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U.S. Department of Energy

Department of Energy
Carlsbad Field Office

Environmental Assessment for Conducting Astrophysics and Other Basic Science Experiments at the WIPP Site

Final

January 2001

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
AMANDA	Antarctic Muon and Neutrino Detector Array
ANSI	American National Standards Institute
AQCR	Air Quality Control Regulations
ARF	airborne release fraction
BLM	Bureau of Land Management
CEQ	Council on Environmental Quality
CBFO	DOE Carlsbad Field Office
CFR	Code of Federal Regulations
CH-TRU	contact-handled transuranic
DOE	U.S. Department of Energy
DOE-EM	DOE's Office of Environmental Management
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
EXO	Enriched Xenon-136 Observatory
FEIS	*Final Environmental Impact Statement for the Waste Isolation Pilot Plant*
FY	fiscal year
GENIUS	Germanium in Liquid Nitrogen Underground System
HEPA	high-efficiency particulate air
IDLH	immediately dangerous to life and health
INPAC	Institute for Nuclear and Particle Astrophysics and Cosmology
LANL	Los Alamos National Laboratory
MACHO	MAssive Compact Halo Object
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
OMNIS	Observatory for Multi-flavor Neutrino Interactions from Supernovae
OSHA	Occupational Safety and Health Administration
PM_{10}	particulate matter less than 10 microns
PNNL	Pacific Northwest National Laboratory
RH-TRU	remote-handled transuranic
ROD	record of decision
ROI	region of influence
SEIS-I	*Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant*
SEIS-II	*Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*
TEEL	Temporary Emergency Exposure Level
TRU	transuranic
UNO	Ultimate underground Nucleon decay and neutrino Observatory
VOC	volatile organic compound
WIMP	Weakly Interactive Massive Particle
WIPP	Waste Isolation Pilot Plant
wt%	weight percent

CHAPTER 1

INTRODUCTION AND STATEMENT OF PURPOSE AND NEED

This chapter presents a short discussion of the history and mission of the Waste Isolation Pilot Plant (WIPP) and the purpose and need for the activities proposed by the U.S. Department of Energy (DOE or the Department).

1.1 HISTORY AND BACKGROUND

DOE currently operates WIPP near Carlsbad, New Mexico, as a disposal site for transuranic (TRU) waste generated as part of the nuclear defense research and production activities of the federal government. TRU waste is contaminated with alpha-emitting radionuclides that are heavier than uranium (that is, their atomic numbers are greater than that of uranium) and that have half-lives longer than 20 years at concentrations greater than 100 nanocuries (13,700 becquerels) per gram of waste. Key radionuclides found in TRU waste include americium-241 and several isotopes of plutonium (plutonium-238, plutonium-239, plutonium-240, and plutonium-241). Throughout the DOE complex, several types of operations (past, current, or future) have generated or will generate TRU waste: (1) nuclear weapons development and manufacturing, (2) plutonium recovery, stabilization, and management, (3) research and development, (4) environmental restoration, and decontamination and decommissioning, (5) waste management, and (6) testing at facilities that are under DOE contract. DOE is responsible for the management and ultimate disposition of TRU waste generated at DOE sites and, as directed by Congress, has constructed WIPP for the purpose of disposing of TRU waste resulting from defense activities. Overall, the WIPP facility is managed by DOE's Office of Environmental Management (DOE-EM), which has the principal mission of cleaning up environmental sites at DOE facilities and disposing of radioactive waste.

TRANSURANIC WASTE

TRU waste is defined as "waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (A) high-level radioactive waste; (B) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of Title 10, Code of Federal Regulations" (WIPP Land Withdrawal Act, Public Law 102-579).

TRU elements, each having several isotopes, are radioactive and typically man-made. The half-lives of many are considerably longer than 20 years. For instance, the half-life of one isotope of plutonium is 24,000 years.

TRU waste is further classified as contact-handled (CH)-TRU waste or remote-handled (RH)-TRU waste. CH-TRU waste has radioactivity levels that are low enough to permit workers to directly handle the containers in which the waste is kept. This level of radioactivity is specified as a dose rate of no more than 200 millirems per hour (mrem/hr) at the outside surface of the container. RH-TRU waste has a surface dose rate greater than 200 mrem/hr, so workers use remote manipulators to handle containers of RH-TRU waste. TRU mixed waste is CH-TRU or RH-TRU waste that also contains hazardous materials, such as lead or organic solvents regulated by the Resource Conservation and Recovery Act (RCRA).

WIPP is located in Eddy County in southeastern New Mexico (Figure 1-1). It is about 50 kilometers (30 miles) east of Carlsbad, New Mexico, in an area known as Los Medaños ("the dunes"), a relatively flat, sparsely inhabited plateau with little surface water. The land in the region is mainly used for grazing; other uses include potash mining and oil and gas exploration and development. The central area within the WIPP site boundary is used exclusively by DOE to dispose of TRU waste; however, other areas are managed for various uses (for example, wildlife, cultural resource, and vegetation management).

The major construction activities at WIPP have been completed. Surface facilities have been constructed, including the Waste Handling Building where TRU waste is received, inspected, and moved to the waste handling shaft for transfer underground. The constructed underground facilities include four shafts, an experimental area, an equipment and maintenance area, and connecting tunnels (Figure 1-2). These underground facilities were excavated in the Salado Formation, 655 meters (2,150 feet) beneath the land surface (Figure 1-3). DOE also has excavated the first panel, which consists of seven disposal rooms. This panel currently is receiving waste. A second panel has also been constructed and stands ready for waste emplacement.

DOE now is proposing to expand the availability of WIPP facilities and infrastructure to scientists who wish to conduct experiments there, to the extent such experiments can be conducted without interfering with WIPP's primary TRU waste disposal mission and to the extent that they reflect contemporary budget priorities. The deep geologic repository at WIPP could provide a suitable environment for experiments in many scientific disciplines, including particle astrophysics, waste repository science, mining technology, low radiation dose physics, fissile materials accountability and transparency, and deep geophysics. Currently, one experiment in astrophysics that has been conducted for several years by Los Alamos National Laboratory (LANL) is located in WIPP. Six other teams of scientists already have proposed astrophysics experiments to DOE and are seeking funding from the scientific community for those experiments.

Scientists see the WIPP site as having two principal advantages over other facilities throughout the world. First, because WIPP is owned by the U.S. government and its purpose is not to sell resources extracted during excavation, access to WIPP is not likely to be affected by economic demand for the extracted resources as it would in a commercial mining environment. Many such sites are in working, privately owned mines that do not offer the same level of stability, particularly for experiments that may take two decades or more to reach conclusions. Second, because the WIPP site is in the United States, use of the WIPP site would reduce travel and living expense costs for U.S. scientists, many of whom have been traveling to Japan or Italy to conduct their experiments. Allowing the use of the WIPP facilities for these experiments would further the mission of the national scientific community and the DOE Office of Science, and ultimately benefit taxpayers by decreasing the total costs of experimental programs funded by the government.

Of particular interest to the current astrophysics and basic science proposals is an area of WIPP once planned for underground experiments. This area was among the first excavated at the WIPP site. Excavations in the area, now known as the North Experimental Area (Figure 1-4), are as long as 1,384 meters (4,540 feet). They are connected to the disposal area by a series of tunnels, each 10 meters (33 feet) wide and 6 meters (20 feet) high. These tunnels, in turn, are crossed by rooms of about the same size as the tunnels every 100 meters (330 feet). The North Experimental Area is largely unused. It is not a part of the disposal area, and there are no plans to use it for disposal. At present, some of the North Experimental Area is used to store salt being excavated for the second disposal panel until it can be removed from the underground facility. One hallway and two rooms crossing that hallway have been identified as a potential location for astrophysics and basic science experiments. For the purposes of this environmental assessment (EA), that area will be called the experiment gallery (Figure 1-5).

