. S. DOE 2002a), [c]For the h-SAMCs, there are 401 stacks per average WIPP disposal room.

Table 4-4. Number of Waste Hoist Trips for GTCC LLW and DOE GTCC-like Waste Streams

Waste Stream	Description	Number of Disposal Packages	Number per Waste Hoist Trip	Number of Trips
1[a]	GTCC LLW Activated Metal	1828	1	1828
2a	GTCC LLW Non-cesium Sealed Sources	448	4	112
2b	DOE GTCC-like Non-cesium Sealed Sources	1	4	1
2c	GTCC LLW Cesium Sealed Sources	359	2	180
2d	DOE GTCC-like Cesium Sealed Sources	12	2	6
3[a]	DOE GTCC-like Activated Metal	10	1	10
4a	GTCC LLW CH Other Waste	30	4	8
4b	DOE GTCC-like CH Other Waste-- excl West Valley	24	4	6
4b	DOE GTCC-like CH Other Waste-- West Valley	498	4	125
4c[a]	GTCC LLW RH Other Waste	25	1	25
4d[a]	DOE GTCC-like RH Other Waste	1070	1	1070

[a]Waste streams 1, 3, 4c and 4d will be disposed in the h-SAMC.

5. RESOURCE AND EQUIPMENT REQUIREMENTS

This section presents the resources and equipment needed to dispose GTCC LLW and DOE GTCC-like waste in the WIPP. As stated in Section 3, additional surface facilities will not be required to handle GTCC LLW and DOE GTCC-like waste, as existing equipment and facilities are assumed to be available and adequate. Therefore, resource and equipment needs identified in this section are limited to those necessary for construction of additional disposal rooms in the underground, and to that necessary for waste emplacement during operations.

5.1 CONSTRUCTION RESOURCES AND EQUIPMENT

All above-ground facilities are assumed to be adequate for the surface handling and waste package preparations necessary for GTCC LLW and DOE GTCC-like waste to be transferred underground. Therefore, the only additional construction necessary to accommodate GTCC LLW and DOE GTCC-like waste is the construction necessary to create disposal space in the WIPP underground. Likewise, because the equipment listed below supports the current WIPP mission, it is assumed to be available to support GTCC LLW activities. Therefore, this equipment will not require purchase. It is listed here to support energy and resource use calculations.

It is assumed that the current WIPP room/panel arrangement is continued, as described in Section 4. The exact location of these additional rooms is not identified, but it is assumed that the additional rooms needed will be mined adjacent to the existing repository workings.

Current mining techniques used at the WIPP will be used to create the necessary disposal room space for GTCC LLW and DOE GTCC-like waste. Principal equipment used for this activity includes:

- Continuous Miner (Electric) 720 hp
- Surface Haul Trucks (Diesel) 525 hp
- Underground Haul Trucks (Diesel) 185 hp
- Salt Hoist (Electric) 2200 hp
- Ventilation Fans (Electric) 600 hp

Principal resources for the construction of a waste panel include:

- Diesel
- Electricity
- Water
- Steel (roof bolts and steel wire mesh fabric)

5.1.1 Calculation of Resources and Equipment Required For Construction of Room Space for GTCC LLW and DOE GTCC-like Waste in WIPP

The process for construction of a disposal panel is as follows. The continuous miner is used to mine salt. Water is used as a mist for dust control during mining. Mined salt or "muck" is placed in the underground haul trucks and transported through haulage routes underground to the salt hoist, where the mined salt is dumped into the salt hoist or "skip." The salt hoist then raises the mined salt to the surface where it is then dumped into the awaiting surface haul truck. The surface haul truck then transports the salt to the salt storage area. This process continues until the desired room and panel configuration is completed. Once completed, the stability of the roof is checked, and roof support is added as appropriate. Roof support consists of steel bolts and wire mesh or fabric to stabilize the roof or "back." Typical roof support materials and configuration details are provided below.

5.1.1.1 Diesel Fuel Requirements

The allocated disposal room diesel fuel requirements presented here are derived from standard fuel consumption use factors for diesel operated machinery. Standard Specific Fuel Consumption (SFC) for diesel engines is assumed to be 0.4 lbs/hp-hr. Equipment horsepower (hp) ratings can be used together with equipment run times to determine specific fuel consumption and then converted to gallons (1 gallon of diesel fuel weighs approximately 7 lbs). The gallons of diesel can be calculated on a per room basis by using the equipment run times (SNL 2007b) required to excavate a room (23,700 tons of salt). Two 185 hp underground haul trucks take approximately 20 minutes to haul 7.3 tons of salt each to the hoist. To excavate a room the underground haul trucks must make 3,247 trips each requiring 541.1 hours of operation and a combined total of 11,440 gallons of diesel fuel per room. The 525 hp surface haul trucks take an estimated 8 minutes to haul 30 tons of salt from the hoist to the salt storage pile. To excavate a room the surface haul trucks must make 790 trips requiring 105.3 hours of operation and 3,160 gallons of diesel fuel per room. Total diesel fuel required per room for construction is 14,600 gallons. Table 5-1 shows the diesel fuel requirements to excavate WIPP disposal room space for the GTCC LLW and DOE GTCC-like waste streams.

5.1.1.2 Electric Power Requirements

The equipment used in mining a room requires electric power. This equipment includes: the continuous salt miner, the salt hoist, the ventilation fans. Electric power requirements for mining is determined by calculating the specific consumption of each piece of equipment used to excavate a room. The volume of a panel from is 4.61E+04 m^3 (DOE 2004a). The volume of an access drift is 2.29E+04 m^3 (from Table 4-1). The total volume of access drift and panel is 6.90E+04 m^3. The density of salt assumed in WIPP performance assessment is 2.18E+03 kg/m^3 (Hansen et al. 2003). Therefore, the mass of salt excavated from a panel and an access drift is 1.50E+08 kg. Assuming seven rooms in a panel, the mass of salt excavated per allocated disposal room in WIPP is 2.15E+07 kg. Therefore, the weight of the salt excavated from a room is 23,700 tons. Using the throughput capacity of the equipment,

run times and power use can be determined. Using the standard conversion of 1 hp per 0.7457 kW and the operation time, a kWh power requirement can be calculated and applied to excavate a WIPP disposal room space for the GTCC LLW and DOE GTCC-like waste streams. It is assumed that the 3 ventilation fans are ran continuously during excavation activities. The 720 hp continuous salt miner has a throughput of 220 tons per day. (SNL 2007b) To excavate a room, the salt miner would have to operate for 2,585 hours, requiring 1.39E+06 kWh. The 2,200 hp salt hoist has a throughput of 7.3 tons per trip and takes 4 minutes to complete a trip. To excavate a room, the salt hoist has to make 3,247 trips taking 216 hours of operation, requiring 3.55E+05 kWh. To excavate 104 boreholes takes 416 hours and 4.65e+04 kWh (SNL 2007b). Total power required per room for construction is 5.21E+06 kWh. These values are applied to the required room space for each of the GTCC LLW and DOE GTCC-like waste streams to obtain the electric power requirements shown in Table 5-1.

5.1.1.3 Water Requirements

Resources required for the operation of WIPP were provided directly from the site (Bostick 2007). Approximately 10,000 gallons of water is used per month for underground use at the site. Of this, 35% is used to water the transportation route and 65% is used for dust suppression during mining operations (SNL 2007b). The site also provided that it takes 1 year to excavate a panel. Based on these values, water requirements can be calculated on a per room basis. Using the following conversions:

- 3.785 liters/gallon and
- 12 months/year,

the water usage per allocated disposal room is 6.49E+04 liters/room. This value can be applied to the room requirements for GTCC LLW and DOE GTCC-like waste to determine the water required to excavate WIPP disposal room space for the GTCC LLW and DOE GTCC-like waste streams. The results are shown in Table 5-1.

5.1.1.4 Steel Requirements

The ceiling or “back” of the excavated panels are reinforced with steel through the use of woven steel fabric held in place by roof bolts. For the purposes of this section it is assumed that the entire back of the panel is covered with wire mesh fabric and held in place by roof bolts in an approximate five foot grid spacing arrangement (SNL 2007b). The volume of a single panel and an access drift from Table 4-1 is 4.61E+04 m^3 plus 2.29E+04 m^3 or 6.90E+04 m^3 and has a height of 4 m (U. S. DOE 1999a). Therefore the area of a panel and an access drift (and amount of steel fabric required to cover it) can be calculated as 17,300 m^2 (186,000 ft^2). Dividing by the five foot grid spacing (5 foot by 5 foot), approximately 7,440 roof bolts are required. The bolts used in construction are assumed to be made from standard steel that has a density of 0.284 lbs/$inch^3$. Therefore a single five foot long, 1 inch bolt would weigh 13.38 lbs, and the weight of the steel roof bolts required to reinforce a single panel can be calculated as 99,000 lbs.

The wire mesh fabric is very similar to "chain-link" fence fabric and is made of steel wire helically wound and interwoven in such a manner as to provide a continuous mesh without knots or ties except in the form of knuckling or twisting the ends of the wire to form the desired selvage of the fabric. Typical industrial/commercial grade steel fabric is a woven from 9 gauge zinc coated (galvanized) wire to form a 2 inch mesh size. The wire is designed to adhere to the American Society for Testing and Materials (ASTM) standard ASTM A 392 and typically has a 366 g/m^2 zinc coating (Class 1). Manufacturers estimate a three foot wide section of woven ASTM A 392 galvanized steel fabric weighs approximately 3.38 lbs/foot, therefore the approximate weight of the fabric is 1.13 lbs/ft^2. Therefore, the weight of the steel fabric required to reinforce a single panel can be calculated as 210,000 lbs. Making the total weight of steel used in the construction of a panel equal to 309,000 lbs, or 44,200 lbs (2.00E+04 kg) per allocated disposal room.

Table 5-1. Resources Required for Construction of WIPP Disposal Room Space GTCC LLW and DOE GTCC-like Waste

Waste Stream	Room Space Required	Diesel (liters)	Electricity (kWh)	Water (liters)	Steel (kg)
1	4.56	2.52E+05	2.37E+07	3.00E+05	9.12E+04
2a	0.28	1.55E+04	1.46E+06	1.84E+04	5.60E+03
2b	0.0019	1.05E+02	9.89E+03	1.25E+02	3.80E+01
2c	0.66	3.65E+04	3.43E+06	4.34E+04	1.32E+04
2d	0.022	1.22E+03	1.14E+05	1.45E+03	4.40E+02
3	0.025	1.38E+03	1.30E+05	1.64E+03	5.00E+02
4a	0.0184	1.02E+03	9.58E+04	1.21E+03	3.68E+02
4b	0.0147	8.12E+02	7.65E+04	9.67E+02	2.94E+02
4b	0.31	1.71E+04	1.61E+06	2.04E+04	6.20E+03
4c	0.063	3.48E+03	3.28E+05	4.15E+03	1.26E+03
4d	2.67	1.48E+05	1.39E+07	1.76E+05	5.34E+04

5.2 Operational Resources and Equipment

Operational resources include electrical power, diesel fuel, and water (SNL 2007b). The equipment listed below is currently in use at the WIPP, and will not be purchased for GTTC LLW and DOE GTCC-like waste. Equipment listed below is for the purposes of calculating energy consumption, as no costs are assumed to be allocated for equipment purchase. The equipment required for WIPP waste handling are:

- Waste Hoist (Electric) 600 hp
- 20-ton forklift (Diesel) 94 hp
- 41-ton forklift (Diesel) 231 hp
- Waste Transporter (Diesel) 138 hp
- Ventilation Fans (Electric) 600 hp

Principal resources for waste handling are:

- Diesel

- Water
- Electricity

5.2.1 Calculation of Resources and Equipment Required For Processing GTCC LLW and DOE GTCC-like Waste at WIPP

The operational requirements for resources for processing GTCC LLW and DOE GTCC-like waste at WIPP is assumed to be similar to current processing requirements for CH waste. The following sections describe the process for determining resource needs based on current WIPP operational equipment.

5.2.1.1 Diesel Fuel Requirements

The allocated per shipment diesel fuel requirements presented here are derived from standard fuel consumption use factors for diesel operated machinery. Standard SFC for diesel engines is assumed to be 0.4 lbs / hp-hr. Equipment horsepower (hp) ratings can be used together with equipment run times to determine specific fuel consumption and then converted to gallons (1 gallon of diesel fuel weighs approximately 7 pounds). The gallons of diesel can be calculated on a per shipment basis by using the equipment run times (provided by the site) required to emplace a disposal package. The 94 hp forklift takes an estimated 10 minutes to haul 1 disposal package from the hoist to the transporter requiring 0.9 gallons of diesel fuel. The 138 hp transporter takes an estimated 20 minutes to haul 1 disposal package from the forklift to the disposal room requiring 2.63 gallons of diesel fuel. The 231 hp RH forklift takes an estimated 1 hour to haul 1 disposal package from the hoist to the borehole requiring 13.2 gallons of diesel fuel. Table 5-4 shows the diesel fuel requirements to process the GTCC LLW and DOE GTCC-like waste streams.