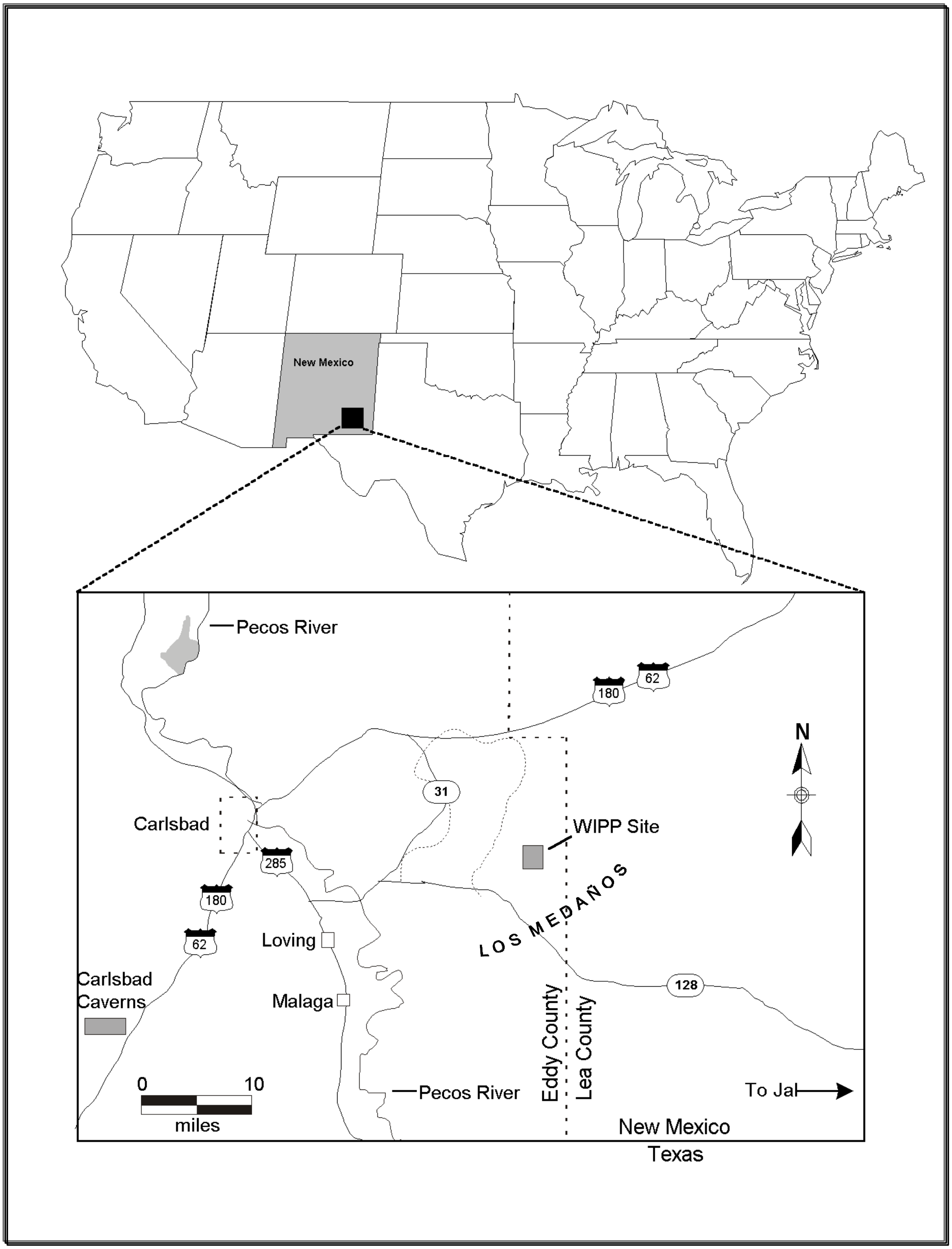


Figure 1-1. Location of WIPP

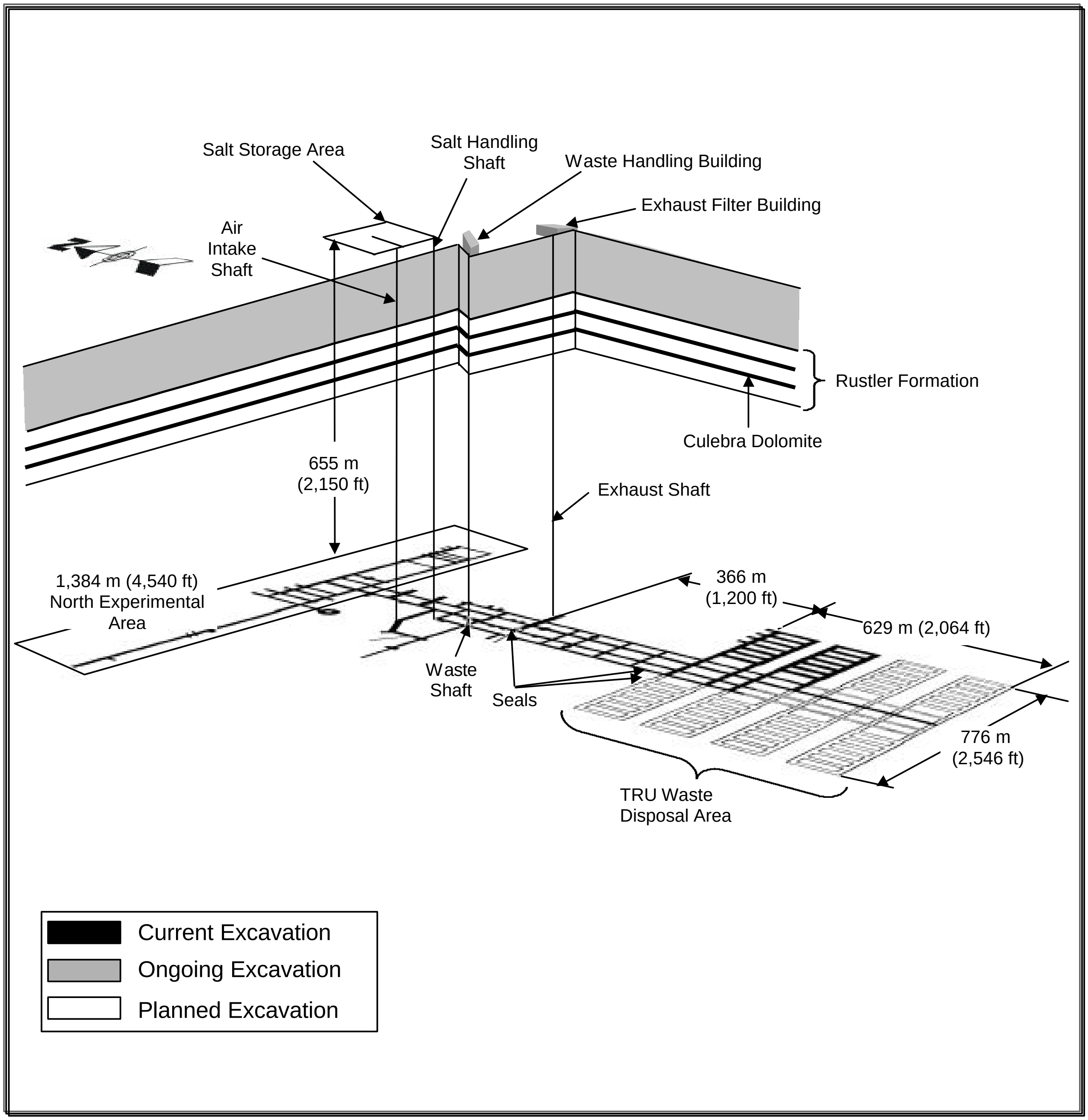


Figure 1-2. WIPP Underground Facilities

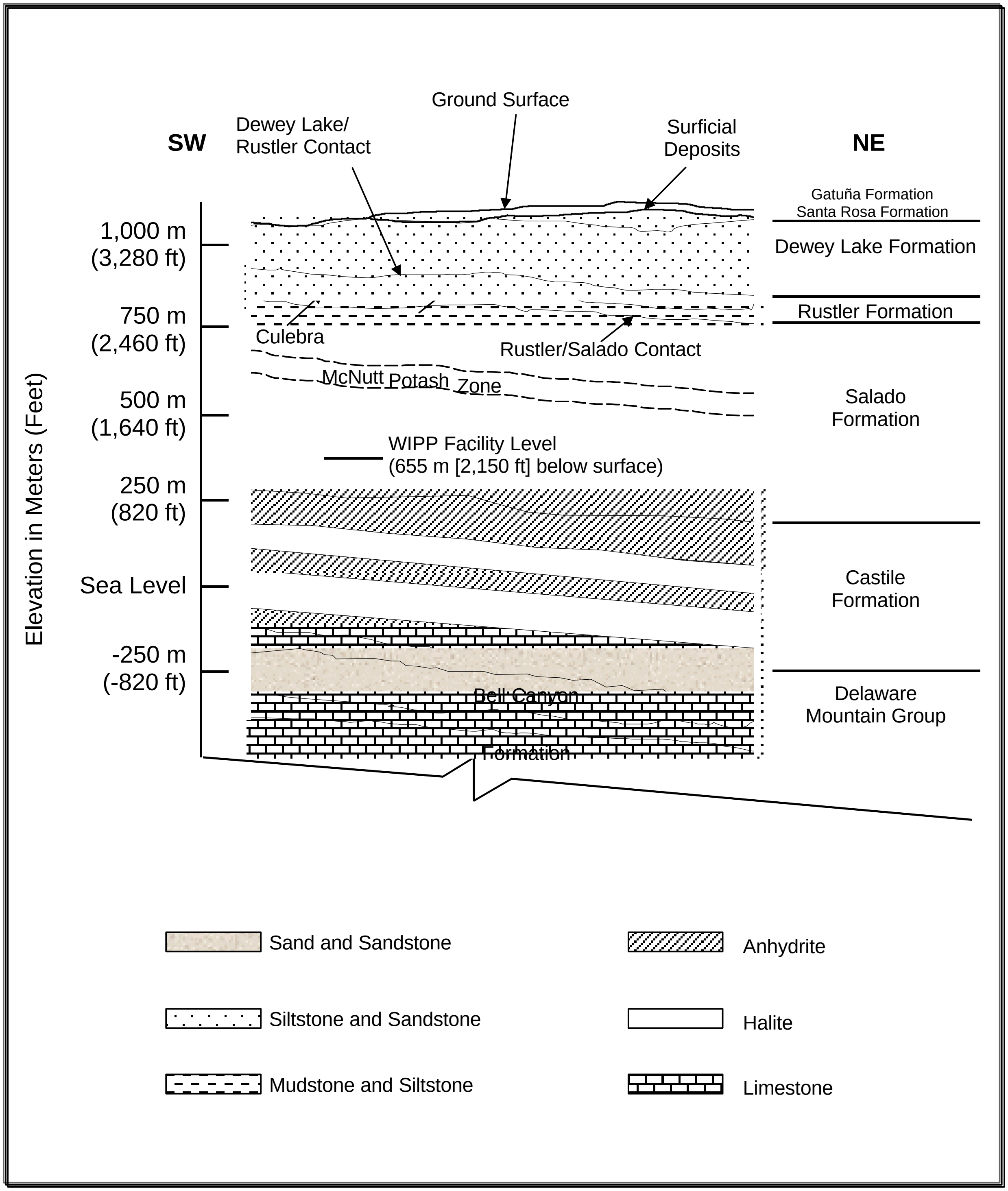


Figure 1-3. WIPP Facility Location Within the Salado Formation

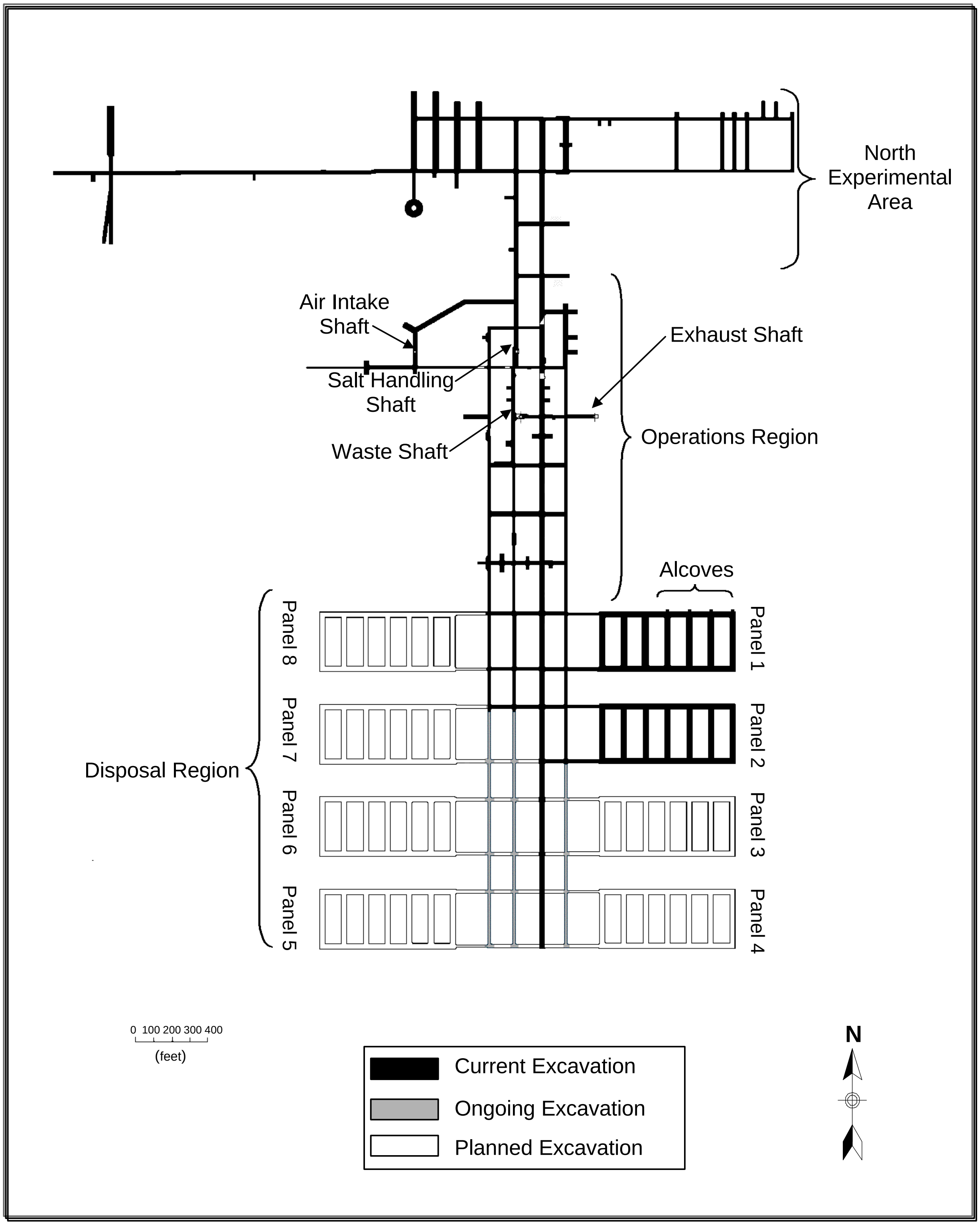
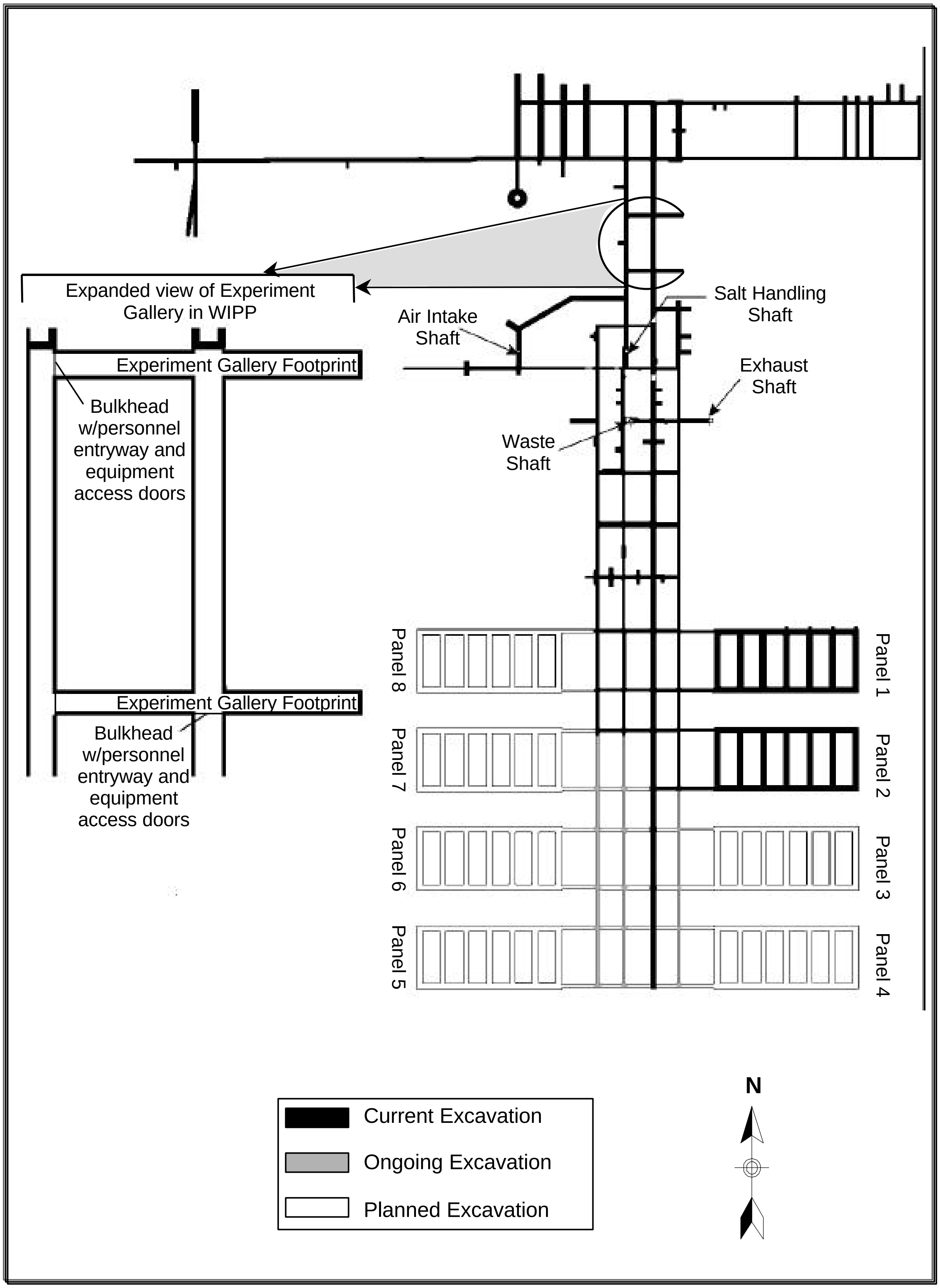


Figure 1-4. North Experimental Area



Expanded view of Experiment Gallery in WIPP
Experiment Gallery Footprint
Bulkhead w/personnel entryway and equipment access doors
Experiment Gallery Footprint
Bulkhead w/personnel entryway and equipment access doors
Air Intake Shaft
Salt Handling Shaft
Exhaust Shaft
Waste Shaft
Panel 8
Panel 7
Panel 6
Panel 5
Panel 1
Panel 2
Panel 3
Panel 4
Current Excavation
Ongoing Excavation
Planned Excavation
N

Because normal background radiation levels can interfere with many experiments, the low background radiation in the WIPP underground facility is one of the factors that makes the site an attractive environment for experiments relating to particle astrophysics, low radiation dose physics, fissile materials accountability, and transparency. Further, WIPP's status as a working underground geologic waste repository also makes it a unique resource for experiments in other fields such as mining, waste repository science, and deep geophysics.

DOE has prepared this EA to examine the potential environmental consequences from conducting particular types of scientific experiments in the experiment gallery at WIPP, including the potential cumulative impacts of conducting experiments with the operation of WIPP as a TRU waste repository. Chapter 2 describes the types of experiments that could be conducted at WIPP or another underground location.

1.2 PURPOSE AND NEED

Congress specifically acknowledged the potential use of the WIPP site for other purposes. Section 4(b)(3) of the WIPP Land Withdrawal Act (Public Law 102-579) allows "such non-WIPP related uses of the Withdrawal as the Secretary determines to be appropriate." In keeping with this congressional directive, DOE seeks to make maximum use of existing WIPP facilities to further the scientific missions assigned to the Department by Congress to the extent it can do so without impacting the primary mission of WIPP, the disposal of defense TRU waste. This multiple use of the WIPP facility would benefit the public by providing an additional return on the existing investment in that facility.

1.3 PERMITS AND REGULATORY REQUIREMENTS

The National Environmental Policy Act (NEPA) requires that a list of active, pending, or potentially required permits be prepared before a proposed action can be conducted at WIPP. Table 1-1 presents this information for current, ongoing activities at WIPP. No additional permits should be needed for the activities proposed in this EA.

U.S. Environmental Protection Agency (EPA) regulations require DOE to inform the EPA Administrator in writing prior to making a planned change in activities or conditions that differ significantly from the most recent compliance application (see Title 40 of the Code of Federal Regulations [CFR] Part 194.4 (a)(3)(i)). DOE would report the underground experiments as planned changes under this regulation before emplacing any experiment in the WIPP underground. In addition, DOE would comply with regulations governing hazardous, low-level radioactive, and low-level mixed radioactive wastes by shipping such wastes offsite in accordance with existing generator regulations; however, DOE does not anticipate that such wastes would be produced under the experiments proposed to date.

1.4 NEPA PROCESS

The NEPA requires federal agencies to examine the potential environmental impacts of their actions before they are implemented (see 42 U.S. Code 4332(2)(C)). For "major federal actions that significantly affect the quality of the human environment," agencies must prepare an environmental impact statement (EIS). When the agency is not certain whether the environmental impacts of a proposal may be significant, the agency must prepare an EA. The Council on Environmental Quality (CEQ) has promulgated regulations that implement these procedural provisions of NEPA (see 40 CFR Parts 1500-1508). DOE has also promulgated NEPA implementing regulations that set forth agency specific NEPA procedures (see 10 CFR Part 1021). This EA was prepared pursuant to NEPA and the applicable CEQ and DOE NEPA regulations.

Table 1-1. Required Permits and Approvals for Ongoing Activities at WIPP

Granting Agency [a]	Type of Permit or Approval[b]	Status
U.S. Department of the Interior, BLM	Right-of-Way for Water Pipeline	Active
U.S. Department of the Interior, BLM	Right-of-Way for the North Access Road	Active
U.S. Department of the Interior, BLM	Right-of-Way for Railroad	Active
U.S. Department of the Interior, BLM	Right-of-Way for Dosimetry and Aerosol Sampling Sites	Active
U.S. Department of the Interior, BLM	Right-of-Way for Seven Subsidence Monuments	Active
U.S. Department of the Interior, BLM	Right-of-Way for Aerosol Sampling Site	Active
U.S. Department of the Interior, BLM	Right-of-Way for Ten Raptor Nesting Platforms	Active
U.S. Department of the Interior, BLM	Right-of-Way for Survey Monument Installation	Active
U.S. Department of the Interior, BLM	Free Use Permit for Caliche	Active
N.M. Environment Department	Operating Permit for two Backup Generators	Active
N.M. Environment Department	Hazardous Waste Facility Permit	Active
N.M. Department of Game and Fish	Individual Banding	Active
N.M. Department of Game and Fish	Master Collecting	Active
N.M. Department of Game and Fish	Concurrence that WIPP activities will have no significant impact on State-listed threatened or endangered species	Active
U.S. Department of the Interior, Fish and Wildlife Service	Master Personal Banding	Active
U.S. Department of the Interior, Fish and Wildlife Service	Concurrence that there are no Federally listed, threatened, proposed, or endangered species at WIPP	Active
U.S. Environmental Protection Agency	Notification of the presence of two Underground Storage Tanks	Active
U.S. Environment Protection Agency	N.M. NPDES Storm Water General Permit	Active
U.S. Environmental Protection Agency	Certification of Compliance with 40 CFR 194	Active
U.S. Nuclear Regulatory Commission	Certificate of Compliance for the TRUPACT-II	Active
U.S. Nuclear Regulatory Commission	Certificate of Compliance for the RH-72B cask	Active
N.M. Commissioner of Public Lands	Right-of-Way for High Volume Air Sampler	Active
N.M. State Engineer Office	H-19b1 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b2 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b3 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b4 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b5 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b6 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b7 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-1 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-2 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-3 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-4 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-5 well, permit to appropriate the underground waters of N.M. for monitoring ad characterization	Active
N.M. State Engineer Office	WQSP-6 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-7 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	Appropriation: Exhaust Shaft Exploratory Borehole	Active
N.M. State Engineer Office	Exploratory: Exhaust Shaft Exploratory Borehole	Active
N.M. State Engineer Office	H-14 and H-15 Test Wells	Active

a. U.S. = United States; BLM = Bureau of Land Management; N.M. = New Mexico
b. NPDES = National Pollutant Discharge Elimination System; TRUPACT-II = transuranic package transporter-II

1.4.1 WIPP NEPA Compliance

In 1980, DOE prepared the *Final Environmental Impact Statement for the Waste Isolation Pilot Plant* (FEIS) (DOE 1980) to assess the potential environmental effects of developing WIPP and of alternatives for disposing of or managing TRU waste. The FEIS proposed a two-phased approach to the development of WIPP: (1) a site and preliminary design validation program, and (2) full construction. This approach was adopted in a Record of Decision (ROD) issued in 1981 (46 Fed. Reg. 9162 [1981]).

After construction of most of the WIPP facilities, DOE prepared the *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* (SEIS-I) (DOE 1990) to update the environmental record established in the FEIS. The SEIS-I ROD, published by DOE in 1990, chose to continue the phased approach to developing WIPP by beginning an underground test phase (55 Fed. Reg. 25689 [1990]). The 1990 ROD also committed the Department to prepare a second supplement disposal phase EIS.

The *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (SEIS-II) was issued in September 1997. The SEIS-II ROD was issued on January 16, 1998 (63 Fed. Reg. 3623 [1998]). In that document, DOE announced its decision to dispose of TRU waste generated by defense activities at WIPP (DOE 1997).

DOE has also prepared two other EAs for activities related to TRU waste disposal. These are the *Environmental Assessment of the Carlsbad Environmental Monitoring and Research Center Facility* (DOE 1995b) and the *Environmental Assessment for the Construction and Operation of the Sand Dunes to Ochoa Powerline Project* (DOE 1995c).

1.4.2 Stakeholder Outreach and Involvement Activities

NEPA requires that federal, state, and local agencies with jurisdiction or special expertise regarding environmental impacts be consulted and involved in the NEPA process. Agencies involved include those with authority to issue permits, licenses, and other regulatory approvals. Other agencies include those responsible for protecting significant resources, such as endangered species or wetlands. Table 1-2 lists the agencies consulted during the preparation of this EA.

Additionally, the DOE Carlsbad Field Office (CBFO) has informally apprised DOE-EM, DOE’s Office of Science, and DOE’s Office of Nuclear Nonproliferation of the possible activities described in this EA. The New Mexico Environment Department and the EPA were sent copies of the draft EA; each submitted comments on the draft, which have been addressed in this final EA.

Also, the CBFO has typically interacted with stakeholder groups and citizens who have an interest in or are potentially affected by DOE activities at WIPP. The CBFO Office of Public Affairs has designed the stakeholder outreach and involvement activities for this EA to respond to regulatory requirements and to the interests of its stakeholders. The CBFO will seek to include research scientists in the public outreach and involvement activities. The design reflects recent CBFO experience at other meetings and informal stakeholder comments and suggestions.

Table 1-2. Governmental Agencies Consulted

Andrew V. Sandoval, Chief Conservation Services Division New Mexico Department of Game and Fish Villagra Building PO Box 25112 Santa Fe, NM 87504
Field Supervisor U.S. Fish and Wildlife Service New Mexico Ecological Services Field Office 2105 Osuna NE Albuquerque, NM 87113
Toby Martinez, Director New Mexico Energy, Minerals and Natural Resources Department Villagra Building 408 Galisteo Santa Fe, NM 87501
New Mexico Environment Department Harold S. Runnels Building 1190 St. Francis Drive Santa Fe, NM 87502
Archaeological Records Management System (ARMS) Laboratory of Anthropology New Mexico State Historic Preservation Division 228 E. Palace Avenue Santa Fe, NM 87501

1.4.2.1 Public Information Materials

The CBFO Office of Public Affairs publicized the draft EA through the activities and publications described below. After informal conversations with key stakeholders, the CBFO identified the following topics that some or all of these materials touched on:

- DOE's Proposed Action and alternative.
- Sufficient detail on the types of experiments contemplated so that stakeholders could comment knowledgeably.
- Materials (chemicals, liquids, gases, etc.) that might be introduced into WIPP; how they would be managed; and cumulative effects of the WIPP waste, volatile organic compounds (VOCs), and any new materials that might be introduced.
- Estimated duration of proposed experiments.
- Location in WIPP where the experiments would take place; if the location is in the old experimental area, an evaluation of the rock and salt mechanics.

- Environmental protections that would be built in to protect against (1) human exposure to radioactive materials in the WIPP waste, (2) introduction of new hazards, and (3) damage to experimental equipment by the hazardous and radioactive materials in WIPP and potential leaks.
- General logistical plans to maintain safety and waste disposal operations.
- Types of organizations that would conduct these studies.
- Process and responsibility for selecting studies to be conducted.
- Overview of modifications that might be made to the WIPP facility to accommodate the studies.
- Anticipated funding sources both for the studies and for any facility modifications.
- Rationale for conducting an EA rather than an EIS – and how the original FEIS, SEIS-I, and SEIS-II covered the proposed activities.
- Clear statement of future experiments contemplated that might lead to other NEPA studies in the near term.
- Outreach activities planned.
- Methods of commenting on the draft EA.
- Standards that would have to be met for the EA to be elevated to an EIS.

News Release

The news release briefly described the Proposed Action and alternative, told how to obtain more information on the EA (including a copy of the full document), and provided details about how the public could comment on it. The CBFO sent the document (via fax) to about 800 local and regional newspapers and trade and scientific publications.

CBFO Monthly Calendar

The *CBFO Monthly Calendar* for October 2000 carried an early notification that the CBFO would seek public comment on the EA later that month, and asked that interested stakeholders who wanted a full copy of the document call the WIPP Information Center (toll-free). This early notification, which went to some 3,000 stakeholders, helped the CBFO estimate how many copies would be sent to the general public.

Newspaper Advertisements

The CBFO advertised the availability of the EA in five general circulation newspapers in New Mexico. These display advertisements ran concurrently with the release of the EA, and one additional ad ran on the Sunday prior to the public meetings.

Fact Sheets

The Office of Public Affairs prepared and distributed six fact sheets on the following topics: the Proposed Action; the potential impacts of the experiments; the search for dark matter, Weakly Interactive Massive Particles (WIMPs), and neutrinos; the public participation process; the NEPA process; and questions and answers about potential underground experiments. These fact sheets were mailed to the 3,100 stakeholders on the WIPP mailing list and the 800 entries on the WIPP media list. They also were added to the WIPP home page.

Updated Mailing List

The Office of Public Affairs updated its stakeholder and media mailing lists to include scientists, other individuals, and organizations potentially interested in the EA and the proposed experiments. The CBFO distributed the fact sheets to all individuals on this mailing list, which included some 3,900 entries.

WIPP Home Page

The WIPP home page provides the full EA, the news release, the fact sheets, and the monthly calendar. In addition, the home page includes an electronic mail (e-mail) address that stakeholders could use to send comments to DOE.

WIPP Information Center

The WIPP Information Center, staffed during business hours, provides fact sheets, news releases, and the full text of the EA. It also transfers calls, as requested, so that CBFO technical staff can answer questions.

The EA

The CBFO provided key stakeholders with the draft EA upon its release. The EA was available to others on request.

Public Meetings

The CBFO held two sets of public meetings during the comment period: one set (an afternoon session and an evening session) in Santa Fe on November 14, 2000, and one set (an afternoon session and an evening session) in Carlsbad on November 16, 2000. The purpose of the meetings was two-fold: to provide the public with information and answer their questions about the EA, and to involve the public by listening to their comments, questions, and suggestions directly. The CBFO NEPA Officer moderated the meetings and answered questions, with assistance from the Battelle team who helped prepare the EA. The NEPA Officer opened the meetings with a brief overview of the EA, the proposed experiments, and the findings. A facilitator recorded comments on flip-charts and posted them on the walls. Stakeholders were encouraged to review the comments and ask the facilitator to add to or correct comments throughout the meeting to ensure that they accurately reflected the comments made. DOE and its contractor asked clarifying questions to ensure that the comments were understood.

The meetings were held in meeting rooms large enough to seat 50 persons. In Santa Fe, five persons representing various organizations and state agencies attended the afternoon session; another person, not affiliated with an organization, attended the afternoon session but did not sign in. Two persons attended the evening session. In Carlsbad, four members of the public attended the afternoon session, and no one attended the evening session.

1.4.2.2 Public Involvement Activities

Comment Period

The CBFO held a 30-day public comment period on the draft EA from October 23 through November 22, 2000. Comments on the EA and DOE responses are contained in Appendix A. The comments were directed to:

Harold Johnson
NEPA Compliance Officer
Carlsbad Field Office
U.S. Department of Energy
P.O. Box 3090
Carlsbad, NM 88221

Phone: 505 234-7349
Fax: 505 234-7008
e-mail: johnsoh@wipp.carlsbad.nm.us
Telephone comment recording line for brief comments: 1-800-336-WIPP (336-9477)

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

Some types of experiments are best (or only) performed deep underground. For this reason, scientists have considered WIPP as a potential site for these types of experiments and have sought permission from DOE to conduct several types of experiments there. As an example, astrophysicists are searching for very small particles with no charge called neutrinos. These particles are so small that they typically pass through the Earth. The only way to detect them is to look for them using facilities as far underground as possible so that the Earth's surface layers filter out other cosmic particles and radiation.