5.2.1.2 Electric Power Requirements

The equipment used to emplace waste that have electric power requirements are: the waste hoist, the ventilation fans and the RH emplacement machine (for RH waste streams). Electric power requirements can be determined by calculating the specific equipment use to process a disposal package. The throughput capacity of the equipment (provided by the site) can be used to determine the run times. Using the standard conversion of 1 hp per 0.7457 kW and the operational time, a kWh power requirement can be calculated and applied to process a disposal package for the GTCC LLW and DOE GTCC-like waste streams. It is assumed that the 3 ventilation fans are ran continuously during excavation activities. It is assumed that the 600 hp waste hoist takes 10 minutes to complete a trip, requiring 7.46E+01 kWh. For RH waste streams, the 100 hp RH emplacement machine takes 20 minutes to emplace a single canister into a borehole, requiring 2.49E+01 kWh. These values are applied to waste hoist trips required for each of the GTCC LLW and DOE GTCC-like waste streams to obtain the electric power requirements shown in Table 5-1.

5.2.1.3 Water Requirements

Water use for calendar year 2006 was 3.98E+06 gallons (Bostick 2007). This value is reduced by the amount of water used during underground mining operations (6500 gallons/month) (see Section 5.1.1.3). This value has been assumed as a representative amount of water to be used during disposal operations for GTCC LLW and DOE GTCC-like waste.

Table 5-2. Estimate of Water Resources Required for WIPP Operation

Resource	Estimate (gallons/day)
Water	10,696

For the same calendar year (2006), the site provided that 4,659 disposal assemblies were emplaced in the WIPP. Using the following conversions:

- 365 days/year,

the water usage per waste hoist trip can be derived.

Table 5-3. Estimate of Water Resources Required Per Waste Hoist Trip

Resource	Estimate (gallons/waste hoist trip)
Water	8.38E+02

The values shown in Table 5-3 and the diesel and electricity values calculated above can be applied to the total number of waste hoist trips for GTCC LLW and DOE GTCC-like waste to determine the resource requirements associated with processing the GTCC LLW and DOE GTCC-like waste streams at WIPP. These results are shown in Table 5-4.

Table 5-4. Operational Resources Required for Disposal of GTCC LLW and DOE GTCC-like Waste at WIPP

Waste Stream	Description	Number of Trips of the Waist Hoist	Diesel fuel (liters)	Electricity kWh	Water (liters)
1	GTCC LLW Activated Metal	1828	2.44E+04	9.54E+05	5.80E+06
2a	GTCC LLW Non-cesium Sealed Sources	112	1.49E+03	5.85E+04	3.55E+05
2b	DOE GTCC-like Non-cesium Sealed Sources	1	1.33E+01	5.22E+02	3.17E+03
2c	GTCC LLW Cesium Sealed Sources	180	2.40E+03	9.40E+04	5.71E+05
2d	DOE GTCC-like Cesium Sealed Sources	6	8.00E+01	3.13E+03	1.90E+04
3	DOE GTCC-like Activated Metal	10	1.33E+02	5.22E+03	3.17E+04
4a	GTCC LLW CH Other Waste	8	1.07E+02	4.18E+03	2.54E+04
4b	DOE GTCC-like CH Other Waste-- excl West Valley	6	8.00E+01	3.13E+03	1.90E+04
4b	DOE GTCC-like CH Other Waste-- West Valley	125	1.67E+03	6.52E+04	3.96E+05
4c	GTCC LLW RH Other Waste	25	3.33E+02	1.30E+04	7.93E+04
4d	DOE GTCC-like RH Other Waste	1070	1.43E+04	5.59E+05	3.39E+06

6. FACILITY WASTES AND EMISSIONS

This section describes the wastes and emissions created through the construction of underground disposal rooms needed for GTCC LLW and DOE GTCC-like waste and by the activities necessary to handle, transport, and emplace these wastes underground for final disposal. In keeping with key assumptions associated with this data package, this section does not present any information related to pre-existing surface facilities, underground support facilities, or wastes and emissions from ancillary activities at the WIPP not directly related to the construction of waste disposal room(s) and disposal of GTCC LLW and DOE GTCC-like waste.

Construction of waste panels at the WIPP is done using conventional mining techniques, in what is called a “room-and-pillar” arrangement (See Figure 4.3). The underground waste panels and rooms are mined using an electric powered continuous miner, rather than by blasting. Mining creates dust, and water is used for dust control. The mined salt is transported underground using diesel powered haul trucks, where it is placed on the salt hoist and lifted to the surface. Once on the surface, the mined salt is transported to the salt storage pile using a diesel power haul truck.

Waste handling and emplacement activities are assumed to use the same techniques and equipment currently employed for both CH-TRU and RH-TRU waste emplacement at the WIPP.

6.1 CONSTRUCTION WASTES AND EMISSIONS

Wastes and emissions that would be produced during the construction of a room are calculated from the specific equipment used during excavation. Standard EPA emissions factors were applied to the equipment usage and diesel fuel requirements identified in Section 5 to determine the emissions during room construction.

Construction waste in the context of this analysis is primarily salt (or muck). There are no other wastes produced as a result of mining identified. Mined salt will be stored in the salt storage area (see Section 3.2.6). Even though water is used in the mining process, the water is used to settle dust, and no wastewater is produced.

Since construction in the context of this analysis is considered to be the mining of necessary disposal room space to accommodate the GTCC LLW and DOE GTCC-like waste, the emissions include: suspended particulates of combustion products and salt dust, CO, HC, and NO_x. These emissions are based on EPA emission factors for Tier 2 diesel engines (EPA 1998).

6.1.1 Calculation of Wastes Resulting From Construction of Room Space for GTCC LLW and DOE GTCC-like Waste in WIPP

To determine the mass of waste salt produced during excavation of disposal room space in WIPP for the GTCC LLW and DOE GTCC-like waste, an estimate of the salt removed per allocated disposal room is needed. The volume of a panel is 4.61E+04 m^3 (U. S. DOE 2004a). The volume of an access drift is 2.29E+04 m^3 (from Table 4-1). The total volume of access drift and panel is 6.90E+04 m^3. The density of salt assumed in WIPP performance assessment is 2.18E+03 kg/m^3 (Hansen et al. 2003). Therefore, the mass of salt excavated from a panel and an access drift is 1.50E+08 kg. Assuming seven rooms in a panel, the mass of salt excavated per allocated disposal room in WIPP is 2.15E+07 kg. This value can be applied to the room requirements for GTCC LLW and DOE GTCC-like waste to determine the salt waste associated with excavation of WIPP disposal room space for the GTCC LLW and DOE GTCC-like waste streams. The results are shown in Table 6-1.