The first basic astrophysics-like experiments were begun at WIPP in 1993 by LANL scientists who used WIPP's low background radiation to test materials to use in constructing specialized detectors. These materials had to be tested in a deep underground facility (SNO 1999). They are currently being emplaced in the deepest neutrino observatory in the world, that in Sudbury, Ontario (the Sudbury Neutrino Observatory), which is 2,070 meters (6,800 feet) below the surface. The LANL scientists followed this effort in 1997 with efforts to develop a very pure silicon-based solid-state detector that they believed might detect "dark matter" (see the text box titled "Of Dark Matter, WIMPs, and Neutrinos and Their Flavors"). This experiment continues underground at WIPP, and scientists believe it may need to be there 1 or 2 more years before they have the data they need (Nelson 2000a).

Other scientists have since expressed interest in moving experiments to WIPP, leading to a meeting in Carlsbad, New Mexico, on June 12-14, 2000. This meeting was attended by nearly 60 astrophysicists and other scientists from throughout the nation interested in conducting experiments at WIPP (Nelson 2000b). (The web page for this meeting can be found at http://www.wipp.carlsbad.nm.us/leptontown; it includes copies of slides presented at the meeting).

Because of the interest of the scientific community in using WIPP for experiments that must be conducted underground, DOE is preparing this document to inform decision-makers about the environmental impacts of allowing the placement of the experiments in WIPP. The Proposed Action is to authorize the use of WIPP facilities for different types of scientific experiments, as described below. For comparison purposes, this EA also examines the no action alternative.

2.1 THE PROPOSED ACTION

The Proposed Action is to allow the astrophysics and basic science experiments described in Section 2.1.1 to be conducted in the experiment gallery and other areas of the WIPP facility, to the extent that they do not interfere with WIPP's mission of disposing of TRU waste. These experiments would be proposed and sponsored by scientists outside of the Department, although some may receive DOE funding. The conduct of the experiments could require some modifications of or additions to the underground experiment gallery at WIPP.

Under the Proposed Action, experiments would not all begin or end at the same time and each would be operated on its own schedule, as funding became available. The experiments could run from 2 years to up to 35 years. For purposes of analysis, however, it is assumed that (1) all experiments would begin simultaneously after preparation of the experiment gallery, (2) each would run for 35 years (the planned operation life of WIPP), and (3) they would then be decommissioned.

OF DARK MATTER, WIMPS, AND NEUTRINOS AND THEIR FLAVORS

Experiments already proposed for the WIPP facility focus on dark matter, WIMPs, and neutrinos, all obscure subjects to the average U.S. citizen. Basically, each experiment, in one way or another, tries to answer the questions, "What is the universe made of?" and "How was it created?"

For years, astrophysicists have tried to mathematically calculate the mass of the universe. Because of the relationship between mass and gravity and the speed of the stars and other heavenly bodies, they can estimate how much mass should exist. But when they calculate the mass of the heavenly bodies we can see, they find the two numbers don't compare. About 90 percent of the mass is missing. Two astronomers are given credit for identifying this problem: Jan Oort in 1932 and Fritz Zwicky in 1933 (MAU 1996).

As a solution to this puzzle, scientists have postulated a yet-unknown substance they call "dark matter." But where and what is it? Astronomers believe that dark matter may be in what are called "MAssive Compact Halo Objects" (MACHOs), which are not luminous to their telescopes but which may be out there and may be very massive. The mass of these objects could be so great that their gravity will not allow light to be reflected back to the scientists' telescopes. These MACHOs may be red dwarfs or black holes, or they may be some other massive object, yet unidentified (MAU 1996).

Physicists, though, believe that there is something more basic but unknown in the universe that may have mass but not interact with other matter. They call these basic particles WIMPs. WIMPs would have escaped detection to date because they have no or little charge and do not interact with, but in fact pass through, most other objects. Several experiments proposed for WIPP are searching for these WIMPs. They are detectors designed to shield out cosmic rays, and yet allow some evidence of the WIMPs to be identified (MAU 1996).

Another candidate for the missing matter is the neutrino. Neutrinos were first postulated by Wolfgang Pauli in 1931, then later became important to Enrico Fermi in 1934. While studying a form of radioactive decay in which a neutron decays into a proton and electron, these two scientists were unable to account for all of the energy and matter released. They postulated that a new particle existed, the neutrino, which they believed at that time had no charge and no mass (as noted below, the belief that the neutrino has no mass has changed in light of more recent findings). This type of radioactive reaction is common to a supernova, a stellar event during which the energy released can be a billion times that of the sun. Therefore, when supernovae occur, large numbers of neutrinos pass through the earth (UCI 2000).

Since the 1930s, scientists have learned much about neutrinos. They've defined them as a fundamental particle of the universe, which has no charge (so they are not affected by electric-magnetic forces like electrons). Because they have no charge, they can go long distances through matter without being affected by it. They also understand that there are at least three "flavors" of neutrinos: one related to electrons, another related to the slightly heavier and charged muon, and the third related to the heavier and charged tau (UCI 2000). The neutrino, though, is still evasive. The last of these flavors, the tau neutrino, had been understood in theory for many years, but was finally detected just this past summer. And scientists have never been able to find evidence of as many neutrinos as theoretically should exist.

Finally, to be a candidate for the universe's missing mass, neutrinos must have mass. In spite of numerous experiments throughout the world, it was only in 1998 that scientists obtained the first evidence that neutrinos do have mass (Physical Review Focus 1998). No measurement of that mass, though, has been obtained to date, and many of the experiments proposed for WIPP hope to be the first to do so.

Much is at stake, for without dark matter of some type, scientists are unsure whether such basic theories as the Big Bang Theory withstand modern scrutiny. Others believe that if neutrinos do have mass, one of the principal theories of physics, the standard model, will be called into question. To the layman, though, the strangest finding may be that a particle modern scientists still struggle to detect and understand may be responsible for more mass in the universe than all of the planets and stars combined.

As part of the Proposed Action, DOE would mitigate potentially significant impacts that might be associated with the conduct of these experiments. Mitigation measures that are already in place at WIPP or that could be used to mitigate various hazards are discussed in Chapter 4. Actual mitigation measures that would be instituted for individual experiments would be determined based on the hazards analysis that DOE would conduct for each experiment before it commences.

2.1.1 Range of Possible Experiments

To date, various organizations have submitted descriptions of nine experiments they would like to locate in WIPP sometime during the next two decades. All of these experiments focus on the search for dark matter, WIMPs, or knowledge concerning neutrinos (Nelson and Bennington 2000).

An underground facility such as WIPP could also be used for other types of experiments, including those in low radiation dose physics, health effects of magnetic fields, fissile materials accountability and transparency, remote sensing, deep geology and seismology, and biological studies of darkness, silence, and radiation on plants and animals. Further, WIPP's status as a working deep geologic waste repository also makes it a resource for experiments in other fields such as mining, waste repository science, and deep geophysics.

To identify the range of the experiments that could be conducted in WIPP or another underground facility, DOE reviewed the nine experiments currently proposed and consulted scientists from Pacific Northwest National Laboratory (PNNL) regarding the needs and potential hazards of these experiments. Eight of the nine experiments are likely candidates for inclusion at WIPP and are described in Section 2.1.1.1. (The ninth, an experimental facility called the Ultimate underground Nucleon decay and neutrino Observatory [UNO], is discussed in Section 2.1.1.6, "Other Experiments Considered But Not Included in Analyses"). In addition, the PNNL experts identified other potential experiments that could be conducted in WIPP and for which authorization could be sought in the future. Based on these efforts, 15 experiments in the following five categories were identified and are included for analysis in this EA:

- Particle physics experiments (Section 2.1.1.1)
- Other astrophysics and physics experiments (Section 2.1.1.2)
- Mine safety and geophysical studies (Section 2.1.1.3)
- Nonproliferation and nuclear accountability experiments (Section 2.1.1.4)
- Chemical and material processing experiments (Section 2.1.1.5)

The intent of this EA is not to limit the experiments conducted at WIPP to only those analyzed in the EA. Other experiments could be permitted at WIPP in the future under this EA as long as the environmental impacts of those experiments are encompassed within the scope of the impacts considered in this EA.

2.1.1.1 Particle Physics Experiments

The following particle physics experiments have already been proposed to DOE and are under consideration for emplacement in WIPP.

LANL WIMP Dark Matter HpSi Detector

This experiment is an outgrowth of the neutrino detector development work conducted by LANL staff for the Sudbury Neutrino Observatory beginning in 1993. Using the same electronics and equipment that were placed in WIPP in 1996, LANL staff have developed silicon crystals and installed them as a dark matter detector in WIPP. The detector has a secure data communications link and is visited by a LANL staff member once a month. The experiment would continue for 2 more years. The experiment is currently in a small blind room in the repository but would be moved to the experiment gallery if it became available for occupation (Nelson 2000b; Nelson and Bennington 2000).

Observatory for Multi-flavor Neutrino Interactions from Supernovae (OMNIS)

OMNIS is a collaboration from all over the world, but led by Ohio State University and the University of California, Los Angeles. The OMNIS team has proposed to the National Science Foundation to install a 9,000-metric-ton (10,000-ton) detector system constructed of lead and/or iron, with 20 modules of 450 metric tons (500 tons) each. The detector would be installed in phases. If the National Science Foundation funded the effort (nearly $40 million would be requested), Congressional approval would be expected in the following fiscal year (FY). The money would lead to 1 year of detector development followed by 3 or 4 years of construction in WIPP. The long construction time would be needed to move the lead and iron into the experiment gallery and assemble the detector.

A related proposal by the University of California, Los Angeles to DOE's Office of Science requests funding to develop plastic scintillators for the OMNIS detector described above. Scintillators show the activity of neutrinos by flashing a particular light that can be detected and measured by scientists. If the plastic scintillators were not produced or prove less sensitive, a standard scintillation liquid would be used. This scintillation liquid would consist of mineral oil containing small amounts of 1,2,4-trimethylbenzene and aromatic fluors, with nearly 106,000 liters (28,000 gallons) contained in the equipment. OMNIS would have a very long operating lifetime. Its main purpose would be to observe neutrinos from supernovae in our galaxy, and the estimated mean time between nearby supernovae is thought to be from 10 to 30 years. The most recent supernova was in 1987. A similar facility is being considered for the Boulby Mine Observatory in the United Kingdom. Scientists hope that by having two facilities, they would increase their chances of finding the data they are pursuing (Nelson and Bennington 2000; Brodzinski et al. 2000; Boyd et al. undated).

This experiment would demand a relatively large area of the experiment gallery that is relatively easily accessible. Moving such a large amount of lead and/or iron into the repository would take several years. Once assembled, though, the detectors would appear as three rows of metal boxes, two of iron and one of lead. Each row would be about 80 meters (260 feet) long, 5 meters (16 feet) wide, and nearly 4 meters (13 feet) high (Figure 2-1). Another 4 meters in width would be needed for access to the equipment. The cost of the facility is currently estimated at $30 million (Nelson 2000b).

There are many potential hazards associated with this experiment. Transportation of the materials, including the equipment and scintillation fluid, would pose acceleration and impact hazards (Nelson and Bennington 2000; Brodzinski et al. undated). The lead used in the detector could pose a toxicity hazard; however, protective equipment and handling procedures would alleviate this hazard. Contact and inhalation hazards could result from the use of or a fire involving scintillation liquid (Bichron 1995).

Surface Experiment Related to OMNIS

In addition to the underground activities of the OMNIS, which are proposed to detect neutrinos from supernovae, another team of scientists has proposed that an array of detectors be constructed on the surface of the WIPP site to help identify the nature of the cosmic radiation that would be detected by OMNIS while waiting for a supernova to occur. This surface experiment would involve burying several hundred detectors in a 6- to 8-square-kilometer (2- to 3-square-mile) area above the WIPP facility. The detectors would be plastic with a plastic scintillator and electronics to detect the cosmic radiation. Each would be approximately 1 to 2 meters (3 to 6 feet) on a side and several centimeters thick. They would be buried 2 to 2.4 meters (6 to 8 feet) deep in an array, using a backhoe, on approximately 200-meter

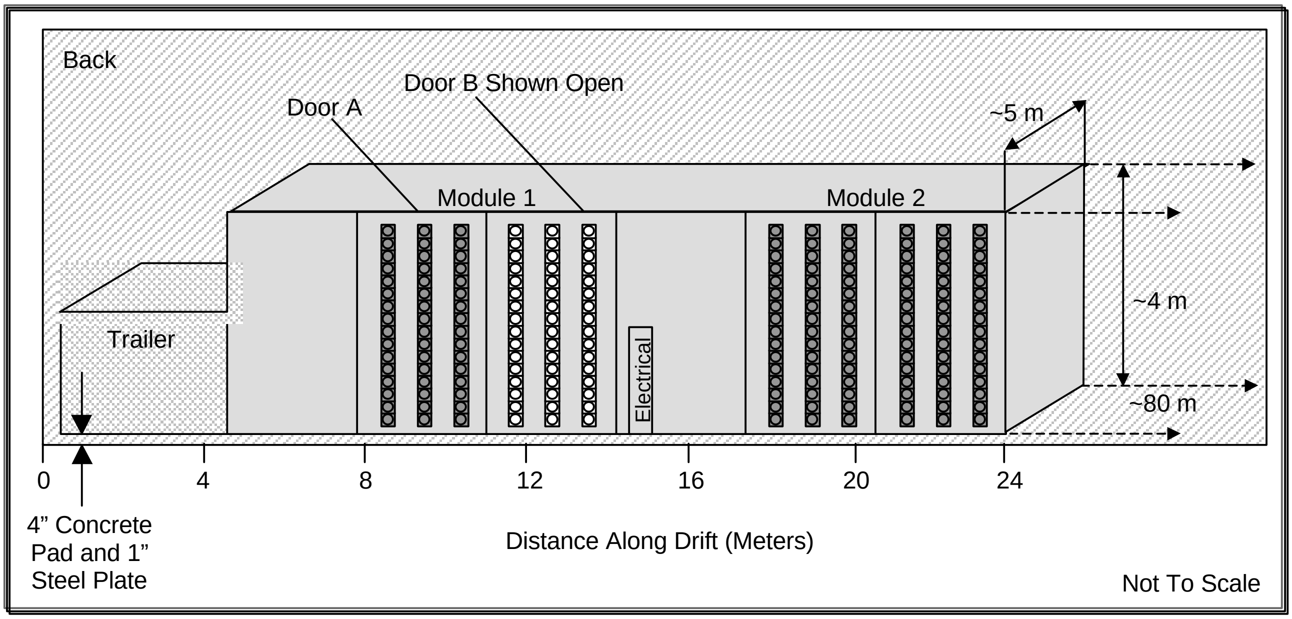


Figure 2-1. OMNIS Lead Detector

(660-foot) centers. Each would include a metal pole that would extend out of the surface about 2 meters (6 feet) high. On the pole would be a solar collector that would power the electronics and a radio transmitter to transmit the data to a central data collector. The detectors, therefore, would not be connected and no cabling would need to be buried between them (Nelson 2000d). The exact location of a particular detector in the surface grid could be displaced from a proposed location should archeologists, biologists, or other scientists find that a particular location would lead to impacts (Nelson 2000d). Hazards associated with this experiment would arise from the surface excavation and handling of the plastic scintillator.

Enriched Xenon-136 Observatory (EXO)

EXO is a worldwide collaboration led by Stanford University that is proposing to build a 9-metric-ton (10-ton) xenon-filled gas detector to measure neutrino-less double beta decay. This experiment's primary purpose is to determine neutrino mass. Compared to OMNIS, this is a small experiment that would be completed a decade after installation. The experiment depends on availability of enriched xenon-136, which currently does not exist. Production of this material is being proposed on a separate track and may be produced by a gaseous centrifuge operation in Russia organized under the auspices of the DOE Nuclear Cities Initiative. Production of the xenon would take several years, making FY2004 the earliest time that the experiment could be constructed at WIPP. Some small-scale development and measurement activities might occur as early as 2002. The full detector would be assembled in pieces underground at WIPP and might require some new excavation. The experiment would use 9 metric tons (10 tons) of the xenon-136 under up to 20 atmospheres of pressure, which could present a hazard if subjected to catastrophic release in a confined environment. In addition to the explosion and high pressure potential caused by such a catastrophic release, this amount of xenon would displace about half the air in a standard WIPP waste disposal room. There are about 70 standard rooms planned for the WIPP repository. Only 14 have been excavated at this time. The experiment would be in a container about 4 by 5 meters (13 by 16 feet), containing mirrors, light sensors, and lasers (Figure 2-2). The lasers could create a radiation hazard (Breidenbach at al. 2000; Brodzinski et al. 2000; Nelson and Bennington 2000).

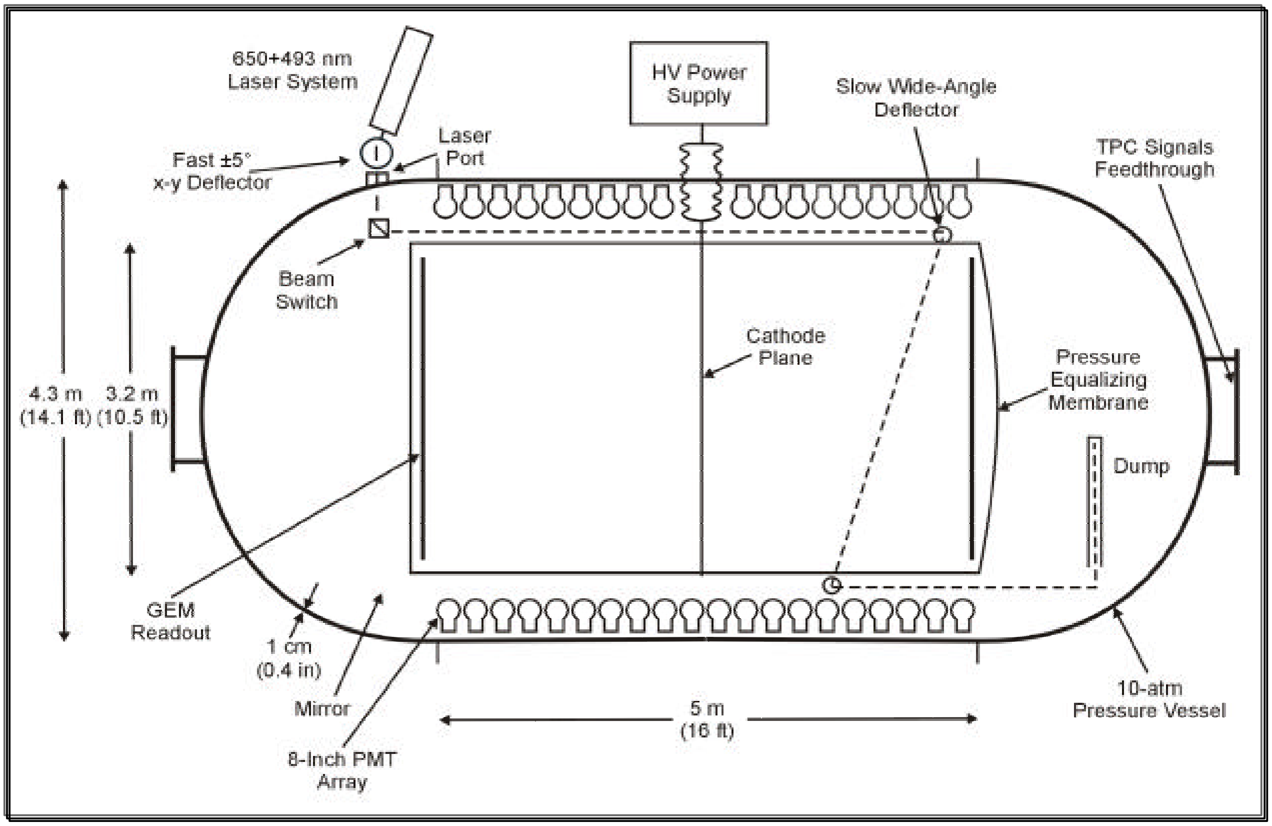


Figure 2-2. Conceptual Layout of EXO Experiment

Germanium in Liquid Nitrogen Underground System (GENIUS)

GENIUS is another experiment aimed at identifying dark matter. This effort is sponsored by the Max Planck Institute in Germany and is a search for dark matter using naked germanium detectors submerged in up to 450 metric tons (500 tons) of liquid nitrogen (Figure 2-3). The principal detector material would be germanium metal, with the germanium-76 isotope of most significance. GENIUS would require significant new excavation and very robust safety analysis and protection systems. The major hazard associated with this experiment would be the cryogen tank of liquid nitrogen in which the detectors are submersed. The tank would contain 1,400 cubic meters (49,440 cubic feet) of liquid nitrogen, which if instantaneously released could displace the air from nearly a million cubic meters, or more than the entire WIPP site. DOE, aware of the hazard, has stated that engineering and safety requirements for this experiment must ensure that, even in a catastrophic accident, the liquid nitrogen released would not present a hazard (Brodzinski et al. 2000; Nelson and Bennington 2000).