Table 6-1. Construction Waste Production Associated with Disposal of GTCC LLW and DOE GTCC-like Waste at WIPP

Waste Stream	Description	Room Space Required	Salt Waste[a] (kg)
1	GTCC LLW Activated Metal	4.56	9.80E+07
2a	GTCC LLW Non-cesium Sealed Sources	0.28	6.02E+06
2b	DOE GTCC-like Non-cesium Sealed Sources	0.0019	4.09E+04
2c	GTCC LLW Cesium Sealed Sources	0.66	1.42E+07
2d	DOE GTCC-like Cesium Sealed Sources	0.022	4.73E+05
3	DOE GTCC-like Activated Metal	0.025	5.38E+05
4a	GTCC LLW CH Other Waste	0.0184	3.96E+05
4b	DOE GTCC-like CH Other Waste-- excl West Valley	0.0147	3.16E+05
4b	DOE GTCC-like CH Other Waste-- West Valley	0.31	6.67E+06
4c	GTCC LLW RH Other Waste	0.063	1.35E+06
4d	DOE GTCC-like RH Other Waste	2.67	5.74E+07

[a]Calculated by multiplying the room requirements per waste stream by 2.15E+07 kg salt/allocated disposal room

6.1.2 Calculation of Emissions Resulting From Construction of Room Space for GTCC LLW and DOE GTCC-like Waste in WIPP

A summary of the EPA standard emissions based on Tier 2 equipment hp ratings is given in EPA (U. S. EPA 1998). The grams per hp-hr factors can be applied to the equipment usage determined in Section 5 to calculate emissions produced as a result of GTCC LLW and DOE GTCC-like waste disposal at WIPP as described below. The values shown in Table 6-2 can be applied to the GTCC LLW and DOE GTCC-like waste streams by multiplying the fraction of a disposal room occupied by the waste stream. These results are shown in Table 6-3.

Table 6-2. EPA Standard Emissions Based on Tier 2 Equipment HP Ratings (EPA 1998).

HP (Tier 2)	CO (g/hp-hr)	HC (g/hp-hr)	NO_X (g/hp-hr)	PM (g/hp-hr)
>0 to 11	5.60	0.60	5.00	0.75
>11 to 16	2.00	0.60	5.00	0.60
>16 to 25	2.00	0.60	5.00	0.60
>25 to 50	2.50	0.60	5.00	0.60
>50 to 100	1.00	0.40	5.20	0.72
>100 to 175	1.00	0.40	4.50	0.40
>175 to 300	1.00	0.40	4.50	0.40
>300 to 600	1.00	0.30	4.50	0.40

6.2 OPERATIONS WASTES AND EMISSIONS

Waste from WIPP operations include: liquid waste (sewage) and solid waste (garbage). Most of the liquid waste produced at the plant is sanitary waste. During normal plant operation, the sources of sanitary waste are toilets, showers, sinks, and the cafeteria. Sanitary waste flows to a sewage lift station, from which it is pumped to the sewage-treatment plant.

Most of the solid waste produced by the plant is paper, rags, plastic materials, garbage from the cafeteria, wood scraps, sheet-metal scraps, tires, used batteries, and oily refuse. Metals and discarded equipment are recycled through a commercial salvage company. All other materials are collected and disposed of at a commercial sanitary landfill.

Since no chemical processing is performed at the plant, there are no appreciable chemical effluents. Residual chlorine levels from the treated sewage-plant effluent are insignificant. The small quantities of waste hydraulic fluids, lubricants, and the like that are produced during plant operation are buried in a commercial sanitary landfill or sent away for salvage. No biocidal waste is discharged since none is used. Emissions from WIPP operations include suspended particulates of combustion products and salt dust, CO, HC, and NO_X. Table 6-3 shows the construction emissions associated with disposal of GTCC LLW and DOE GTCC-like waste at WIPP.

Table 6-3. Construction Emissions Associated with Disposal of GTCC LLW and DOE GTCC-like Waste at WIPP

ID	Description	Room Space Required	CO (kg)	HC (kg)	NO_x (kg)	PM (kg)
1	GTCC LLW Activated Metal	4.56	7.09E+02	2.58E+02	3.19E+03	2.83E+02
2a	GTCC LLW Non-cesium Sealed Sources	0.28	4.35E+01	1.59E+01	1.96E+02	1.74E+01
2b	DOE GTCC-like Non-cesium Sealed Sources	0.0019	2.95E-01	1.08E-01	1.33E+00	1.18E-01
2c	GTCC LLW Cesium Sealed Sources	0.66	1.03E+02	3.74E+01	4.62E+02	4.10E+01
2d	DOE GTCC-like Cesium Sealed Sources	0.022	3.42E+00	1.25E+00	1.54E+01	1.37E+00
3	DOE GTCC-like Activated Metal	0.025	3.89E+00	1.42E+00	1.75E+01	1.55E+00
4a	GTCC LLW CH Other Waste	0.0184	2.86E+00	1.04E+00	1.29E+01	1.14E+00
4b	DOE GTCC-like CH Other Waste-- excl West Valley	0.0147	2.28E+00	8.32E-01	1.03E+01	9.14E-01
4b	DOE GTCC-like CH Other Waste-- West Valley	0.310	4.82E+01	1.76E+01	2.17E+02	1.93E+01
4c	GTCC LLW RH Other Waste	0.063	9.79E+00	3.57E+00	4.41E+01	3.92E+00
4d	DOE GTCC-like RH Other Waste	2.67	4.15E+02	1.51E+02	1.87E+03	1.66E+02

6.2.1 Calculation of Wastes Resulting From Processing of GTCC LLW and DOE GTCC-like Waste at WIPP

Wastes produced for calendar year 2006 (Bostick 2007) were assumed to be like the wastes produced as a result of GTCC LLW and DOE GTCC-like waste disposal at WIPP and are described below.

Table 6-4. Estimate of Wastes Produced From WIPP Operation

Resource	Estimate
Liquid Waste, gallons/year	2.35E+06
Solid (Sanitary) Waste, tons/year	273.7
Solid (Hazardous) Waste, tons/year	26.4
Sludge Waste, tons/year	75.8

For the same calendar year (2006), 4,659 disposal assemblies were emplaced in the WIPP (SNL 2007b). Using the following conversions:

- 901.2 kg/ton,

the waste produced per waste hoist trips can be derived.

Table 6-5. Estimate of Wastes Produced Per CH-TRU Waste Hoist Trips Processed at WIPP

Resource	Estimate
Liquid waste, gallons/waste hoist trip	503.64
Solid (Sanitary) waste, kg/waste hoist trip	53.3
Solid (Hazardous) waste, kg/waste hoist trip	5.14
Sludge waste, kg/waste hoist trip	14.8

The values shown in Table 6-5 can be applied to the total number of waste hoist trips for GTCC LLW and DOE GTCC-like waste to determine the liquid and solid waste production associated with processing the GTCC LLW and DOE GTCC-like waste streams at WIPP. These results are shown in Table 6-6.

Table 6-6. Operational Waste Production Associated with Disposal of GTCC LLW and DOE GTCC-like Waste at WIPP

Waste Stream	Description	Waste Hoist Trips	Liquid Waste (liters)	Solid (Sanitary) Waste (kg)	Solid (Hazardous) Waste (kg)	Sludge Waste (kg)
1	GTCC LLW Activated Metal	1828	3.49E+06	9.74E+04	9.40E+03	2.70E+04
2a	GTCC LLW Non-cesium Sealed Sources	112	2.14E+05	5.97E+03	5.76E+02	1.65E+03
2b	DOE GTCC-like Non-cesium Sealed Sources	1	1.91E+03	5.33E+01	5.14E+00	1.48E+01
2c	GTCC LLW Cesium Sealed Sources	180	3.43E+05	9.59E+03	9.25E+02	2.66E+03
2d	DOE GTCC-like Cesium Sealed Sources	6	1.14E+04	3.20E+02	3.08E+01	8.86E+01
3	DOE GTCC-like Activated Metal	10	1.91E+04	5.33E+02	5.14E+01	1.48E+02
4a	GTCC LLW CH Other Waste	8	1.53E+04	4.26E+02	4.11E+01	1.18E+02
4b	DOE GTCC-like CH Other Waste-- excl West Valley	6	1.14E+04	3.20E+02	3.08E+01	8.86E+01
4b	DOE GTCC-like CH Other Waste-- West Valley	125	2.38E+05	6.66E+03	6.43E+02	1.85E+03
4c	GTCC LLW RH Other Waste	25	4.77E+04	1.33E+03	1.29E+02	3.69E+02
4d	DOE GTCC-like RH Other Waste	1070	2.04E+06	5.70E+04	5.50E+03	1.58E+04

6.2.2 Calculation of Air Emissions Resulting From Processing of GTCC LLW and DOE GTCC-like Waste at WIPP

A summary of the EPA standard emissions based on Tier 2 equipment hp ratings is given in EPA (U. S. EPA 1998). The grams per hp-hr factors can be applied to the equipment usage determined in Section 5 to calculate emissions produced as a result of GTCC LLW and DOE GTCC-like waste disposal at WIPP as described below. The values shown in Table 6-2 can be applied to the GTCC LLW and DOE GTCC-like waste streams by multiplying the fraction of a disposal room occupied by the waste stream. These results are shown in Table 6-7. Based on site provided information, salt dust is not considered a hazardous emission, only a “nuisance dust” that is controlled through water application (SNL 2007b).

Table 6-7. Operational Emissions Production Associated with Processing of GTCC LLW and DOE GTCC-like Waste at WIPP

Waste Stream	Description	Waste Hoist Trips	CO (kg)	HC (kg)	NO_x (kg)	PM (kg)
1	GTCC LLW Activated Metal	1828	1.13E+02	4.51E+01	5.27E+02	5.43E+01
2a	GTCC LLW Non-cesium Sealed Sources	112	6.91E+00	2.76E+00	3.23E+01	3.32E+00
2b	DOE GTCC-like Non-cesium Sealed Sources	1	6.17E-02	2.47E-02	2.88E-01	2.97E-02
2c	GTCC LLW Cesium Sealed Sources	180	1.11E+01	4.44E+00	5.19E+01	5.34E+00
2d	DOE GTCC-like Cesium Sealed Sources	6	3.70E-01	1.48E-01	1.73E+00	1.78E-01
3	DOE GTCC-like Activated Metal	10	6.17E-01	2.47E-01	2.88E+00	2.97E-01
4a	GTCC LLW CH Other Waste	8	4.93E-01	1.97E-01	2.31E+00	2.37E-01
4b	DOE GTCC-like CH Other Waste-- excl West Valley	6	3.70E-01	1.48E-01	1.73E+00	1.78E-01
4b	DOE GTCC-like CH Other Waste-- West Valley	125	7.71E+00	3.08E+00	3.61E+01	3.71E+00
4c	GTCC LLW RH Other Waste	25	1.54E+00	6.17E-01	7.21E+00	7.42E-01
4d	DOE GTCC-like RH Other Waste	1070	6.60E+01	2.64E+01	3.09E+02	3.18E+01

7. COSTS, DURATIONS, AND PERSONNEL

In developing estimated costs associated with disposal of GTCC LLW and DOE GTCC-like waste in WIPP, it is assumed that no additional facilities or workers will be required to process the additional waste, and additional underground excavations will be necessary to accommodate the GTCC LLW and DOE GTCC-like waste volume. Thus, operations costs are derived from current WIPP processing costs, and construction costs are derived from mining costs.

7.1 CONSTRUCTION COSTS, DURATIONS, AND PERSONNEL

The cost of mining salt at WIPP is identified in a recent letter to Joel Parriott, Board of Physics and Astronomy (Nelson 2002). This document gives the cost of mining salt, and the cost of fortifying the roof before emplacement activities can begin.

7.1.1 Calculation of Costs From Construction of Room Space for GTCC LLW and DOE GTCC-like Waste in WIPP

A summary of the information regarding the cost of mining salt at WIPP is given in Table 7-1 (Nelson 2002). This information has been evaluated to obtain the construction costs that would be incurred as a result of GTCC LLW and DOE GTCC-like waste disposal at WIPP as described below.