Institute for Nuclear and Particle Astrophysics and Cosmology (INPAC)

INPAC is a multi-campus research unit of the University of California. INPAC has proposed to the Keck Foundation that it develop a general purpose underground nuclear physics laboratory at WIPP. The design of the laboratory would include a 9-meter (30-foot) in diameter by 6-meter (20-foot) tall tank filled with ultrapure water, with an adjoining electronics room. To reduce the effects of leakage or flooding, the tank would be placed in secondary containment to capture any spills. Some new excavation for the secondary containment tank is likely (the base for a 2- to 5-meter by 12-meter [8- to 16-foot by 40-foot]

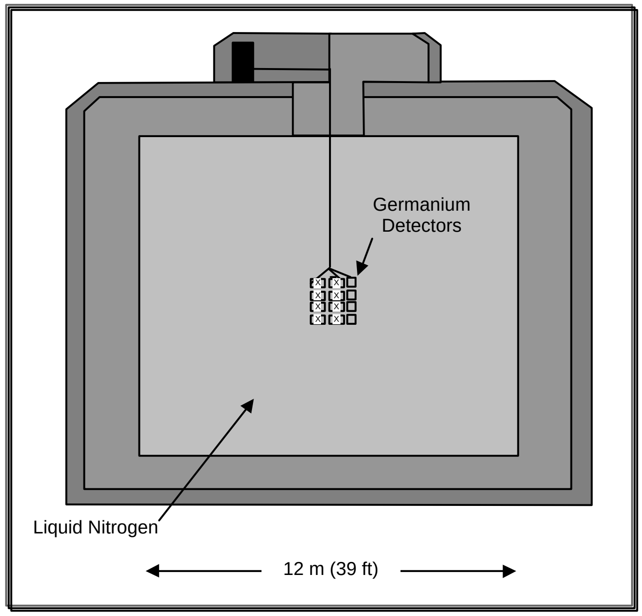


Figure 2-3. Conceptual Layout of GENIUS Experiment

catchment tank) (Figure 2-4). Funding of this project is currently unknown and it is not likely to be a reality for several years. This facility is proposed to provide scientific infrastructure to all the experiments occupying the site, as well as to serve as the site for several efforts to identify other dimensions and WIMPs. It would last for the duration of all experiments (INPAC 1999; Nelson and Bennington 2000; Brodzinski et al. 2000). This proposal is predicated on the requirement of all experimenters to have access to clean rooms, machine shop facilities, electronics shops, computational facilities, etc. Since most of the proposed experiments are intended to measure some rare nuclear phenomenon, it is imperative that other, more common, nuclear phenomena not produce signals that mimic the expected rare event. Most obvious are unwanted radioactive impurities in the materials composing the various experiments. Therefore, it would be necessary to provide a "screening" laboratory for evaluation of potential construction materials. This laboratory, as proposed, would house the evaluation instrumentation in a large volume of pure water as a shield from environmental radiation (INPAC 1999; Nelson and Bennington 2000; Brodzinski et al. 2000).

Majorana Project

A collaboration with Duke University has proposed the Majorana Project, another double-beta decay experiment based on the use of germanium-76. This experiment also is a mid-size experiment that would operate for about a decade after installation. The quantities of germanium-76 required for this experiment do not currently exist, and would likely be produced in Russia, via the gaseous centrifuge process, organized under the auspices of the Nuclear Cities Initiative. Like GENIUS, the Majorana Project's germanium detectors also require liquid nitrogen for cooling, but unlike GENIUS, the quantity of liquid nitrogen is not very large, nor is it all contained in one tank. This experiment would use up to 10 Dewars-size containers each with up to 100 liters (26 gallons) of liquid nitrogen (Figure 2-5). A catastrophic release of any one of these containers would only displace about 65 cubic meters (2,295 cubic feet) of air, or only a small fraction of the air in a WIPP room. Prototype detectors have been constructed and tested in the basement laboratories at Duke, and the collaboration wants to move the development work to WIPP in the near future. The development work would be of about the same scale

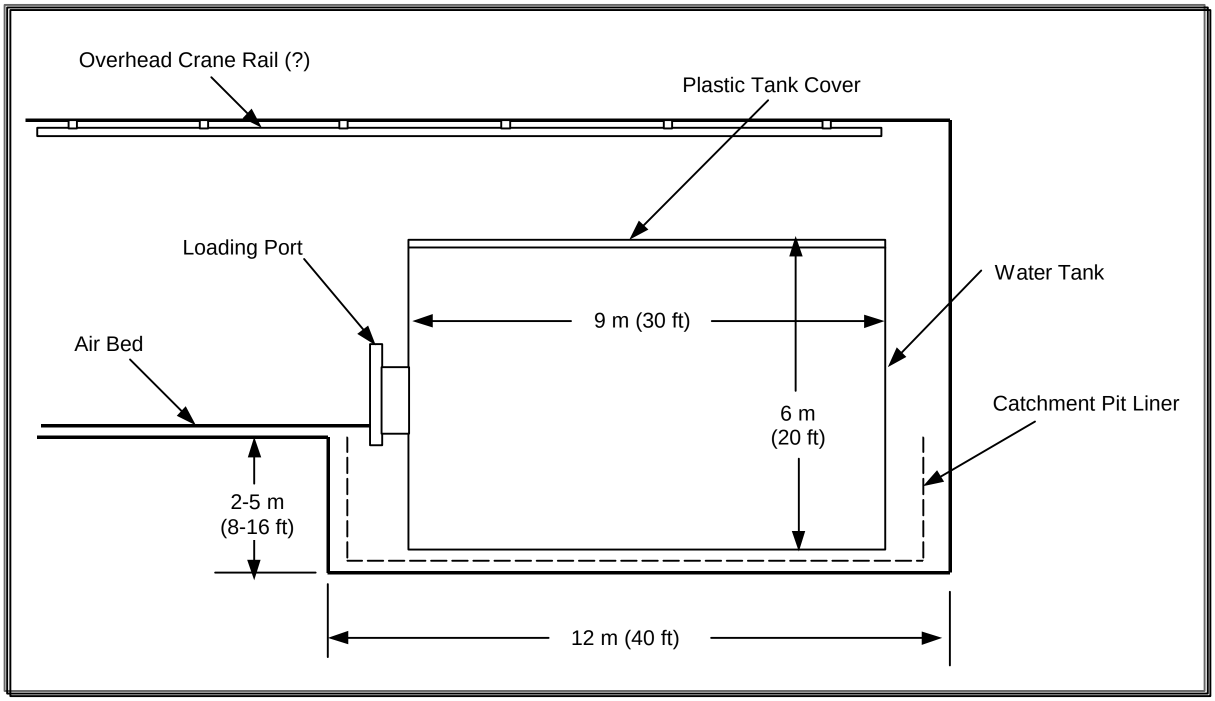


Figure 2-4. INPAC Experimental Cavity

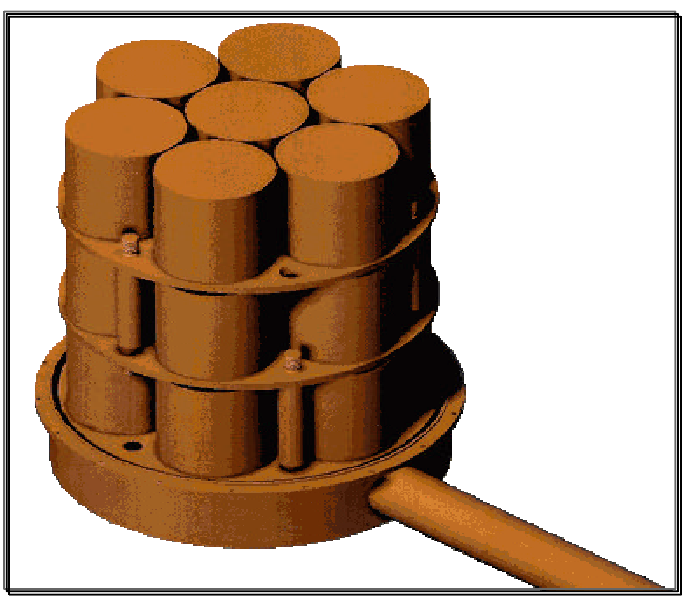


Figure 2-5. Majorana Project Detector Experiment

as the LANL WIMP project described above. Full-scale development is several years away, but if funded in 2003, this project could begin detector and equipment assembly in 2004. The detector would not require a large amount of space. Conservative estimates are that an area equivalent to 5 meters by 10 meters by 4 meters (16 feet by 33 feet by 13 feet) high would be suitable (Brodzinski et al. 2000; Nelson and Bennington 2000).

Neutrino Factory Detector at WIPP

Within the next decade, a collaboration of scientists is proposing to build a muon collider at either Brookhaven National Laboratory or Fermi National Accelerator Laboratory. The muon collider would begin with construction of a muon storage ring at one of the two facilities. The facility would be capable of sending neutrinos through the earth to detectors at WIPP and at the other neutrino observatories throughout the world (see the text box titled “Other Underground Astrophysics Experimental Observatories”). The proposed WIPP detector would most likely be a 4- to 5-meter (13- to 16-foot) in-diameter, iron or lead detector that would use magnets to deflect daughter products for neutrino interactions in the detector (Nelson and Bennington 2000; Brodzinski et al. 1999). The lead involved could pose toxic hazards, while the magnetized iron could pose radiation hazards. The length of the detector could be as long as 300 to 500 meters (980 to 1,640 feet) and would have to point toward either the Fermi or Brookhaven facilities.

The facility would have to be constructed underground. Additional excavation would be necessary and would probably be east of the experiment gallery. Figure 2-6 shows the latest proposed location for the detector.

2.1.1.2 Other Astrophysics and Physics Experiments

Study of Magnetic and Radiation Field Interaction

Physicists have long known there is a relationship between magnetic and radiation fields due to research done as part of the nuclear weapons program, but they do not understand the interactions between those fields. Because cell phones, television stations, radio stations, and power and transmission lines all emit electromagnetic radiation, and other technological developments such as hospital x-ray machines and new products create radiation fields, a better understanding of this relationship may be important to future health research.

An underground laboratory with low radiation levels would allow scientists to build a laboratory for such studies. The laboratory was estimated at 12 meters by 9 meters by 4.5 meters (40 feet by 30 feet by 15 feet). It would need to be isolated from fields generated by other experiment equipment. Within the laboratory, scientists would create and control magnetic fields and monitor them as small radiation fields would be introduced. The radiation sources envisioned would be the type used to calibrate equipment (Brodzinski et al. 2000; Jarvis 2000).

2.1.1.3 Mine Safety and Geophysical Studies

Mine Tremor and Sensor Studies

A variety of in-mine monitoring systems are used throughout the nation to detect rock bursts and tremors in mines. The accuracy and precision of some of these systems are poorly known. Testing of prototype systems and their capabilities and limitations might be better characterized using small explosive caps in a deep geologic mine. The experiment would use such caps after installation of a three-dimensional grid with centimeter-size sensors. The sensors would be connected to a central personal computer in the mine (Rohay 2000; Brodzinski et al. 2000; Smoot 2000).

OTHER UNDERGROUND ASTROPHYSICS EXPERIMENTAL OBSERVATORIES

Below is a list of other major astrophysics observatories and major experiments searching for Dark Matter, WIMPs, and neutrinos.

Sudbury Neutrino Observatory: The Sudbury Neutrino Observatory is 2,070 meters (6,800 feet) underground in an active nickel mine in Sudbury, Ontario. It has a 30-meter (98-foot) wide barrel-shaped container filled with water. In the middle of the water is a round container with 900 metric tons (1,000 tons) of heavy water inside (about $300 million worth). Around the heavy water are 9,600 photomultiplier tubes that can detect changes in light so small that they could detect a candle on the moon. The objective of the observatory is to identify neutrinos, which sometimes give off a slight glow as they pass through water, deep underground (SNO 1999).

Kamiokande and Super Kamiokande: Kamiokande is the oldest of the underground detectors used in neutrino research. It was first completed in 1983 and later upgraded in 1985. It is a 16-meter by 15.6-meter (52-foot by 51-foot) tank containing 1,000 photomultiplier tubes in 2,700 metric tons (3,000 tons) of pure water. It is located 1,000 meters (3,300 feet) underground in the Mosumi Mine of the Kamioka Mining and Smelting Company in Japan. Super Kamiokande is also in the mine. Completed in 1996, it contains two tanks, one inside the other. The outer tank contains 29,000 metric tons (32,000 tons) of water; the inner tank contains 16,300 metric tons (18,000 tons) of water and 11,200 photomultiplier tubes. Super-Kamiokande has ten times the volume and twice the density of photomultiplier tubes as the older Kamiokande (University of Tokyo 2000; University of Washington 1999).

Gran Sasso: Gran Sasso, a more general physics laboratory, is located in a tunnel off the 10.4-kilometer (6.5-mile) Gran Sasso Tunnel in Italy containing the highway connecting Teramo and Rome. The distance between the laboratory and the surface, at the maximum point, is about 1,400 meters (4,600 feet). The laboratory contains three halls where the experiments are conducted, each more than 100 meters (330 feet) long and 18 meters (59 feet) high (Gran Sasso Laboratories 2000).

Boulby Mine Dark Matter Experimental Facility: Also planned for a portion of the OMNIS experiment, the Boulby Mine Dark Matter Experimental Facility is located 1,100 meters (3,600 feet) underground in the United Kingdom in a salt seam of a mine owned by Cleveland Potash Ltd. The facility is the location for several current and future experiments (Cleveland Potash 2000).

AMANDA: The Antarctic Muon and Neutrino Detector Array (AMANDA) and several other similar experiments (DUMAND, RICE, and RAND) are searching for neutrinos and WIMPs by placing detectors deep under ice or deep under the ocean’s waters. AMANDA is being constructed at the South Pole by drilling deep into the polar ice cap and placing the sensors in deep water-drilled holes (Berkeley 2000; Autodynamics 2000).

Soudan Underground Laboratory: Located 690 meters (2,260 feet) underground, in the Minnesota’s Soudan Underground Mine State Park, this laboratory is jointly operated by the University of Minnesota and various other research organizations. The mine is operated by the State of Minnesota as a tourist park where sightseers can view historical mining practices. Originally opened in 1980, Soudan is the site for a large detector for a neutrino beam from Fermi National Accelerator Laboratory, 730 kilometers (450 miles) away (University of Minnesota 1996; Minnesota DNR 2000).

Other experiments or observatories (of lesser significance) are located in Russia, France, and South Dakota (Autodynamics 2000).

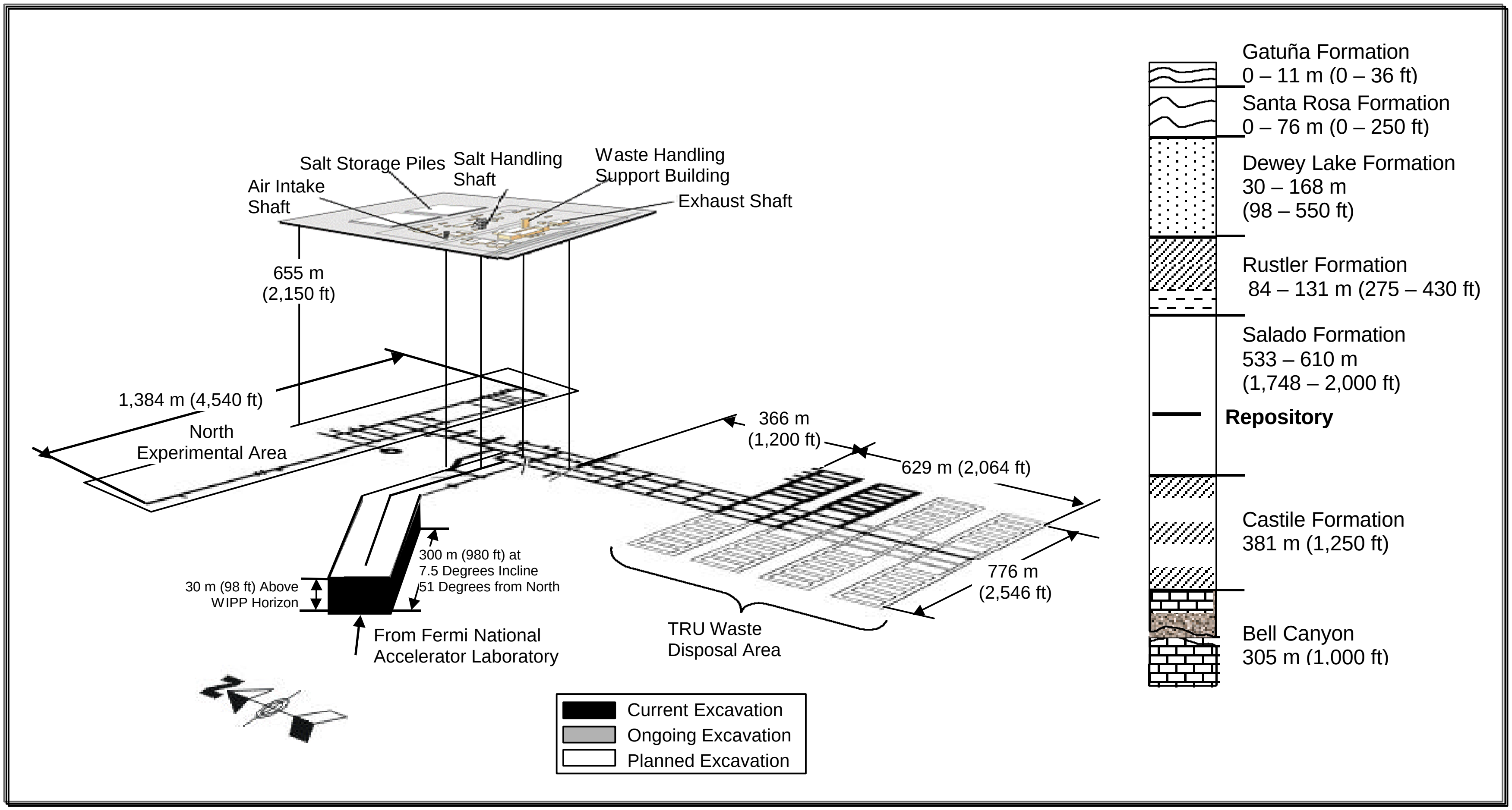


Figure 2-6. Proposed Neutrino Factory Detector at WIPP

Decoupling of Explosive Events in Salt

One of the difficulties in monitoring for compliance of a comprehensive test ban is that salt mines can be used to conceal mining and explosions. Salt can be mined by solution, making mining activity hard to detect. Salt also presents the opportunity to separate an explosion from the surrounding rock, making explosions hard to detect. Also, there are numerous salt mines in areas of the world where nuclear tests may occur. To better understand explosions in salt mines, small holes could be drilled into a part of a salt mine (1 centimeter to 1 meter [0.4 inch to 40 inches] long) in which small explosive charges (blasting cap, M-80, or shotgun size) could be ignited. The sensors used for the mine tremor study described above could be used to determine and model how decoupling in salt may occur (Rohay 2000; Barnett 2000).

Heat Study of Salt Deposits

The thermal stress response of salt deposits would allow a better understanding of the past and future behavior of such deposits. Scientists, therefore, proposed to place a 5-meter (16-foot) long electrode into a hole in either the floor or wall of a drift in the experiment gallery and establish an array of sensors at a radius of 15 meters (50 feet) around the electrode. The electrode would be connected to a 220-kilovolt power source; the salt around the electrode would be allowed to reach equilibrium over several weeks. The sensor would be connected to a data logger that would record how the salt reacts to the additional heat.

2.1.1.4 Nonproliferation and Nuclear Accountability Experiments

In addition to the decoupling experiment described in Section 2.1.1.3, nonproliferation and nuclear accountability experts proposed using TRU waste to be disposed of at WIPP as a surrogate for fissile materials to test monitoring devices for such materials for accountability purposes. Among the possible surveillance techniques to be tested are (1) placing radio frequency tags on the material to be monitored; (2) placing radiation monitors on the shafts to see if material is being removed; and (3) conducting acoustic imaging of materials to see if they can be identified through the salt formation. Other methods would include burying neutron detectors with some of the waste to monitor the neutron flux. Before doing so, natural flux in the salt environment would need to be identified. Testing and calibrating equipment would demand a small room in the experiment gallery into which equipment and small amounts of nuclear material (equivalent to sealed sources used to calibrate equipment) would be brought (Griggs 2000).