Table 7-1. Estimate of Salt Mining Costs at WIPP[a]

Activity	Cost
Salt Mining and Removal, dollars/ton	20
Roof and Floor Support Structures, dollars/m^2	25

[a](Nelson 2002)

It is assumed that the costs associated with construction of room space for GTCC LLW and DOE GTCC-like waste at WIPP are limited to the cost of mining and roof structural supports. Furthermore, the costs shown in Table 7-1 account for the diesel, electricity and water needed in construction. The cost per kg of salt can be determined using Equation 7.1.

$$C_s = (C_s)/(U_c) + S_i /(HD_s) \qquad (7.1)$$

Where C_s is the cost of salt mining in dollars/kg, C_s is the cost of salt mining in dollars per ton, U_c is a standard unit conversion for mass (907.2 kg/ton), S_i is the cost of emplacing support structures per m^2, D_s is the density of salt (2.18E+03 kg/m^3 from Section 6.1.1), and H is the height of the cavity, 4 m (U. S. DOE 1999a). The result is a total cost of 2.49E -02 dollars per kg salt.

The mass of salt excavated from a panel and an access drift is 1.50E+08 kg (Section 6.1). Assuming seven rooms in a panel, the mass of salt excavated for an allocated disposal room in WIPP is 2.15E+07 kg which can be applied to the total mass for a room to get 5.35E+05 dollars per allocated disposal room, or 535K per room. This value can be applied to the room space required for each waste stream as shown in Table 7-2.

Table 7-2. Costs from Construction of Room Space for GTCC LLW and DOE GTCC-like Waste Streams in WIPP

Waste Stream	Description	Room Space Required	Room Construction Cost[a] (K, dollars)
1	GTCC LLW Activated Metal	4.56	2,440
2a	GTCC LLW Non-cesium Sealed Sources	0.28	150
2b	DOE GTCC-like Non-cesium Sealed Sources	0.0019	1
2c	GTCC LLW Cesium Sealed Sources	0.66	353
2d	DOE GTCC-like Cesium Sealed Sources	0.022	12
3	DOE GTCC-like Activated Metal	0.025	13
4a	GTCC LLW CH Other Waste	0.0184	10
4b	DOE GTCC-like CH Other Waste-- excl West Valley	0.0147	8
4b	DOE GTCC-like CH Other Waste-- West Valley	0.31	166
4c	GTCC LLW RH Other Waste	0.063	34
4d	DOE GTCC-like RH Other Waste	2.67	1,430

[a]Calculated by multiplying 535K dollars/allocated disposal room by the room requirements for each waste stream.

7.1.2 Calculation of Duration Associated with Construction of Room Space for GTCC LLW and DOE GTCC-like Waste in WIPP

The time required to construct a panel is 12 months (SNL 2007b). Assuming 365 days per year, and seven rooms in a panel, the duration of room excavation is 52.1 days (1.7 months). This value can be applied to the room space required for each waste stream as shown in Table 7-3.

7.1.3 Calculation of Man-Hours Associated with Construction of Room Space for GTCC LLW and DOE GTCC-like Waste in WIPP

Section 7.1.1 indicates that construction coats are 535K dollars per allocated disposal room. Assuming seven rooms per panel, the panel cost would be 3,745K. Since room construction is an ongoing operation at WIPP at all times, the cost associated with room construction are part of the WIPP average annual budget, which is $218 million per year (calculated in Section 7.2 of this document). Expenditures over a 12-month period (the time required to construct a panel) would be 218 M. Thus, panel construction cost is 1.72 percent of the WIPP annual budget.

The WIPP annual budget accounts for 1,095 full-time employees. This includes: managers, administrators, secretaries, clerks, administrative professionals, engineers, scientists, technicians, craftsmen, laborers, general workers, and operators (U. S. DOE 1998). Assuming that 1.72 percent of these employees are involved in ongoing mining operations, 19 full-time employees would be utilized. Assuming 2000 hours per year and 1 year to mine a panel, a total of 38,000 man hours is required to mine a panel, or 5,428 man hours to mine an allocated disposal room. This value can be applied to the room space required for each waste stream as shown in Table 7-3.

Table 7-3. Duration and Man-hours Associated with Construction of Room Space for GTCC LLW and DOE GTCC-like Waste Streams in WIPP

Waste Stream	Description	Room Space Required	Duration[a] (hours)	Room Construction[b] (Man-hours)
1	GTCC LLW Activated Metal	4.56	5,702	24,800
2a	GTCC LLW Non-cesium Sealed Sources	0.28	350	1,520
2b	DOE GTCC-like Non-cesium Sealed Sources	0.0019	2	10
2c	GTCC LLW Cesium Sealed Sources	0.66	825	3,580
2d	DOE GTCC-like Cesium Sealed Sources	0.022	28	119
3	DOE GTCC-like Activated Metal	0.025	31	136
4a	GTCC LLW CH Other Waste	0.0184	23	100
4b	DOE GTCC-like CH Other Waste-- excl West Valley	0.0147	18	80
4b	DOE GTCC-like CH Other Waste-- West Valley	0.31	388	1,680
4c	GTCC LLW RH Other Waste	0.063	79	342
4d	DOE GTCC-like RH Other Waste	2.67	3,339	14,500

[a]Calculated by multiplying 52.1 days to excavate a room by 24 hours/day by the required room space for each waste stream; [b]Calculated by multiplying 5,428 man hours/allocated disposal room by the required room space for each waste stream.

7.2 OPERATIONS COSTS, DURATIONS, AND PERSONNEL

In this section, the operations costs, durations and personnel involved in processing the GTCC LLW and DOE GTCC-like waste streams at WIPP are given.

7.2.1 Calculation of Operations Costs Associated with Processing GTCC LLW and DOE GTCC-like Waste in WIPP

The WIPP site operations estimated costs for FY 2002 through 2008 are shown in Table 7-4 (U. S. DOE 2002a). This budget provided in the *Integrated Planning, Accounting, Budgeting System* (IPABS) is based on detailed planning by the DOE. The budget is broken down into costs for transportation, disposal, and remaining mission critical activities. Based on this budget information for FY 2002 through 2008, an average annual operation cost of $218 million per year was calculated (does not include costs associated with transportation).

Table 7-4. WIPP Operations Costs[a,b]

Carlsbad Operations	2002 (M)	2003 (M)	2004 (M)	2005 (M)	2006 (M)	2007 (M)	2008 (M)	Average Annual Cost (M)
Transportation	$68	$70	$56	$56	$56	$56	$56	$60
Disposal	$54	$55	$60	$47	$51	$49	$53	$53
Remaining Mission-Critical	$107	$111	$102	$101	$103	$106	$109	$106
Total	$229	$236	$218	$204	$210	$211	$219	$218

[a]From the *TRU Waste Management Plan*, Revision 3 (U. S. DOE 2002a); [b]All costs in millions of 2002 dollars and are not adjusted to 2006.