2.1.1.5 Chemical and Material Processing Experiments

Deep Mine Electroplating

Cosmic rays induce unwanted radioactivity in all materials. Though typically this radioactivity is at a level that does not result in concern, some materials for particularly sensitive experiments are often damaged by these cosmic rays. Many of these materials can be purified, but it is difficult to do so in an environment with cosmic rays present because the rays cause the materials to be redamaged. Producing these materials in a production facility deep underground would allow them to escape the cosmic rays. A typical production facility would involve several modular rooms 3 meters by 3.6 meters (10 feet by 12 feet) in size. In the rooms, a half dozen electroplating baths ranging in size from a couple of gallons of liquid to 189-liter (50-gallon) drums would be necessary. Typically, the purification process involves sulfuric acid (7 percent) and sometimes other acids. A portable fume hood with high-efficiency particulate air (HEPA) filtration would be used to contain any fumes from the acid baths or pickling processes (Brodzinski et al. 2000).

Crystal or Microprocessor Development

Crystal or microprocessor development experiments would use the same types of chemical baths and techniques described in the discussion of deep mine electroplating, above.

2.1.1.6 Other Experiments Considered But Not Included in Analyses

The UNO experimental facility (formerly the Next generation Nucleon decay and Neutrino experiment) is one of the nine experiments currently submitted for consideration to be conducted at WIPP. The UNO is more than a decade from proposal and has been estimated to cost up to $0.5 billion. The detector, proposed by a collaboration of numerous U.S. and international astrophysicists, would involve excavating a room large enough to hold a tank containing more than 450,000 metric tons (500,000 tons) of ultra-pure water. Some scientists have estimated that the room would be nearly 10 stories high and might be larger than the WIPP facility itself. The UNO has been proposed by scientists who believe it is time to discuss replacing one of the world's top neutrino detectors, the Super-Kamiokande detector in Japan. The UNO would observe cosmic neutrinos as well as those generated by a neutrino (muon) factory like that proposed for Brookhaven National Laboratory or Fermi National Accelerator Laboratory. The anticipated operating life of the UNO, if ever built, could be more than 50 years. Because it would be so large, would involve so much water, and would operate so long, DOE believes construction of the UNO at WIPP is well beyond the scale of other near-term experiments. For this reason, it is not analyzed in this EA. A separate NEPA document describing the impacts of the UNO would be necessary, if the project were developed beyond the current conceptual stage (Brodzinski et al. 2000; Nelson and Bennington 2000).

Numerous other experiments were postulated by experts at PNNL, all of them interesting to various scientific disciplines. They included the study of biorhythms, the ability of birds to navigate (some believe it is by the stars), plant and animal development in an atmosphere without cosmic rays or magnetic fields, biological dosimetry experiments, experiments in acoustics, and behavioral and sociological studies. These types of experiments would employ equipment that is similar to the experiments described in previous sections or would not involve the use of hazardous materials. For this reason, they are not included in the analyses, and their impacts are considered to be included within the impacts assessed (Brodzinski et al. 2000). Should additional experiments be proposed that are unlike the experiments described above or that could pose unidentified hazards, additional NEPA analysis would be conducted.

2.1.2 WIPP Experiment Gallery

The WIPP facility is 655 meters (2,150 feet) underground (WIPP 2000a). Underground facilities offer an environment far from electromagnetic fields and suitable to experiments that require absolute darkness and acoustic isolation (WIPP 2000b). The experiment gallery (Figure 2-7) is one of the earliest areas of the WIPP repository to be excavated (Nelson 2000c). The gallery includes a north/south drift that connects the North Experiment Area with the central part of the facility. It also includes two cross-cutting drifts. This area of the repository has been fully excavated and is not currently in use (Nelson 2000c).

The north/south drift in the experiment gallery is 100 meters (330 feet) long by 10 meters (33 feet) wide (Figure 2-7). The crosscutting drifts each have approximately 46 meters (150 feet) on each side of the north/south drift. They too are 10 meters (33 feet) wide. The result is an area shaped similar to a capital I with 2,850 square meters (30,690 square feet) of floor space. The ceilings throughout this area are 6 meters (20 feet) high (Nelson 2000c). The experiment gallery would be nearly 0.8 kilometer (0.5 mile) from the nearest TRU waste emplacement cell.

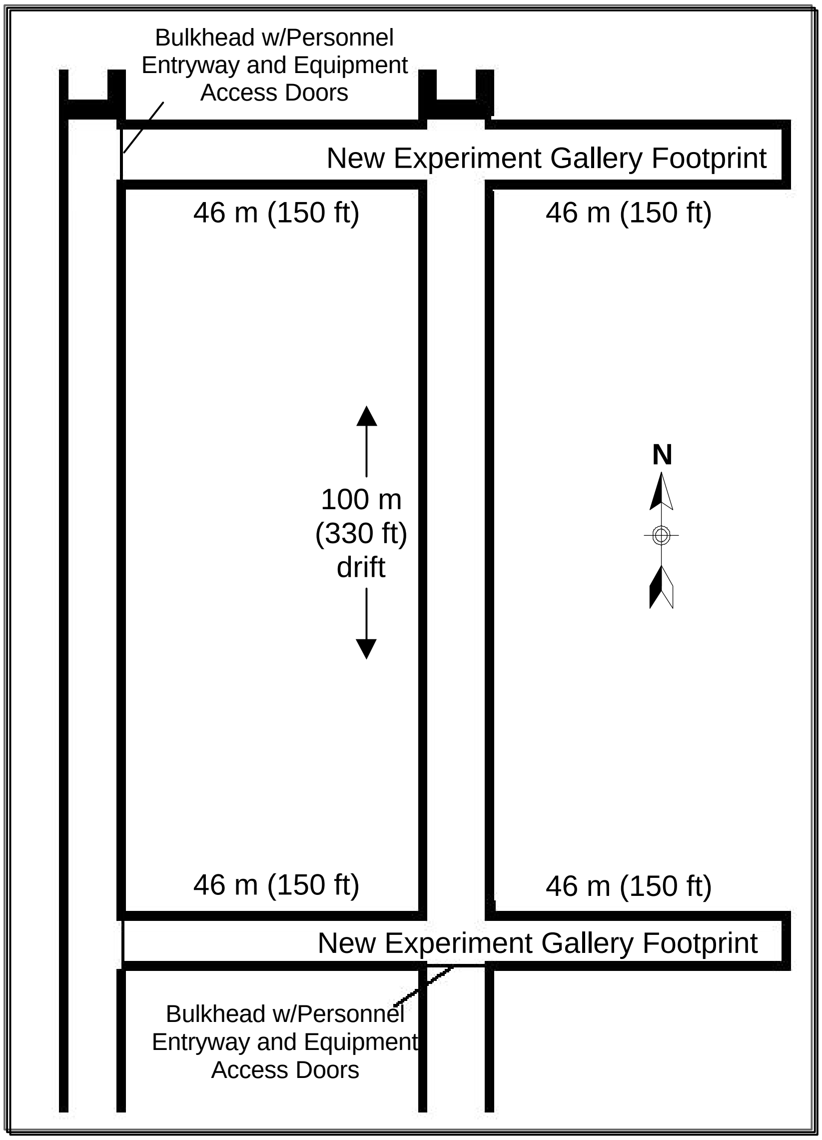


Figure 2-7. Closeup of Experiment Gallery

For wastes produced in the course of conducting the experiments, a less-than-90-day waste accumulation area would be located near the experiment gallery. The exact location of the waste accumulation area would be determined when DOE knows which experiments would be conducted in the experiment gallery and how the experiments would be arranged physically.

2.1.3 Construction, Preparation, and Maintenance Activities

At the WIPP site, construction, preparation, and maintenance activities would be minimal. DOE is proposing to seal the ends of each drift in the experiment gallery at its opening to the rest of the repository with bulkheads that would include both doors for equipment and doors for people. Air flow in the rest of the repository is maintained at a flow rate that allows the use of diesel equipment. Within the experiment gallery, such equipment would rarely be used, so the flow bulkheads would allow the flow rate to be reduced to just that for safe occupation. This would enable any salt dust to quickly settle within the experiment gallery (Nelson 2000a). Figure 2-8 shows the current airflow and ventilation system in the WIPP underground. The figure shows that the air supply in the area of the experiment gallery is "North Area Air" (indicated by the letter "N" embedded in arrows representing intake supply air). This air supply is separated from other areas of the WIPP underground (for example, the embedded letter "D" in arrows representing intake supply air for the disposal area) by the use of engineered features such as bulkheads and airlocks; these features are also shown in Figure 2-8.

Some experiments would require air conditioning and humidity control to maintain experimental and data recording equipment within operating specifications. For those experiments, bulkheads would be required with exchangeable filters and/or refrigerated air conditioners (Nelson 2000a).

Some astrophysicists and other scientists have requested that DOE expand the experiment gallery to the east or west to allow for larger experiments or those that must be placed at particular locations or angles. As noted in the descriptions above, several have requested particular locations of modifications to the gallery. As part of the Proposed Action, DOE could authorize additional excavation near the experiment gallery as long as it could be done safely by DOE's current excavation staff, could be done without impacting emplacement of TRU waste, and would not impact repository performance. During any construction or modification activities, care would be taken to minimize fugitive dust emissions. For purposes of analysis, the additional excavation would be limited to east and west of the experiment gallery and to an extent no greater than that necessary for a standard WIPP disposal panel similar to Panels 1 and 2. The excavated area of such a panel is approximately 11,530 square meters (124,150 square feet) of floor space, including access drift (Balduini 2000). Salt from the excavations would be placed with the other salt from WIPP excavations at the surface of the facility (Nelson 2000a).

On the surface, the only anticipated disturbances due to these activities may be the construction of a small meeting place and laboratory from which experiment scientists could monitor activities below the surface or the placement of near surface detectors in conjuction with the OMNIS experiment. Any support buildings would be located in areas already disturbed by WIPP activities, within the fenceline for the facility.

Preparation of the experiments would demand the lowering of tons of lead, iron, liquids, equipment, and modular rooms over a period of 4 or 5 years. The elevator and hoist at the WIPP facility would be used for these activities, as they are available around disposal activities. The waste hoist at the WIPP facility is capable of lowering 41 metric tons (45 tons) of material at a time (Breidenbach et al. 2000). Once in the repository, the material would be moved north into the experiment gallery, where it would be assembled using standard construction methods.

Maintenance activities in the experiment gallery would be the same as maintenance activities in other areas of the WIPP underground. At WIPP, personnel working underground conduct a monitoring and excavation maintenance program. WIPP facilities are inspected a minimum of four times a year by the Mine Safety and Health Administration, as required by the Land Withdrawal Act. In addition, geotechnical instrumentation provides continuous information about rock mass movement and deformation. Underground workers also have the authority to close a suspect area to entry until it has been inspected by excavation safety personnel and made safe by bringing down loose rock or installing safety control measures.

Before any experiment is placed in the WIPP underground, a hazards analysis would be performed for that experiment. The hazards analysis would provide specific information about (1) the types of waste that could be produced in the course of conducting the experiment, and (2) the waste handling methods to

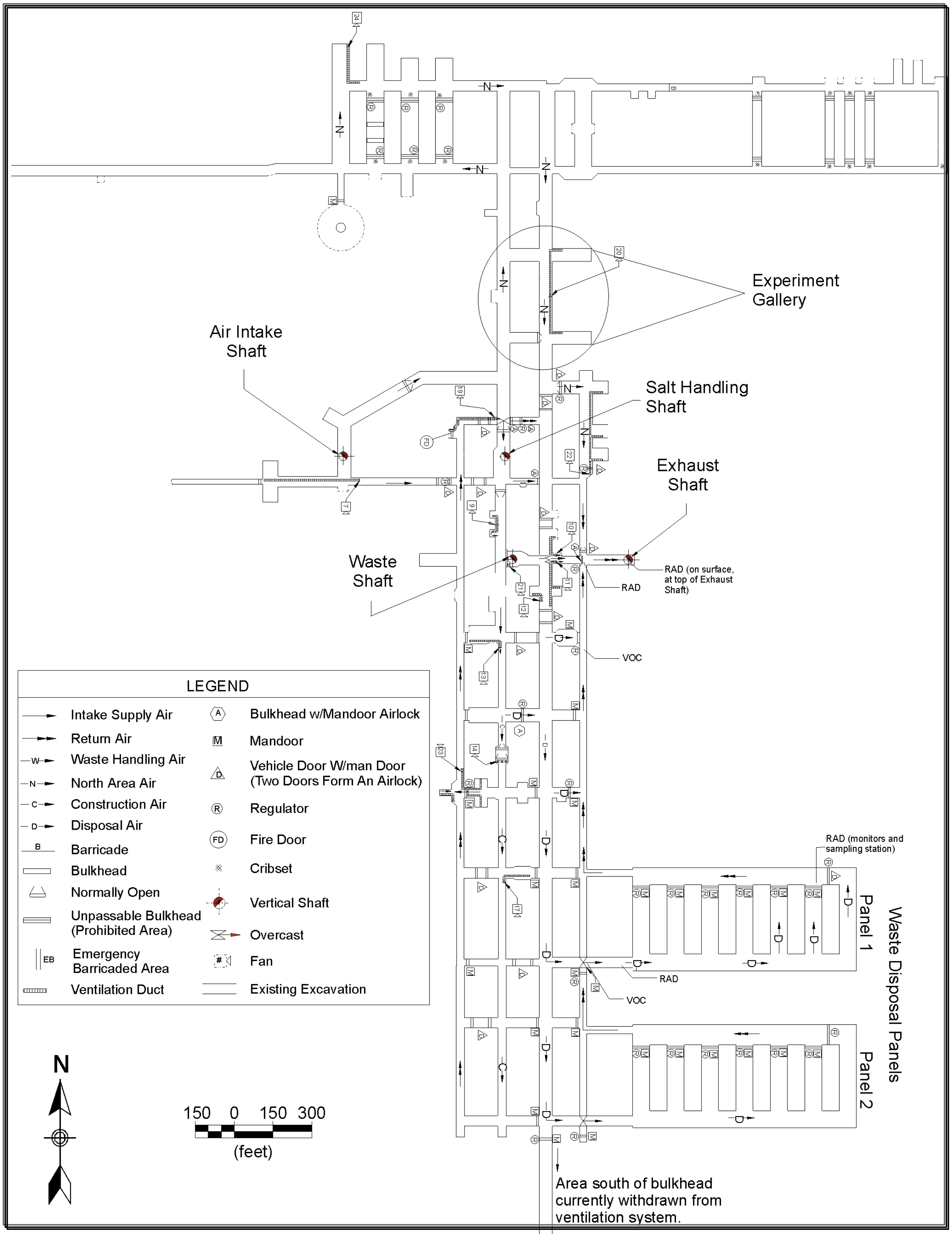


Figure 2-8. Air Flow/Ventilation System and RAD/VOC Monitors in the WIPP Underground

be used. The hazards analysis would also identify hazard mitigation measures to be implemented as part of a particular experiment to minimize the hazard to workers and the public.

2.1.4 Operation of the Experiments

Each experiment would be operated in a different fashion. Overall, most would require data-gathering using a computer system, replacement of components to test different materials, and chemical processes similar to those conducted in a standard laboratory aboveground.

For purposes of analysis, it is assumed that the 15 experiments would have two individuals in the repository, 40 hours over 5 consecutive days a week (the surface experiment would not need additional workers). A total of 30 people, therefore, would be expected in the repository's experiment gallery at any one time. In addition, another 8 to 10 individuals might be in the aboveground monitoring building.

For purposes of analysis, it also is assumed that each experiment would continue for 30 years, after 5 years of preparation and construction. Following the 35-year period, the experiments would be decommissioned with the WIPP facility. All of the experiments described above could be conducted within the experiment gallery at WIPP.

2.1.5 Decommissioning

Decommissioning activities for the experiment gallery would begin with removal of all experimental equipment and materials, including all lead, iron, liquids, and hazardous materials. The experiment gallery would be decommissioned in compliance with requirements of the New Mexico Environment Department's Hazardous Waste Facility Permit. The materials and equipment used in the experiments either would be decontaminated, if possible, and reused and recycled, or would be disposed of at permitted disposal facilities. The disposal of experimental materials and equipment would be the responsibility of the experimenters. Decontamination would be required as a result of the use of hazardous or radioactive materials in the experiments, not as a result of WIPP disposal operations.

Other decommissioning activities would be identical to those for the WIPP facility (see the text box titled "Closure and Decommissioning"). These activities were described and the potential environmental impacts of these activities were analyzed in WIPP SEIS-II (DOE 1997).

2.2 NO ACTION ALTERNATIVE

Under the no action alternative, no astrophysics or other proposed or anticipated basic science experiments would be conducted at WIPP. The area defined as the experiment gallery at WIPP would remain, as it currently is, until some other use for it is found or disposal operations are terminated and the facility is dismantled and decommissioned.

2.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

The only decision pending before the Department is whether to allow the use of WIPP for several different types of scientific experiments sponsored by scientists outside of the Department (although some may receive DOE funding). Although it is possible that these experiments could be conducted at other underground facilities (for example, the proposed Yucca Mountain Repository in Nevada, mines located in various parts of the United States or the world, existing astrophysics facilities) or that a new national underground laboratory could be constructed, these decisions are neither before DOE at this time nor even within DOE's jurisdiction. For these reasons, DOE examined only whether to authorize the use of WIPP for the type of scientific experiments described in Section 2.1.1.

CLOSURE AND DECOMMISSIONING

DOE will close the repository when WIPP achieves full capacity (currently 175,600 cubic meters [6.2 million cubic feet]) of TRU waste. Final facility closure will include the placement of a repository sealing system, which will consist of natural and engineered barriers within the WIPP repository to prevent water from entering it and impede gases or brines from migrating out.

Plans for the shaft sealing system include completely filling the shaft with engineered materials possessing high density and low permeability. Shaft seal components for that portion of the shaft that is within the Salado Formation will provide the primary barrier by limiting fluid transport along the shaft during and beyond the 10,000-year period. Shaft seal components within the Rustler Formation will limit commingling between brine-bearing members, as required by state regulations. Shaft seal components from the Rustler to the surface will fill the shaft with common materials of high density, consistent with good engineering practice.

The Department will decommission the site in a manner that will allow for safe, permanent disposition of surface and underground facilities, which will be consistent with the then-applicable regulations. Little or no contamination of facilities is expected. Equipment and facilities will be decontaminated as necessary. Usable equipment will be removed and surface facilities dismantled. A berm will be constructed around the perimeter of the closure area, which will include 70 hectares (175 acres). The area above the 10 panel equivalents will be 50 hectares (125 acres), the area of the salt pile will be 12 hectares (30 acres), and the area of the surface facilities will be 8 hectares (20 acres). The height of the berm will be sufficient to identify the closure area and impede access. DOE will restore the areas occupied by the salt pile and surface facilities and, if necessary, any of the area overlying the disposal panel area, although surface disturbance of this area will be minimal. This decommissioning period is anticipated to take up to 10 years. Any salt remaining after WIPP closure and construction of the berm will be sold or disposed of in accordance with the Materials Act of 1947.

The anticipated long-term controls for the WIPP site after the Department closes it include active controls, monitoring, and passive controls. The 100-year active institutional control period will extend through the year 2143, during which the Department will use a fence and an unpaved roadway along the perimeter of the repository surface footprint area (the waste disposal area projected to the surface) to control access. The fence line will be posted with signs that warn of the danger and that state that access by unauthorized persons is prohibited. Routine, periodic patrols and surveillances of the protected area will be conducted as well as periodic inspection and necessary corrective maintenance of the fence, signs, and roadway. In addition, the Department will prohibit drilling within the Land Withdrawal Area to preclude inadvertent intrusion into the repository.

The Department will place a number of permanent markers to inform and warn subsequent generations that radioactive waste is buried there. This permanent marker system will be designed to minimize the likelihood of human intrusion. Current plans include markers that will identify the site, relay warning messages, use multiple methods for marking the site, use multiple means of communications (e.g., language, pictographs, scientific diagrams), use multiple levels of complexity within individual messages on individual marker system elements, and be constructed of materials with little intrinsic value.

—Other actions under consideration by DOE include:

- Construction of two "information centers," one on the surface and one buried beneath the surface, with more information on the type of waste disposed of at WIPP, why the waste is dangerous, and why TRU waste should not be disturbed
- Placement of additional warning messages approximately 6 meters (20 feet) beneath the surface, within the perimeter
- Placement of large permanent magnetic materials and radar reflectors within the berm so that the site can be remotely detected
- Creation of offsite archival records at several local, state, and federal organizations.

CHAPTER 3

EXISTING ENVIRONMENT

The following sections briefly describe the environmental resources at the WIPP site that may be affected by the proposed activities. The primary source of information on these resources is WIPP SEIS-II (DOE 1997).

3.1 LAND USE

The FEIS (DOE 1980) states that almost 7,700 hectares (19,000 acres) of land surrounding WIPP were committed to the WIPP project. It notes that 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. The Bureau of Land Management (BLM) administers 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 administers most of the land within 50 kilometers (30 miles) of the WIPP site. Within 80 kilometers (50 miles) of the site, land uses include dryland farming, irrigated farming along the Pecos River, forest, wetland, and urban areas.

SEIS-I (DOE 1990) notes the release of approximately 4,450 hectares (11,000 acres) of previously restricted land for unrestricted use, allowing exploration for and development of mineral resources and permanent habitation. It describes a land withdrawal boundary, which defines the WIPP site, as encompassing 16 sections (4,146 hectares [10,240 acres]) of federal land in Township 22 South, Range 31 East. This boundary was delineated so as to extend at least 1.6 kilometers (1 mile) beyond any WIPP underground development.

On October 30, 1992, the President signed into law the Land Withdrawal Act (Public Law 102-579); it was amended in 1996 (Public Law 104-201). 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. However, EPA has determined that the exercise of existing rights under oil and gas leases within the Land Withdrawal Area would not affect WIPP performance and that, therefore, some oil and gas exploration below 1,800 meters (6,000 feet) is allowed under the Land Withdrawal Act. The Act also establishes certain rights and responsibilities, one of which was the preparation of a Land Management Plan (DOE 1993a). The WIPP Land Management Plan establishes a goal of multiple-use management for the surface area, as well as opportunities for participation in land use planning by the public and by federal, state, and local agencies.

The site has been divided into four areas under DOE control. 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 public land use concept of multiple use. Mining and drilling for purposes other than support of the WIPP project, however, are restricted (DOE 1997). The type of land use surrounding WIPP has not changed substantially since the preparation of SEIS-II in 1997 (DOE 1997), although the level of development has increased.

3.2 GEOLOGY

3.2.1 Regional Setting and Surface Geology

WIPP is located in southeastern New Mexico, in the Pecos Valley Section of the Great Plains Physiographic Province. 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 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. Prominent local physiographic features include Nash Draw (a shallow, 8-kilometer [5-mile] wide valley open to the southwest located west of the WIPP site) and the San Simon Swale (a broad depression about 24 kilometers [15 miles) east of the WIPP site) (Figure 3-1) (DOE 1997).

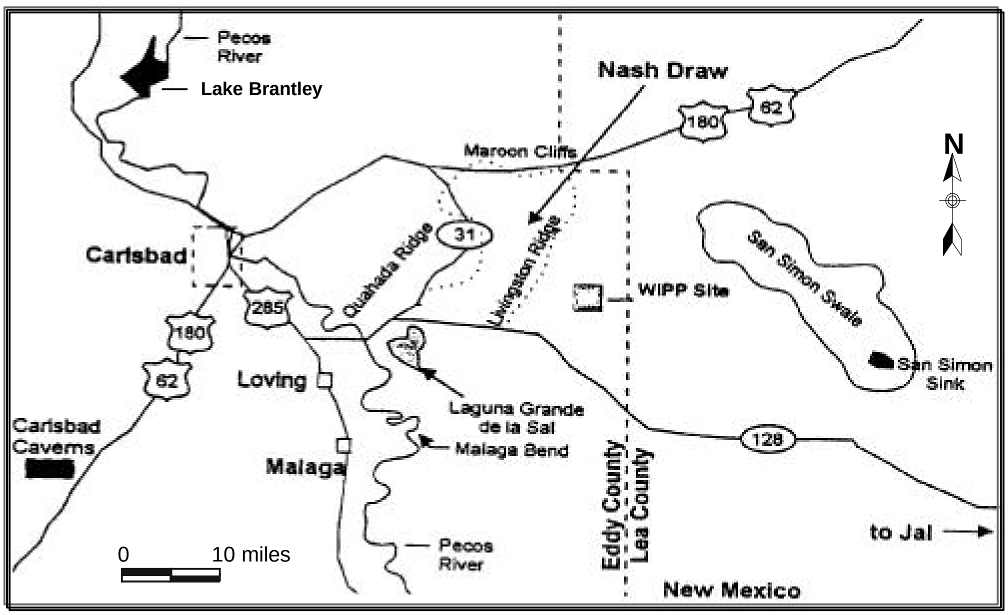


Figure 3-1. Physiographic Features Near the WIPP Site

3.2.2 Subsurface Geology

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.[1] These rocks represent the thickest portion of the structural basin underlying WIPP. They are composed of saltbeds and are essentially hydrologically isolated from overlying layers (DOE 1997).

[1] A geologic period of the Upper Paleozoic era, extending from the end of the Carboniferous period to the beginning of the Mesozoic era (from about 295 million to 250 million years ago).

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 (see Figure 1-3).

3.2.3 Faulting and Seismicity

No surface displacement or faulting younger than early Permian have been reported, indicating that tectonic movement since then, if any, has not been noteworthy. The most recent earthquake recorded at the WIPP site occurred on April 14, 1995; its epicenter was located approximately 240 kilometers (150 miles) south of the site. It was assigned a magnitude of 5.3 and had no effect on any structures at WIPP (DOE 1997).

3.3 HYDROLOGY

3.3.1 Surface Water

WIPP is located east of the Pecos River and within the Pecos River basin (which represents about one-half of the drainage area of the Rio Grande Water Resources Region). The drainage area of the Pecos River at this location is 49,200 square kilometers (19,000 square miles). The WIPP site has a few small intermittent creeks, the only westward-flowing tributaries of the Pecos River within 32 kilometers (20 miles) north or south of the site.

The Pecos River is the main surface water resource in the WIPP vicinity. Due to inflow from brine springs (from the Rustler Formation) and slight exceedance of water quality levels of certain heavy metals over water quality standards (DOE 1996a), river water is not used for human consumption. Irrigation and livestock watering are the primary uses of the water from the Pecos.

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 runoff and percolation. The maximum recorded flood on the Pecos River occurred on August 23, 1966, near Malaga, about 25 kilometers (15 miles) from WIPP. The maximum elevation of the flood was 90 meters (300 feet) below the elevation of the WIPP surface facility.

3.3.2 Groundwater

The WIPP repository is situated in the thick, relatively impermeable Salado Formation salt beds 655 meters (2,150 feet) below the ground surface (see Figure 1-3). Generally, groundwater in the Rustler and Dewey Lake Formations and the units overlying them is essentially isolated from the hydrology of the Salado Formation.

The Rustler Formation includes the Culebra and Magenta Dolomites, two units containing water of low quality (brine to brackish) (DOE 1996b). The Culebra Dolomite, which is the first notable water-bearing unit above the Salado Formation, has been investigated for its potential to transport radionuclides released from the repository. Groundwater flow in the units overlying the Salado Formation has been assumed to occur primarily in the Culebra Dolomite, although it is recognized that regional flow in the Rustler Formation is three-dimensional and occurs to some degree in all Rustler units (DOE 1996b). 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 (DOE 1996b). The location of the water table is generally considered to be the Dewey Lake Formation.

Only a few locations of groundwater recharge and discharge to and from the Rustler Formation are known. The only documented areas of naturally occurring groundwater discharge in the vicinity of WIPP are the Pecos River near Malaga Bend (Hunter 1985) and, to a lesser extent, the saline lakes in Nash Draw. This local flow associated with Nash Draw is unrelated to groundwater flow at WIPP. The only documented area of groundwater recharge is also near Malaga Bend (Hunter 1985). This location is hydraulically downgradient from the repository, and recharge here has little relevance to flow near WIPP. Recent regional groundwater modeling by Corbet and Knupp (1996) has suggested that groundwater in the Culebra, Magenta, and Dewey Lake and Triassic units originates in areas that are north and northeast of the WIPP site (DOE 1996b).

3.4 BIOLOGICAL RESOURCES

The vegetation at the WIPP site area is dominated by shinnery oak (*Quercus havardii*), mesquite (*Prosopsis grandulosa*), sand sage (*Artemisia filifolia*), and smallhead snakeweed (*Gutierrezia microcephala*) (DOE 1990).

Ninety-eight species of birds are known to inhabit or migrate through the area (DOE 1993b, 1994, and 1995a). The Harris hawk (*Parabuteo unicinctus*), loggerhead shrike (*Lanius ludovicianus*), and black-throated sparrow (*Anphispiza bilineata*) are resident birds.

Small mammals that are common at the WIPP site area include the black-tailed jackrabbit (*Lepus californicus*), the desert cottontail (*Sylvilagus auduboni*), and Ord's kangaroo rat (*Dipodomys ordii*). Mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) are among the larger mammals that occur at the site. Stock watering ponds and tanks provide aquatic habitat for yellow mud turtles (*Kinosteron flarescens*) and tiger salamanders (*Ambystoma tigrinum*) (DOE 1993b, 1994, 1995a).

The Department concluded in SEIS-I that there is no critical habitat for terrestrial species identified as endangered, threatened, or candidate species by either the U.S. Fish and Wildlife Service or the New Mexico Department of Game and Fish at the site (DOE 1990).

In 1996, DOE conducted a survey on the WIPP Land Withdrawal Area and associated lands to investigate the potential for impacts to rare, threatened, endangered, or sensitive plant or animal species as a result of the potential actions presented in SEIS-II (DOE 1997). The 1996 survey included an assessment of suitable habitats for these species. No federal- or state-listed species were found on the WIPP Land Withdrawal Area during the survey. The data reported in the survey, which support the conclusions of other studies, remain valid in 2000 and indicate that permanent populations of these species are not currently established on WIPP lands (Lynn 2000).

Currently, the U.S. Fish and Wildlife Service lists 5 federally endangered, 5 federally threatened species, and 3 candidate species for Eddy County (FWS 2000). The New Mexico Department of Game and Fish currently lists 11 endangered and 21 threatened animal species (NMDG&F 2000), while the New Mexico Energy, Minerals, and Natural Resources Department lists 8 endangered and 18 state-sensitive plant species for Eddy County (NMEMNR 2000) (Table 3-1).

Table 3-1. State of New Mexico Threatened and Endangered Species (Eddy County)

Scientific Name	Common Name	Status
Birds		
Haliaeetus leucocephalus	Bald eagle	Federal and State Threatened
Sterna antillarum	Interior least tern	Federal and State Endangered
Strix occidentalis lucida	Mexican spotted owl	Federal Threatened
Falco femoralis septentrionalis	Northern aplomado falcon	Federal and State Endangered
Empidonax traillii extimus	Southwest willow flycatcher	Federal and State Endangered
Pelecanus occidentalis carolinensis	Brown pelican	State Endangered
Phalacrocorax brasilianus	Neotropic cormorant	State Threatened
Falco peregrinus anatum	American peregrine falcon	State Threatened
Charadrius melodus circumcinctus	Piping plover	State Endangered
Columbina passerina pallescens	Common ground dove	State Endangered
Cynanthus latirostris magicus	Broad-billed hummingbird	State Threatened
Vireo bellii	Bell’s vireo	State Threatened
Vireo vicinior	Gray vireo	State Threatened
Ammodramus bairdii	Baird’s sparrow	State Threatened
Passerina versicolor	Varied bunting	State Threatened
Mammals		
Mustela nigripes	Black-footed ferret	Federal Endangered
Cynomys ludovicianus	Black-tailed prairie dog	Federal Candidate
Vulpes velox	Swift fox	Federal Candidate
Tympanuchus pallidicinctus	Lesser prairie chicken	Federal Candidate
Cryptotis parva	Least shrew	State Threatened
Pseudemys gorzugi	Western river cooter	State Threatened
Reptiles		
Sceloporus arenicolus	Sand dune lizard	State Threatened
Lampropeltis alterna	Gray-banded kingsnake	State Endangered
Nerodia erythrogaster transversa	Blotched water snake	State Endangered
Thamnophis proximus diabolicus	Arid land ribbon snake	State Threatened
Crotalus lepidus lepidus	Mottled rock rattlesnake	State Threatened
Fish		
Notropis simus pecosensis	Pecos bluntnose shiner	Federal and State Threatened
Gambusia nobilis	Pecos gambusia	Federal and State Endangered
Astyanax mexicanus	Mexican tetra	State Threatened
Cycleptus elongatus	Blue sucker	State Endangered
Moxostoma congestum	Gray redhorse	State Threatened
Cyprinodon pecosensis	Pecos pupfish	State Threatened
Etheostoma lepidum	Greenthroat darter	State Threatened
Percina macrolepida	Bigscale logperch	State Threatened
Invertebrates		
Popenaias popeii	Texas hornshell	State Endangered
Pyrgulopsis pecosensis	Pecos pyrg snail	State Threatened
Vertigo ovata	Ovate vertigo snail	State Threatened
Plants		
Echinocereus fendleri kuenzleri	Kuenzler hedgehog cactus	Federal and State Endangered
Coryphantha (Escobaria) sneedii var. *leei*	Lee pincushion cactus	Federal Threatened, State Endangered
Amsonia tharpii	Tharp’s bluestar	State Endangered
Coryphantha scheeri	Scheer’s pincushion cactus	State Endangered

Table 3-1. State of New Mexico Threatened and Endangered Species (Eddy County) (continued)

Scientific Name	Common Name	Status
Echinocereus lloydii	Lloyd's hedgehog cactus	State Endangered
Eriogonum gypsophilum	Gypsum wild buckwheat	Federal Threatened, State Endangered
Hexalectris nitida	Shining coral-root	State Endangered
Hexalectris spicata	Crested coral-root	State Endangered
Aquilegia chrysantha var. chaplinei	Chapline's columbine	State Sensitive
Astragalus gypsodes	Gypsum milkvetch	State Sensitive
Astragalus waterfallii	Waterfall milkvetch	State Sensitive
Chaetopappa hersheyi	Hershey's cliff daisy	State Sensitive
Chrysothamnus nauseosus ssp. *texensis*	Guadalupe rabbitbrush	State Sensitive
Epipactis gigantea	Giant helleborine orchid	State Sensitive
Eustoma exaltatum	Catchfly gentian	State Sensitive
Hedeoma apiculata	McKittrick pennyroyal	State Sensitive
Justicia wrightii	Wright's justicia	State Sensitive
Penstemon cardinalis spp. *regalis*	Guadalupe penstemon	State Sensitive
Philadelphus hitchcockianus	Hitchcock's mockorange	State Sensitive
Polygala rimulicola	Guadalupe milkwort	State Sensitive
Proboscidea sabulosa	Dune unicorn plant	State Sensitive
Pseudocymopterus longiradiatus	Desert parsley	State Sensitive
Sibara grisea	Gray sibara	State Sensitive
Sophora gypsophila var. *guadalupensis*	Guadalupe mescal bean	State Sensitive
Streptanthus sparsiflorus	Guadalupe jewelflower	State Sensitive
Valeriana texana	Texas tobacco root	State Sensitive

Sources: FWS 2000, NMDG&F 2000, NMEMNR 2000

3.5 CULTURAL RESOURCES

Sixty archaeological sites and 91 isolated occurrences (single or few artifacts, or isolated features) have been recorded in the Land Withdrawal Area. The sites and isolates are almost exclusively prehistoric in origin, with only one of the 60 sites having both prehistoric and historic components. The 91 isolated occurrences have been recorded and are not likely to yield information beyond what has already been documented. Isolated occurrences are generally not eligible for inclusion in the National Register of Historic Places (NRHP). Additional investigations, therefore, are generally not required for isolates.

Many of these cultural resources are likely to yield important information about the prehistoric and early history of southeastern New Mexico. Based on the site inventory data, and assuming environmental homogeneity and a fairly even distribution of archaeological sites across the landscape, DOE estimates that the WIPP project area may contain a total of about 99 archaeological sites and 153 isolates (DOE 1993a). Historic landmarks in Eddy County include historic settlements and remains of historic trails (NMSHTD 1984). There are no known Native American sacred sites or burials in the Land Withdrawal Area. Prior to the passage of the Land Withdrawal Act in 1992, BLM managed the cultural resources at WIPP. A memorandum of understanding between DOE and the Department of the Interior in 1994 transferred management responsibility for the cultural resources to DOE. Cultural resources are currently managed according to guidelines set forth in the WIPP Land Management Plan (DOE 1993a). DOE and the State of New Mexico have signed a Joint Powers Agreement that includes provisions specifying how DOE will satisfy its obligations regarding cultural resources under Sections 106 and 110 of the National Historic Preservation Act. Any cultural resources encountered during the Proposed Action would be addressed according to the conditions set forth in the Joint Powers Agreement.

3.6 SOCIOECONOMICS

The 1997 population estimate for Eddy County was 53,256, of which approximately 40 percent were minorities. The 1997 population estimate for Lea County was 56,387, of which approximately 37 percent were minorities (U.S. Bureau of the Census 2000b).

Per capita income for Eddy County in 1994 was approximately $16,100, while the 1993 median family income was approximately $27,100. In 1993, about 20 percent of the population of Eddy County lived below the poverty level (U.S. Bureau of the Census 2000b). For Lea County, per capita income in 1994 was approximately $15,250, while the median family income in 1993 was almost $27,400. In 1993, about 23 percent of the population of Lea County lived below the poverty level (U.S. Bureau of the Census 2000b).

Economic figures for Eddy County in 1997 indicate a county-wide workforce of 16,368 employees, the majority of which were employed in the mining (17 percent), manufacturing (10 percent), retail trade (22 percent), or services (28 percent), especially health services (12.5 percent) industries. Payroll income for the county was approximately $416 million, the majority of which was earned in the mining (27 percent), manufacturing (16 percent), retail trade (11 percent), transportation and public utilities (13 percent), and service (19.5 percent) industries. Over half of the income in service industries came from the health services sector and two-thirds of the income in transportation came from the trucking sector (U.S. Bureau of the Census 2000a).

Economic figures for Lea County in 1997 indicate a county-wide workforce of 15,759 employees, the majority of which were employed in the oil and gas (13 percent), retail trade (23 percent), or services (28 percent) industries. Payroll income for the county was approximately $358 million, the majority of which was earned in the oil and gas (19 percent), transportation and public utilities (13 percent), retail trade (13 percent), and service (23 percent) industries. About 40 percent of the income in service industries came from the health services sector (U.S. Bureau of the Census 2000a).

3.7 NOISE

The ambient noise level around WIPP has been estimated to be about 50 decibels at a distance of 120 meters (400 feet) from the Waste Handling Building due to normal operations (DOE 1980). This qualitative estimate was determined to be accurate for WIPP SEIS-II (DOE 1997) and remains accurate for the current WIPP operations. DOE requires its facilities to comply with Occupational Safety and Health Administration (OSHA) standards as promulgated in 29 CFR Part 1910.95 for protection of workers.

3.8 AIR QUALITY

The EPA has classified Eddy County, New Mexico, where WIPP is located, as an attainment area for all six criteria pollutants under the National Ambient Air Quality Standards: nitrogen dioxide, sulfur dioxide, carbon monoxide, particulate matter less then 10 microns (PM_{10}), lead, and ozone. WIPP is also in a Class II Prevention of Significant Deterioration area, and any new sources of emissions would have to adhere to the standards for such an area.

Air quality monitoring data collected since 1990 are summarized in annual WIPP site environmental reports. On October 30, 1994, DOE, after notifying EPA, ceased to monitor criteria air pollutants at WIPP because there was no longer a regulatory requirement to do so. WIPP has completed inventories of potential pollutants and emissions in accordance with EPA and New Mexico Air Quality Control Regulations (AQCR). Based on these inventories, WIPP has no permitting or reporting requirements at this time except for those applying to two primary backup diesel generators. An AQCR operating permit was issued for the two diesel generators in 1993 (DOE 1995a). These diesel generators are assumed to emit four pollutants (nitrogen dioxide, sulfur dioxide, carbon monoxide, and PM_{10} and have strict limits on emissions for these pollutants.

3.9 ENVIRONMENTAL JUSTICE

Environmental justice in the context of this document refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities at WIPP. The environmental justice region of influence (ROI) covers all populations within an 80-kilometer (50-mile) radius of the reservation boundary of WIPP.[2] This region includes parts of three counties in New Mexico (Chaves, Eddy, and Lea) and parts of seven counties in Texas (Andrews, Culberson, Gaines, Loving, Reeves, Ward, and Winkler). Seventy-five percent of the ROI lies within New Mexico, and the remaining 25 percent lies within Texas.

The following population data are derived from the 1990 Census of Population and Housing (U.S. Bureau of the Census 1994); these data are the best available environmental justice data at the block group level. (Block grouping is a division of territory, the size of which varies according to population density, that has approximately 400 households.) Race/ethnic data from the 2000 census for all geographic levels (including block groups) will be released in April 2001; poverty data will be available in 2002 (UNM 2000).

Within the environmental justice ROI, the total population of 101,129 persons includes 4.1 percent non-White, 32.6 percent Hispanic, and 36.8 percent minority (all except White non-Hispanic persons). In addition, 21.5 percent of the total population had 1989 incomes below the poverty level, as defined by the U.S. Bureau of the Census. There are no Native American reservations in the ROI (U.S Bureau of Census 1994). Figures 3-2 and 3-3 display maps of the distribution of minority and low-income populations according to the percentage of the block group population in the environmental justice ROI.