Assuming WIPP receives 17 shipments per week (U. S. DOE 2002a) or 850 shipments per year (17 shipments per week for 50 weeks), the average annual cost per shipment is $187K per shipment, as shown in Table 7-5. Average cost per shipment for disposal is $62K and remaining mission-critical activities is $125K.

Table 7-5. Average Operations Cost per WIPP CH-TRU Shipment[a]

Operations Activities	Average Processing Cost per Shipment[b] (K)
Disposal	$62
Remaining Mission-Critical	$125
Total	**$187**

[a]Based on data from the *TRU Waste Management Plan*, Revision 3 (U. S. DOE 2002a); [b]Assuming 17 shipments/week (U. S. DOE 2002a) for 50 weeks/year.

The processing cost for the GTCC LLW and DOE GTCC-like waste streams can be estimated by multiplying the average processing cost per shipment ($187,000) by the number of estimated shipments for each waste stream from (SNL 2008). Table 7-6 below lists the number of shipments, disposal cost, remaining mission critical costs, and the total processing cost for each GTCC LLW and DOE GTCC-like waste streams.

The number of shipments required for the GTCC LLW and DOE GTCC-like waste streams shown in Tables 7-6, 7-7, and 7-12 are based on SNL (2008) and makes the following assumptions: one h-SAMC will be transported per shipment; each TRUPACT-II container will contain two 7-packs of 55-gallon drums and three TRUPACT-II containers will be transported in each truck (forty-two 55-gallon drums per shipment); two Cs Irradiators will be transported per shipment; and the 86 shipments required for waste stream 4d represents 38 shipments stored and 48 shipments projected (SNL 2008).

Table 7-6. Operational Costs Associated with Processing GTCC LLW and DOE GTCC-like Waste Streams at WIPP

Waste Stream	Description	Total Shipments[a]	Disposal Cost[b] (M)	Remaining Mission Critical Cost[c] (M)	Total Cost[d] (M)
1	GTCC LLW Activated Metal	12,796	793	1,600	2,390
2a	GTCC LLW Non-cesium Sealed Sources	77	4.77	9.63	14.4
2b	DOE GTCC-like Non-cesium Sealed Sources	4	0.25	0.50	0.75
2c	GTCC LLW Cesium Sealed Sources	240	14.9	30.0	44.9
2d	DOE GTCC-like Cesium Sealed Sources	17	1.05	2.13	3.18
3	DOE GTCC-like Activated Metal	68	4.2	8.5	12.7
4a	GTCC LLW CH Other Waste	6	0.37	0.75	1.12
4b	DOE GTCC-like CH Other Waste-- excl West Valley	5	0.31	0.63	0.94
4b	DOE GTCC-like CH Other Waste-- West Valley	86	5.33	10.8	16.1
4c	GTCC LLW RH Other Waste	173	10.7	21.6	32.4
4d	DOE GTCC-like RH Other Waste	7,486	464	936	1,400

[a]Shipment data from (SNL 2008); [b]Calculated by multiplying 62K dollars/shipment processed by the number of shipments for each waste stream; [c]Calculated by multiplying 125K dollars/shipment processed by the number of shipments for each waste stream; [d]Calculated by multiplying 187K dollars/shipment processed by the number of shipments for each waste stream.

7.2.2 Calculation of Durations Associated with Processing GTCC LLW and DOE GTCC-like Waste in WIPP

On average, WIPP operations processes 17 shipments/week. Two eight-hour shifts are operated each day so there is a total of 112 hours in a week. Therefore, it requires 6.59 hours to process a shipment at WIPP. The hours required to process GTCC LLW and DOE GTCC-like waste shipments are shown in Table 7-7.

Table 7-7. Operational Durations Associated with Processing GTCC LLW and DOE GTCC-like Waste Streams at WIPP

Waste Stream	Description	Total Shipments[a]	Duration (hours)[b]
1	GTCC LLW Activated Metal	12,796	84,300
2a	GTCC LLW Non-cesium Sealed Sources	77	507
2b	DOE GTCC-like Non-cesium Sealed Sources	4	26
2c	GTCC LLW Cesium Sealed Sources	240	1,580
2d	DOE GTCC-like Cesium Sealed Sources	17	112
3	DOE GTCC-like Activated Metal	68	448
4a	GTCC LLW CH Other Waste	6	40
4b	DOE GTCC-like CH Other Waste-- excl West Valley	5	33
4b	DOE GTCC-like CH Other Waste-- West Valley	86	567
4c	GTCC LLW RH Other Waste	173	1,140
4d	DOE GTCC-like RH Other Waste	7,486	49,300

[a] Shipment data from (SNL 2008); [b]Calculated by multiplying 6.59 hours/shipment processed by the number of shipments.

7.2.3 Calculation of Number of Employees Associated with Processing GTCC LLW and DOE GTCC-like Waste in WIPP

The total number of Full-Time Equivalent (FTE) employees reported in the 1996 *Baseline Environmental Management Report* (BEMR) for WIPP (U. S. DOE 1996a) is shown in Table 7-8.

Table 7-8. Full-Time Equivalent Composition Table

Labor Category	Total FTE[a]		
	1996	1997	1998
General Managers, Exec	91	86	84
Gen Admin Sec and Clerical	78	75	72
Admin and other professionals	219	226	225
Engineers	294	296	300
Scientists	124	118	111
Technicians	149	153	139
Crafts	51	55	62
Laborers and Other Gen Workers	3	2	2
Operators	48	74	100
Total	**1,057**	**1,085**	**1,095**

[a] Projections are based on FY 1996 planning baselines.

The SEIS-II (U. S. DOE 1997a) also reported a similar number to that of the 1996 BEMR. The WIPP SEIS-II (U. S. DOE 1997a) reported that the DOE would remain a stable federal

employer, providing direct employment of 1,095 project personnel annually, based on an average budget of $180 million.

For this assessment it is assumed that the DOE remains a stable federal employer, providing direct employment of 1,095 project personnel annually for the operating life of the WIPP facility. Thus, the staffing requirements will not change as a result of bringing GTCC LLW and DOE GTCC-like waste to WIPP.

Staffing requirements for CH waste handling operations (surface and underground) are provided in the *WIPP Contact Handled (CH) Technical Safety Requirements* (U. S. DOE 2005a). A summary of those requirements is given in Table 7-9. The staffing requirements are broken into four process areas for waste handling: General CH Waste Handling Operations, CH Bay Operations, Surface Operations, and Underground Operations. Some of the staff may be available to serve in more than one area during operations, but for the purposes of this evaluation it is assumed that staff will only serve in one of the four process areas. It is also assumed that CH processing is available at all three dock positions in the CH Bay, and one transporter/forklift is in operation during underground operations. The labor category listed in Table 7-9 corresponds to the labor category given in Table 7-8. The total by labor category is given in Table 7-10.

Table 7-9. Staffing Requirements for CH Waste Handling Operations[a]

Title	Labor Category	FTE
CH Waste Handling Operations		
Facilities Shift Manager General	General Managers, Exec	1
Central Monitoring Room Operator	Operators	1
Surface Roving Watch	Technicians	1
CH Waste Handling Engineer	Engineers	1
CH Bay Operations		
Radiological Control Technician	Technicians	3
Radiological Control Air Monitoring Technician Rover	Technicians	2
Waste Handling Technician (crane operator)	Technicians	3
Waste Handling Technician (direct off-loading of waste)	Technicians	3
Waste Handling Technician (fork lift driver and a spotter)	Technicians	2
Surface Operations		
Waste Handling Technician (fork lift driver and a spotter)	Technicians	2
Underground Operations		
Radiological Control Technician	Technicians	1
Waste Handling Technician (fork lift driver and a spotter)	Technicians	2
UG Facility Operations Engineer	Engineers	1
Underground Roving Watch	Technicians	1
Hoisting Operator (Operator, Top and Bottom Lander)	Operators	3

[a]from *WIPP Contact Handled (CH) Technical Safety Requirements* (U. S. DOE 2005a).

Table 7-10. Staffing Requirements for CH Waste Handling Operations by Labor Category[a]

Labor Category	FTE
General Managers, Exec	1
Engineers	2
Technicians	20
Operators	4
Total	27

[a]Summarized from Table 7-9.

Assuming WIPP receives 17 shipments (U. S. DOE 2002a) per week or 850 shipments per year (17 shipments per week for 50 weeks), the personnel employed at WIPP on a per shipment processed basis is shown in Table 7-11.

Table 7-11. Personnel Employed at WIPP on a per Shipment Processed Basis

Labor Category	Total FTE	FTE per WIPP CH-TRU Shipment Processed
General Managers, Exec	1	1.18E-03
Engineers	2	2.35E-03
Technicians	20	2.35E-02
Operators	4	4.71E-03
Total	27	3.18E-02

The values in Table 7-11 can be applied to the shipments of GTCC LLW and DOE GTCC-like waste as shown in Table 7-12.

Table 7-12. Personnel Associated with Processing GTCC LLW and DOE GTCC-like Waste Streams at WIPP

Waste Stream	Description	Number of Shipments Processed[a]	General Managers, Exec (FTE)[b]	Engineers (FTE)[c]	Technician (FTE)[d]	Operators (FTE)[e]	Total (FTE)[f]
1	GTCC LLW Activated Metal	12,796	15.1	30.1	301	60.3	407
2a	GTCC LLW Non-cesium Sealed Sources	77	0.09	0.18	1.81	0.36	2.45
2b	DOE GTCC-like Non-cesium Sealed Sources	4	0.00	0.01	0.09	0.02	0.13
2c	GTCC LLW Cesium Sealed Sources	240	0.28	0.56	5.64	1.13	7.63
2d	DOE GTCC-like Cesium Sealed Sources	17	0.02	0.04	0.40	0.08	0.54
3	DOE GTCC-like Activated Metal	68	0.08	0.16	1.60	0.32	2.16
4a	GTCC LLW CH Other Waste	6	0.01	0.01	0.14	0.03	0.19
4b	DOE GTCC-like CH Other Waste--excl West Valley	5	0.01	0.01	0.12	0.02	0.16
4b	DOE GTCC-like CH Other Waste--West Valley	86	0.10	0.20	2.02	0.41	2.73
4c	GTCC LLW RH Other Waste	173	0.20	0.41	4.07	0.81	5.50
4d	DOE GTCC-like RH Other Waste	7,486	8.83	17.6	176	35.3	238

[a]The number of shipments is based on information from (SNL 2008); [b]Calculated by multiplying 1.18E-03 FTE/shipment processed by the number of shipments; [c]Calculated by multiplying 2.35E-03 FTE/shipment processed by the number of shipments; [d]Calculated by multiplying 2.35E-02 FTE/shipment processed by the number of shipments; [e]Calculated by multiplying 4.71E-03 FTE/shipment processed by the number of shipments; [f]Calculated by multiplying 3.18E-02 FTE/shipment processed by the number of shipments.

8. TRANSPORTATION

This section provides data to be used in analyzing the risks of transporting GTCC LLW from its current location to the WIPP. Inventories per shipment of GTCC LLW are based on information provided in (SNL 2008). All CH waste transportation to the WIPP is assumed to be in TRUPACT-II containers or the equivalent; there are up to three TRUPACT-II containers per truck. For shipments of the h-SAMC to WIPP, the CNS 3-55 will be used. The Type B packages used for each type of GTCC LLW material are listed in the (SNL 2008). The destination for all of these shipments is WIPP.

Table 8-1 provides the number of projected shipments of GTCC LLW and DOE GTCC-like waste from various locations and entities that would arrive at WIPP. The shipments are partitioned based on waste stream and in the cases of waste streams 1 and 3 by package type. All data are from (SNL 2008).

Table 8-1. Summary of GTCC LLW and DOE GTCC-like Waste Shipments to WIPP[a]

Waste Stream	ID	Description	Package Type	Number of Shipments[b]
1[a]	Com	GTCC LLW Activated Metal	h-SAMC	12,796
2a	Com	GTCC LLW Non-cesium Sealed Sources	55-gallon drum	77
2b	DOE	DOE GTCC-like Non-cesium Sealed Sources	55-gallon drum	4
2c	Com	GTCC LLW Cesium Sealed Sources	Irradiator [c]	240
2d	DOE	DOE GTCC-like Cesium Sealed Sources	Irradiator [c]	17
3[a]	DOE	DOE GTCC-like Activated Metal	h-SAMC	68
4a	Com	GTCC LLW CH Other Waste	55-gallon drum	6
4b	DOE	DOE GTCC-like CH Other Waste-- excl West Valley	55-gallon drum	5
4b	DOE	DOE GTCC-like CH Other Waste-- West Valley	SWB	86
4c	Com	GTCC LLW RH Other Waste	h-SAMC	173
4d	DOE	DOE GTCC-like RH Other Waste	h-SAMC	7,486

[a]SAMC and AMC packages are not suitable for WIPP disposal and were excluded this analysis; [b]The number of shipments is based on information from (SNL 2008).

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