More recent data estimates on low-income and minority populations are available at the county level. Tables 3-2 and 3-3 show estimated county-level low-income and minority data, respectively, for the affected counties in the ROI.

The proportion of Hispanic, minority, and low-income persons in the ROI are all greater than in the United States as a whole. Also, the proportion of low-income persons in the ROI is greater than in both New Mexico and Texas. Finally, the proportion of Hispanic persons in the ROI is smaller than in New Mexico but greater than in Texas.

[2] Towns in this ROI include Artesia, Atoka, Black River village, Carlsbad, El Paso Gap, Hope, Lakewood, Loco Hills, Loving, Malaga, Riverside, Seven Rivers, and Whites City in Eddy County, New Mexico and Eunice, Hobbs, Humble City, Jal, Lovington, Maljamar, Monument, Nadine, and Oil Center in Lea County, New Mexico. This ROI also includes Mentone in Loving County, Texas, and both Arno and Orla in Reeves County, Texas. The other counties in New Mexico and Texas that are part of this ROI have no communities within the 80-kilometer radius.

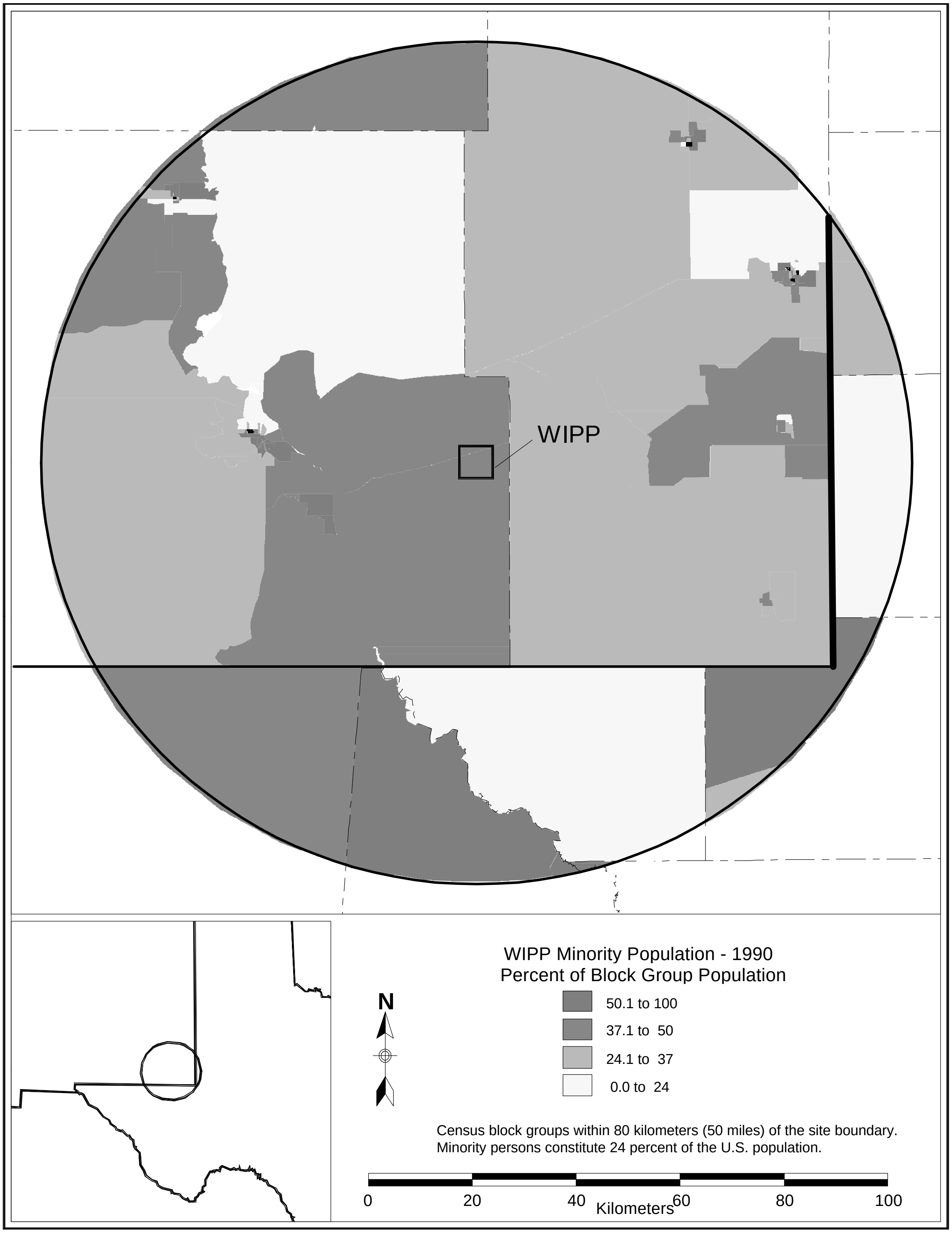


Figure 3-2. Minority Population, WIPP ROI

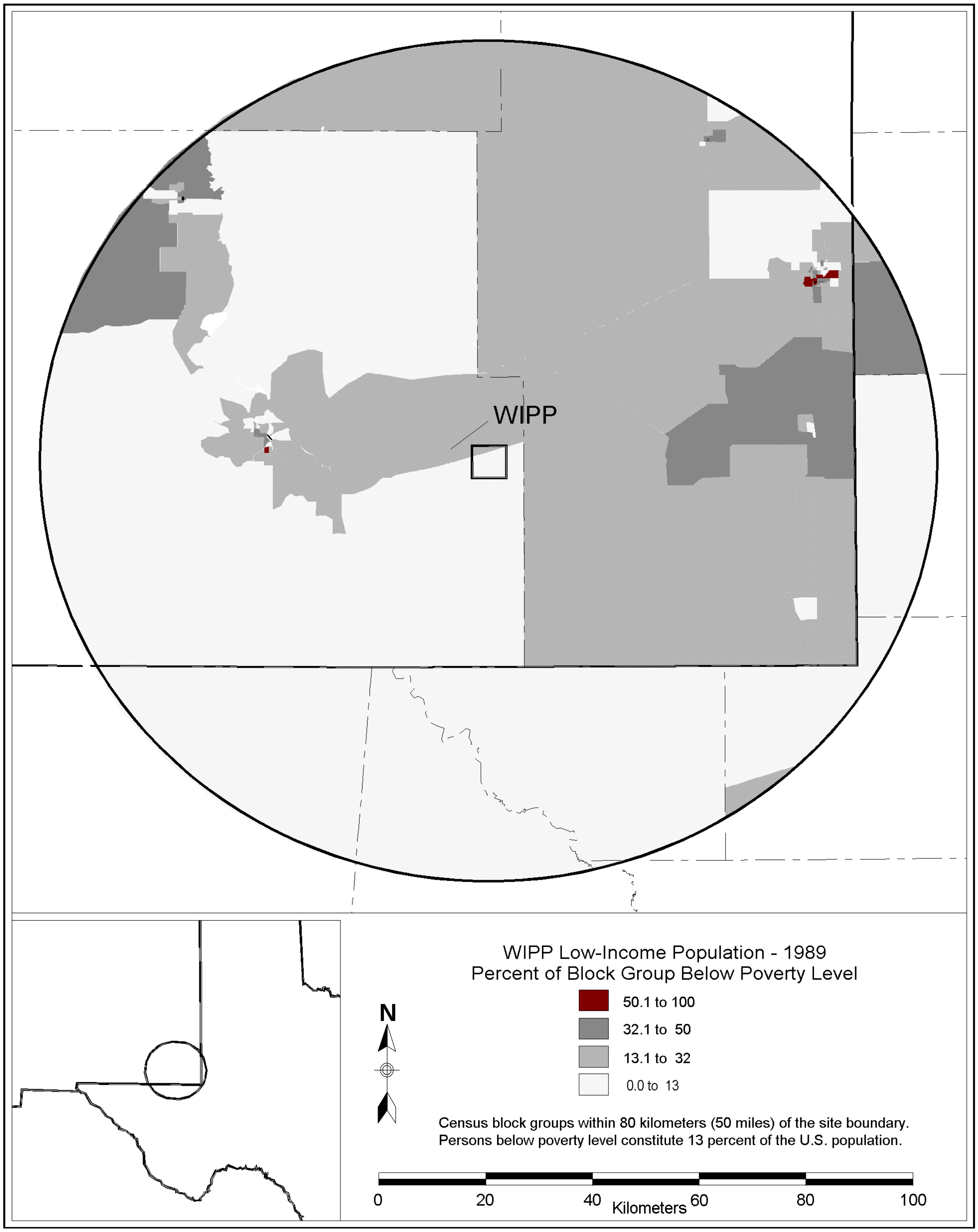


Figure 3-3. Low-Income Population, WIPP ROI

Table 3-2. ROI County Estimates for Low-Income Populations

County	Percent Estimate[a]
New Mexico	
Eddy	18.6
Lea	20.7
Chaves	23.1
Texas	
Andrews	15.8
Culberson	32.6
Gaines	20.6
Loving	22.9
Reeves	27.5
Ward	19.4
Winkler	16.8

a. Estimates model 1997 income reported in the March 1998 Current Population Survey (U.S. Bureau of the Census 1998).

Table 3-3. ROI County Estimates for Minority Populations

County	Percent Estimate
New Mexico	
Eddy	40.6
Lea	37.6
Chaves	42.5
Texas	
Andrews	41.4
Culberson	77.0
Gaines	42.3
Loving	16.8
Reeves	79.5
Ward	47.8
Winkler	46.2

Source: U.S. Bureau of the Census 2000c.

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CHAPTER 4

ENVIRONMENTAL IMPACTS

The following sections describe the environmental impacts that could occur as a result of the proposed activities at the WIPP site.

4.1 HUMAN HEALTH

The human health impacts of the proposed astrophysics experiments are quantified in this section to the extent possible given the uncertainties in the actual experiments to be performed at WIPP. For the most part, the health hazards associated with each experiment are discussed individually, although specific hazards may be associated with more than one proposed experiment. Potential synergistic effects from operating multiple experiments simultaneously were considered. It was determined that there were no significant synergistic effects from multiple, simultaneous experiments on human health, other than those specifically identified in Section 4.1.1 (such as the effects of magnetic fields from neutrino factory detector experiments on other experiments or on experimental workers).

4.1.1 Proposed Action

Many of the experiments described in Chapter 2 are in early planning stages. Therefore, many details typical of human health analyses are not yet available. The objective of this section is to bound potential impacts using the best available information.

The potential hazards that could be introduced into the WIPP facility were identified using the descriptions of the possible experiments in Section 2.1. A comprehensive list of the hazards is presented in Table 4-1. The potential hazards include existing hazards associated with salt excavation and handling heavy objects in surface and underground facilities, exposures to hazardous chemical and radioactive materials, inadequate oxygen levels, exposures to magnetic fields, and electrocution.

Table 4-1 shows that most of the hazards introduced by the potential experiments would be standard industrial hazards (for example, heavy lifting, rotating machinery, electrical hazards, etc.) or laboratory hazards (for example, acids, low temperatures, pressurized containers, and lasers). Radioactive materials that could be introduced to the WIPP facility would include standard calibration sources. Hazardous chemicals that could be introduced into WIPP include large quantities of lead; a scintillation liquid; and sulfuric acid (7 percent). In addition, germanium metal, a widely used and relatively nontoxic substance used in the semiconductor industry, would be introduced into the WIPP facility.

Routine exposures to hazardous chemicals and radioactive materials would be controlled in accordance with OSHA requirements, DOE orders, and other federal standards, as applicable. The hazardous chemicals and radioactive materials would be contained within sealed systems (for example, tanks and piping systems), and routine exposures to workers and the public would be nonexistent. Accidental releases of these materials may occur; the associated impacts are addressed in Section 4.2.

The radioactive materials that could be introduced into the WIPP environment would be significantly less hazardous than the TRU waste being emplaced. Xenon-136 is a noble gas that is radioactively stable and is not an inhalation hazard. Germanium-76 would be in metallic form and is also stable. Some detectors would contain radioactive materials. The type of radioactive materials is currently unknown, but they would be introduced to WIPP in the form of sealed sources. Handling, storage, and use of the radioactive

Table 4-1. Summary of Potential Hazards That Could Be Introduced by the Proposed Science Experiments

Potential Hazard	Cause/Source	Potential Mitigation[a]
Acceleration	Heavy objects (e.g., lead and iron detector) Excavation equipment	Hoist design, safety features Operator procedures, training Redundant lifting equipment
Chemical reactions	Electroplating baths Scintillation liquid[b] Welding gases	Operator procedures and training Chemical safety program Underground access training (including evacuation procedures)
Contamination	Salt environment (airborne salt dust)	Active ventilation Dust control
Corrosion	Airborne salt Sulfuric acid Scintillation liquid	Active ventilation system Dust control Equipment design and material selection Secondary containment Personal protective equipment and operational procedures and training
Electrical	AC power supply and distribution system Electric-power equipment Electronics shop Machine shop	Grounded and insulated electrical cables Operator training
Explosion	Small explosive caps, M-80s Liquid nitrogen tank and piping system Scintillation liquid Welding gases Xenon-136 tank and piping system	Pressure vessel design Pressure relief system Cryogenic system design specifications Operator procedures and training
Fire	Electroplating baths Scintillation liquid Combustible TRU waste Welding gases AC power system	Secondary containment Fire detection and suppression system TRU waste disposal rooms physically isolated from experimental area Welding procedures Self-rescuer Underground access training (including evacuation procedures)
Heat and temperature	Machine shop equipment Electric-driven equipment	Operator training Barriers
High pressure	Xenon-136 tank and piping system Liquid nitrogen tank and piping system Welding gases	Tank, piping system design specifications Pressure-relief systems Operator procedures and training

Table 4-1. Summary of Potential Hazards That Could Be Introduced by the Proposed Science Experiments (continued)

Potential Hazard	Cause/Source	Potential Mitigation[a]
Impact	Heavy objects Excavation equipment Material handling equipment (e.g., forklifts) Roof collapse	Operator procedures and training Vehicle barriers Roof shoring and bracing
Leakage	Liquid nitrogen tank and piping system Dewar-type containers of liquid nitrogen Sulfuric acid containers and electroplating bath Ultrapure water tank Scintillation liquid tank Xenon-136 storage tank and piping system	Secondary containment Ventilation system Leakage monitoring and detection system Inspection/maintenance procedures Operational procedures and training
Low temperature	Liquid nitrogen tank and piping system Dewar-type containers of liquid nitrogen	Cryogenic system design Insulation Secondary containment Personnel protective equipment (insulated gloves, etc.) Operator procedures and training
Natural phenomena	Earthquake Flood Tornado	Site characteristics Evacuation procedures Emergency equipment
Power source failure	Loss of ventilation airflow Loss of lighting system Loss of AC-powered safety systems (e.g., fire detection/suppression system)	Redundant power supply and distribution system Personnel protective equipment Underground access training (including evacuation procedures) Backup battery-powered systems
Radiation	TRU waste Calibration sources Lasers Magnetized iron	DOE, ANSI (laser), and ACGIH (magnetic field) exposure standards Underground ventilation system Filtered vents on TRU waste containers Separation Shielding Operator procedures and training Monitoring/detection systems
Structural damage or failure	Roof collapse Hoist Liquid nitrogen tank Xenon-136 tank Scintillation liquid tank	Hoist and storage tank design standards Subsurface design standards (e.g., shoring and bracing requirements) Secondary containment

Table 4-1. Summary of Potential Hazards That Could Be Introduced by the Proposed Science Experiments (continued)

Potential Hazard	Cause/Source	Potential Mitigation[a]
Toxicity/inadequate oxygen levels (oxygen displacement)	Xenon-136 tank and piping system Liquid nitrogen tank and piping system Lead Germanium Scintillation liquid Sulfuric acid Liquid nitrogen TRU waste Diesel exhaust Carbon monoxide (e.g., from underground fire)/oxygen deficiency	External oxygen supply Underground ventilation system Monitoring/detection systems Fume hood Self-rescuers Operator procedures and training MSHA underground access training (including evacuation procedures)
Vibration and noise	Excavation equipment Ventilation system Machine shop equipment	DOE/OSHA noise limits Ear protection Operational procedures and training

a. ACGIH = American Conference of Governmental Industrial Hygienists; ANSI = American National Standards Institute; MSHA = Mine Safety and Health Administration

b. The scintillation liquid is a mixture of mineral oil (more than 90 weight percent [wt%]), 1,2,4-trimethylbenzene (less than 10 wt%), and aromatic fluors (less than 0.2 wt%).

detectors would be in accordance with DOE requirements for sealed sources, and would represent no more of a radiological hazard than those present at a typical counting or calibration laboratory. Routine exposures to workers would be controlled in accordance with operational procedures and training and DOE radiation exposure limits, including implementation of as low as reasonably achievable (ALARA) requirements. Standard radiological exposure controls and special safeguards controls could be implemented to ensure that the risks associated with the nuclear materials were properly managed. Consequently, the radiological hazards presented by these materials would be insignificant relative to the TRU radionuclides (for example, plutonium-239, americium-241) being handled and emplaced in the WIPP facility. In WIPP SEIS-II, DOE found that there would be less than 1 cancer fatality to involved workers as a result of TRU waste handling and emplacement at WIPP (DOE 1997). Because the types, forms, and quantities of radiological materials associated with the experiments are significantly less hazardous than the TRU waste, health impacts to workers involved in the experiments would be only a small fraction of the impacts calculated for WIPP emplacement workers. For this reason, no additional human health impacts would be anticipated for routine exposures to radioactive materials used in the proposed science experiments in the WIPP facility.

Although workers involved in the science experiments could potentially be exposed to the TRU wastes being disposed of at the WIPP facility, the science experiment construction crews and operations personnel would not normally be exposed to the TRU waste handling systems and emplacement rooms. Thus, any exposure durations and distances for these workers would be significantly less than those for TRU waste handlers, and the radiological and hazardous chemical exposures to astrophysics experiment workers would be less than those calculated for TRU waste handlers in WIPP SEIS-II.

Health impacts to experimental workers were estimated by adjusting the impacts to noninvolved workers that were calculated in WIPP SEIS-II to account for differences in exposure durations and dose rates. In WIPP SEIS-II, the radiological impacts to the worker population involved in handling and emplacing contact-handled TRU (CH-TRU) waste were calculated to be between 0.4 and 0.5 latent cancer fatalities

(898 to 1,240 person-rem). To arrive at this estimate, it was assumed that 36 workers (32 in the Waste Handling Building and 4 underground) would be exposed at 1 meter (3 feet) from the CH-TRU waste container for 2 hours per day, 4 days per week, 50 weeks per year. The total exposure duration is therefore 14,400 worker-hours per year.

The experimental area would be nearly 0.8 kilometer (0.5 mile) from the nearest waste emplacement cell; therefore, the distance between the underground experimental workers and the emplaced waste would be far greater than the exposure distance for underground emplacement workers. Exposure durations would also be lower for experimental workers because they would not need to pass by or enter the disposal rooms to gain access to the experimental area. The radiation shielding provided by the salt walls and bulkheads that separate the experimental and disposal areas would further reduce the dose rate. Therefore, the dose rate in the experimental area from TRU waste was assumed to be nonexistent.

To estimate the bounding radiological impacts to underground experimental workers, it was assumed that each worker would be exposed for the short time it takes to walk between the access shaft and the experimental area. This was conservatively assumed to take 15 minutes per trip and would occur twice per day. Thus, it was assumed that each experimental worker would be exposed for 30 minutes per day. A total of 30 experimental workers were assumed to be in the underground facility 5 days per week, 50 weeks per year (see Section 2.1.4). This would result in a total exposure duration of about 3,800 worker-hours per year, or about one-third of the exposure duration used in WIPP SEIS-II for involved workers.

A conservative exposure distance of 100 meters (330 feet) from the emplaced TRU waste was assumed. Using the $1/r^2$ approximation ("r" is the distance between the radiation source and the receptor) and a reference dose rate of 2.9 millirems per hour at 1 meter (3 feet) from the waste containers (from WIPP SEIS-II), the dose rate to experimental workers would be four orders of magnitude (one ten-thousandth) of the dose rate used in WIPP SEIS-II to calculate health impacts to involved workers. Combining the reduced dose rates and exposure durations for experimental workers, the health impacts were estimated to be about 0.04 person-rem (assuming 35 years of operation) or about 2E-05 latent cancer fatalities. Therefore, no health impacts to experimental workers were estimated to occur from routine exposures to TRU waste.

EXPONENTIAL NOTATION

Exponential notation is used to express very large or very small numbers. For example, the number 1 billion could be written as 1,000,000,000 or, using exponential notation, as 1E+09. Translating from exponential notation to a more traditional number requires moving the decimal point either right (for a positive number after the E) or left (for a negative number after the E). If the value given is 5E+02, move the decimal point two places (insert zeroes if no numbers are given) to the right of its present location. The result would be 500. If the value given is 5E-04, move the decimal point four places to the left of its present location. The result would be 0.0005.

Underground experimental workers would not be exposed to routine airborne radiological and hazardous chemical materials released from emplaced TRU waste because the ventilation airflow is split between the experimental area and the disposal area (see Figure 2-8). Any airborne emissions from TRU waste would be drawn into the ventilation exhaust system for the disposal rooms and discharged to the surface without passing through the experimental area. Routine exposures would be nonexistent; therefore, there would be no health impacts from routine airborne radiological or hazardous chemical emissions from the emplaced TRU waste to experimental workers.[3]

[3] Because of the split airflow shown in Figure 2-8, activities in the experiment gallery would have no impact on a Confirmatory VOC Monitoring Plan required by the Hazardous Waste Facility Permit issued by the New Mexico Environment Department (see Table 1-1).

As stated in Section 2.1.3, a small building would be constructed at the surface to support underground experimental activities. Exposures of experimental workers in this building to radioactive and hazardous chemical emissions would be the same as those calculated in WIPP SEIS-II to "noninvolved workers." Noninvolved workers are defined as employees who work at WIPP but are not directly involved in handling and disposing of TRU waste. WIPP SEIS-II estimated that the maximally-exposed noninvolved worker would have a 4E-07 probability of a latent cancer fatality from radiation exposures and a 1E-07 probability of cancer incidence from hazardous chemical exposures. The impacts to experimental workers who would occupy the surface support building would not exceed these estimates because their occupancy assumptions, radiation dose rates, and chemical concentrations would not be greater.[4]

Workers in the experiment gallery could be exposed to magnetic fields produced by magnetized iron used in some science experiments, and specifically in neutrino factory detector experiments. The actual magnetic field strength to be produced by the various experiments is unknown at this time. However, worker exposures to magnetic fields would be controlled in accordance with DOE and American Conference of Governmental Industrial Hygienists (ACGIH) requirements. In addition, the magnetic field from neutrino factory detector experiments might interfere with other experiments. Consequently, shielding or other mitigation may be necessary to reduce the magnetic field intensities from such experiments. This mitigation would also reduce the exposures of experimental workers to magnetic fields emitted by such experiments. Therefore, no impacts to worker health from magnetic field exposures would be anticipated.

Lasers could be introduced into the WIPP facility in support of one or more experiments. The type of laser, power level, and wavelengths of laser radiation required for the experiments are not known at this time. Similar to magnetic field exposure limits, DOE would follow DOE, American National Standards Institute (ANSI), and OSHA requirements for controlling exposures to laser (nonionizing) radiation; therefore, no worker health impacts would be anticipated from routine exposures to laser radiation.

4.1.2 No Action Alternative

Under this alternative, no experiments would be emplaced at WIPP. Therefore, no human health impacts due to such experiments would occur.

4.2 ACCIDENTS

4.2.1 Proposed Action

The hazards listed in Table 4-1 form the basis for selecting and analyzing potential accidents that could affect WIPP workers and the general public. Observations about these potential accident scenarios indicate that accidents involving many of the hazards identified in Table 4-1 would most likely occur during handling and maintenance of the experimental components, rather than while the experiments were being conducted. This is because the experiments would be conducted in closed systems, with little operator intervention, in which the hazards would be contained and prevented from reaching a worker or member of the public. For example, the experimental apparatus for the scintillation fluid to be used in the OMNIS experiment would be sealed and would be unlikely to fail unless some external force were applied (for example, seismic event, collision). In other cases, the hazard would be in an inherently accident-resistant form such as solid metallic lead or germanium-76 materials, insulated and grounded electrical cables, calibration-type sealed sources, and so forth. Furthermore, where significant hazards

[4] The dose rates and chemical concentrations would not be greater because the WIPP SEIS-II calculations assumed that the noninvolved worker would be located at the point of least atmospheric dispersion.

would be readily apparent, engineering and safety requirements designed to prevent a release are already proposed.

An example is the set of design and safety requirements to prevent release of the liquid nitrogen that would be used in the proposed GENIUS experiment. In still other cases, accident mitigation systems are proposed to control the consequences of accidents, should they occur. Examples of these types of systems include the secondary confinement system for the ultrapure water tank and the portable fume hood to be used to contain fumes and aerosols generated in the deep mine electroplating experiment.

Many of the hazards identified in Table 4-1 are standard industrial or laboratory hazards that are not unique to the Proposed Action. Some of these hazards are already present at other sites, where existing safety programs and controls prevent the hazards from becoming accidents. These hazards include electrical hazards, rotating machinery, cutting/drilling equipment, pressurized containers, collisions with heavy objects, low temperatures, moving equipment, and lifting heavy objects. These hazards would be present regardless of the site for the experimental equipment and are neither more nor less hazardous than they would be if the activities were conducted at a surface facility. Thus, accidents resulting from hazards such as these would result in identical impacts at any potential underground facility.

WIPP SEIS-II (DOE 1997) analyzed the impacts of various accidents involving TRU wastes, including container drops, fires, hoist failure, and roof falls. The impacts of these accident scenarios involving the proposed science experiments are addressed in the following paragraphs.

4.2.1.1 Fires

WIPP SEIS-II estimated the frequency of an underground fire involving a TRU waste container at about once per ten thousand to once per million years (0.001 to 0.000001 per year). The public radiological consequences were calculated to be a 0.3 probability of a latent cancer fatality in the exposed population and a 4E-03 probability of a latent cancer fatality to the maximally-exposed individual member of the public. The maximally-exposed noninvolved worker was calculated to have a 3E-03 probability of a latent cancer fatality, and the maximally-exposed involved worker was calculated to have a 0.06 probability of a latent cancer fatality. The consequences of exposures to hazardous chemicals from the fire were lower than the radiological consequences.

Fires involving experimental materials would result in lower radiological impacts to the public and noninvolved workers than those calculated in WIPP SEIS-II. This is because of the relatively small quantities of radioactive materials (see Section 2.1.1.4) that could be introduced into the WIPP experiment gallery and the durable form and packaging of sealed sources.

However, a large quantity of scintillation liquid, currently planned to be a mixture of mineral oil (greater than 90 weight percent [wt%]), 1,2,4-trimethylbenzene (less than 10 wt%), and aromatic fluors (less than 0.2 wt%), is proposed to be used in the OMNIS experiment. According to the Material Safety Data Sheet (MSDS) for this material, the scintillation liquid is a combustible liquid that may be ignited by high heat, sparks, open flames, or strong oxidizers such as fluorine, nitric acid, and sulfuric acid. The threshold limit value for 1,2,4-trimethylbenzene is 25 parts per million. The MSDS also warns that combustion/burning of this material can form carbon monoxide, which could be lethal to workers and fire protection personnel in the WIPP underground facility. Special precautions would be required to prevent uncontrolled releases of the scintillation liquid, exposure of the scintillation liquid to ignition sources, or both, in addition to providing fire separation of the scintillation liquid from the TRU waste disposal rooms (for example, bulkheads, fire barriers, split ventilation system) and appropriate fire detection and suppression systems. Note that underground personnel are also required to receive underground access training (including emergency evacuation procedures) and carry self-rescuers (a portable breathing apparatus that chemically eliminates carbon monoxide). These types of accidents would be addressed in a supplement to the WIPP safety analysis report, and appropriate accident prevention and mitigation controls would be implemented. The applied safety features and controls would reduce the frequency or consequences of these types of accidents to below levels at which there would be a concern. Furthermore, specific controls, such as separation, could be required to prevent sulfuric acid or other incompatible chemicals from contacting the scintillation liquid.

An uncontrolled fire could lead to catastrophic failure of the large liquid nitrogen tank to be used in the proposed GENIUS experiment. As stated in Section 2.1.1.1, the cryogenic tank is sized at 1,400 cubic meters (49,440 cubic feet). As with the fire involving scintillation liquid, special precautions in the form of engineered safety features and controls would be required to prevent this accident from occurring in the WIPP underground facility. Potential mitigation measures would include the split ventilation system between the experimental area and the disposal rooms, fire detection and suppression systems, underground access training (including emergency evacuation procedures), and fire barriers to either prevent this type of accident from occurring or reduce its consequences. These controls are assumed to reduce the likelihood of occurrence of such an event to levels below which there is cause for concern. The effects on workers at the surface and the public in the vicinity of the WIPP site would be insignificant because the nitrogen gas released is nontoxic and would be quickly diluted to breathable concentrations in unconfined areas.

Similarly, the 9-metric-ton (10-ton) xenon-136 container system could fail if exposed to fire conditions. However, catastrophic failure of the xenon-136 container system would displace only about half the air in a standard WIPP disposal room and would therefore have significantly smaller localized impacts to underground workers than catastrophic failure of the liquid nitrogen tank. Engineered safety features, such as fire detection and suppression systems or fire barriers, would also mitigate this accident. Precautions similar to those required for the liquid nitrogen tank could be imposed to prevent this accident from occurring. These controls are assumed to reduce the likelihood of occurrence to levels below which there is cause for concern.

4.2.1.2 Handling Accidents

The frequency of an accidental drop, puncture, and failure of a TRU waste container was estimated in WIPP SEIS-II to be once per hundred years (0.01 per year). The resulting radiological consequences were calculated to be 0.02 latent cancer fatalities to the exposed population, a 2E-04 probability of a latent cancer fatality to the maximally-exposed individual member of the public and noninvolved workers, and a 0.06 probability of a latent cancer fatality to the maximally-exposed involved worker. This accident scenario is described as a forklift striking and puncturing drums on the lower tier of a stack of drums, followed by a drum on the top of a stack falling to the floor, resulting in failure of the lid seal. Such an accident would not result in exposures to underground experimental workers because of the split ventilation system between the experimental area and the TRU waste disposal area.

Handling accidents involving experimental materials would result in lower consequences than those involving TRU waste for the same reasons given for fires. It is possible that a handling accident could rupture the scintillation liquid tank, liquid nitrogen tank, or xenon-136 container, leading to unacceptable consequences. As a result, engineered safety features and controls would be implemented to prevent the occurrence of these accidents. Examples of mitigation measures would be vehicle barriers, tank design and fabrication standards, impact protection, secondary containment for liquids, split ventilation between experimental and disposal areas, and operator procedures and training.

Handling accidents could also occur during construction and assembly of the experimental apparatus, such as dropping or being struck by a lead or iron component of the OMNIS detector, a large tank, or other heavy object. Such accidents are unlikely to involve a TRU waste container due to the separation between the experimental and disposal areas. The most likely impacts would be personnel injury, fatality, or equipment damage. Standard industrial heavy lifting practices and controls would be implemented to prevent such occurrences, including periodic inspection and maintenance of lifting equipment, operator training, special lifting procedures, and, if required, redundant lifting capability.

4.2.1.3 Roof Fall

As with all underground activities, there is a risk of roof falls and cave-ins onto experimental workers and equipment. The roof fall scenario in WIPP SEIS-II was estimated to have a frequency up to once per hundred years (0.01 per year), but would result in no radiological impacts to the exposed population (0.2 latent cancer fatalities) or maximally-exposed member of the public (0.002 probability of a latent cancer fatality).

The radiological consequences of roof falls into an experimental area would be significantly lower than a roof fall in a TRU waste disposal room due to the relatively small quantities of radioactive material associated with the experiments. Releases of radioactive material from sealed sources would be unlikely due to the durability of the material form and container system.

Roof falls in the experimental area could lead to failure of experimental apparatus to contain potentially hazardous or combustible materials. Examples would include failure of the liquid nitrogen tank, xenon-136 tank, sulfuric acid tank or electroplating bath, and scintillation liquid tank. The consequences of roof falls onto this equipment are similar to failures caused by fires and handling accidents. Additional shoring and bracing or impact protection over the tanks could prevent major structural damage of the tanks, should a roof collapse occur. Secondary containment systems would also be effective in preventing uncontrolled releases of liquids from the various tanks and subsequent exposures of experimental workers. Note that roof falls are most likely to occur when panels have been open a long time. Ground control monitoring and operation in the experiment gallery would be conducted in the same fashion as the rest of the WIPP underground.

Steps would be taken to prevent roof falls and other problems related to movement of the salt. While it is difficult to generalize regarding design parameters for the various proposed experiments due to their different design lives and geometries, certain design principles can be specified. First, designs would account for excavation sizes and layout (for example, by not placing rooms too close together). Second, where necessary, rooms would be placed at somewhat different horizons to account for the influence of partings and seams on ground movement, which can be beneficial if used correctly. Third, where needed, design strategies such as shaping would be used to enhance stability. Fourth, rooms would be designed to account for creep closure (for example, by oversizing in the horizontal plane), and, if necessary, access could be provided to allow ongoing maintenance of long-lived rooms. Finally, proven ground control materials and techniques (such as bolting and cabling), which provide adequate safety, would be used.

4.2.1.4 Hoist Failure

Hoist failure, analyzed in WIPP SEIS-II, is a severe yet extremely unlikely accident. Such an event would cause serious damage to any equipment or materials and fatalities to workers directly involved in the hoist operations would be anticipated. The frequency of a hoist failure event while the hoist is fully loaded was estimated in WIPP SEIS-II to be about 5E-07 per year. This would be increased somewhat to account for the additional hoist trips needed to move equipment, materials, and personnel associated with the proposed experiments to the underground facility. The radiological impacts to the exposed population were calculated to be up to 5 latent cancer fatalities, and the impact to the maximally-exposed member of the public could be up to a 0.08 probability of a latent cancer fatality.

The radiological consequences of a hoist failure involving experimental equipment would be much less than those calculated in WIPP SEIS-II because of the relatively small quantities of radioactive materials involved in the proposed science experiments relative to TRU waste and the nondispersible form of these radionuclides. The radiological dose to the public from such a waste hoist accident would not likely result in any cancer fatalities among members of the public.

Hazardous chemical impacts from a potential hoist failure were calculated using the methods described in WIPP SEIS-II, Appendix G (DOE 1997). For hazardous chemical impacts, the intake of each hazardous chemical was compared to Emergency Response Planning Guideline (ERPG) concentrations developed by the American Industrial Hygiene Association (AIHA). Where ERPG values are not available, Temporary Emergency Exposure Levels (TEELs) (Craig 2000) were used. The ERPGs, or substitute TEELs, were compared to the air concentrations of each hazardous chemical that could be released from the hoist accident.

The ERPGs are defined for three levels of health impacts (DOE 1997):

- The ERPG-1 air concentration is the “low” health impact level. It is defined as the maximum air concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing anything other than mild transient adverse health effects or without perceiving a clearly defined objectionable odor.

- ERPG-2 air concentrations are slightly more hazardous. The ERPG-2 level is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective action.

- ERPG-3 air concentrations indicate a high impact from the exposure. The ERPG-3 level is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening effects. Above ERPG-3 values, an individual may experience or develop a life-threatening effect as a result of a 1-hour exposure.

Therefore, no life-threatening health effects would be anticipated unless air concentrations exceeded ERPG-3 values.

A total of three hazardous chemicals were identified (see Table 4-1) that could potentially be lowered into the underground facility in quantities significant enough to result in health impacts if they were released. These are the mineral oil and 1,2,4-trimethylbenzene in the scintillation liquid and the sulfuric acid. Lead appears to be the only potential carcinogen to be lowered into the WIPP experimental facility. However, carcinogenic risk factors for inhalation of lead are not available, so no carcinogenic effects were quantified.

The equation used to calculate the air concentrations of hazardous chemicals is as follows:

$$C = S \times \frac{E}{Q}$$

where

C = Air concentration (milligrams per cubic meter)

S = Source term release rate (milligrams per second)

E/Q = Atmospheric dispersion coefficient (seconds per cubic meter)

The atmospheric dispersion coefficient, E/Q, used in the calculations was taken from WIPP SEIS-II (DOE 1997) and amounts to 6.5E-04 seconds per cubic meter for the maximally-exposed member of the public and maximally-exposed noninvolved worker.

Because the exact quantities of hazardous chemical materials that may be loaded into the hoist are unknown, bounding assumptions were made to estimate the source term release rates. For the scintillation liquid, it was assumed that up to fourteen 210-liter (55-gallon) drums of the chemicals could be loaded onto the hoist. Only relatively small quantities of sulfuric acid would be needed for the experiments, so it was assumed that a 190-liter (50-gallon) drum of 7 percent acid could be loaded onto the hoist at a time.

A release fraction was estimated using information in the *Nuclear Fuel Cycle Accident Analysis Handbook* (NRC 1998) to calculate the quantity of the chemicals that would potentially be made airborne as a result of a hoist crash. The formula given in NRC (1998) to calculate the airborne release fraction (ARF) from a free-fall spill of liquid is as follows:

$$ARF = 8.12x10^{-10}\, Arch_a^{0.55}$$

$$Arch_a = \frac{r_a^2 H^3 g}{m^2}$$

where

$Arch_a$ = Archimedes number

ρ_a = Air density (1.185 kilograms per cubic meter)

H = Spill height (655 meters)

g = Acceleration due to gravity (9.81 m/sec^2)

μ = Solution viscosity (assumed to be similar to water, μ_{water} = 0.001 poise @ 20°C)

After substituting the above values into the formula, the calculated ARF was determined to be about 0.01 (that is, 1 percent of the liquid would become airborne). Due to the uncertainties in this estimate and the relatively large spill height, the analysis uses an increased ARF of 0.1 (that is, 10 percent of the liquid is assumed to become airborne). In addition, to ensure that the consequences are bounded, it was assumed that 100 percent of the airborne liquid would be in the form of respirable-sized droplets. Furthermore, it was assumed that no droplets would be deposited on shaft surfaces, ventilation ducts, or other surfaces. No credit was taken for reducing the quantity of material released and subsequent consequences via deposition on surfaces, filtration, or other mitigation mechanisms. It was assumed that the release would occur over a 30-minute time period.

The following calculations illustrate the process used to calculate the source term released and subsequent air concentrations at the maximum exposed individual location for the hoist accident involving sulfuric acid. The calculations for the other materials were identical, except for the quantity of material per hoist trip.

Quantity on hoist	=	50 gal	=	189,000 cm^3
Mass on hoist	=	189,000 $cm^3 \times$ 1.834 g/cm^3	=	347,000 g
Mass airborne	=	347,000 g $\times$ 0.1	=	34,700 g
Mass H_2SO_4 released	=	34,700 g $\times$ 7%	=	2,430 g
S	=	2,430 g/1,800 sec	=	1.35 g/sec
C	=	1.35 g/sec $\times$ 6.5E-04 sec/m^3		
	=	8.8E-04 g/m^3		
	=	0.88 mg/m^3		

ABBREVIATIONS:
cm^3 = cubic centimeter
g = gram
g/cm^3 = grams per cubic centimeter
g/m^3 = grams per cubic meter
g/sec = grams per second
gal = gallon
mg/m^3 = milligrams per cubic meter
sec = second
sec/m^3 = seconds per cubic meter

The input data and calculated air concentrations for the remaining hazardous chemicals are shown in Table 4-2. The table also presents the ERPG (or TEEL substitutes) that were used to determine health impacts. As shown, the air concentration for mineral oil exceeds the ERPG-2 concentration and some adverse, yet non-life-threatening, effects may occur. However, none of the hazardous chemical air concentrations exceeded the ERPG-3 values, so life-threatening effects are not anticipated. Note that the ERPG values assume that the individuals are exposed for 1 hour. It is unlikely that an individual would be exposed to these concentrations for a sufficient length of time to experience such severe effects.

Table 4-2. Hazardous Chemical Impacts from Hoist Failure

Hazardous Chemical	Quantity on WIPP Hoist	Specific Gravity	Air Concentration at Max Individual Location	ERPG-2[b] or TEEL-2[c]	ERPG-3[b] or TEEL-3[c]
			(milligrams per cubic meter)		
Sulfuric acid	One 50-gallon drum	1.83	0.88	10	30
1,2,4-trimethylbenzene	Fourteen 55-gallon drums	0.86[a]	9.3	180	500
Mineral oil	Fourteen 55-gallon drums	0.86[a]	83	10	500

a. Source: MSDS for scintillation liquid.
b. Source: ERPG concentrations developed by the AIHA (DOE 1997).
c. Source: Craig 2000.

4.2.1.5 Other Accident Scenarios

The accident scenarios discussed in the preceding sections were taken from WIPP SEIS-II and adapted to reflect the conditions associated with the proposed experiments. Other scenarios that represent unique hazards not examined in WIPP SEIS-II are discussed in this section.

A key element of WIPP's long-term performance is related to the historic and current absence of significant quantities of water. This absence of water indicates a lack of a pathway to transport radionuclides to the accessible environment. Several experiments propose to introduce water or other liquids into the underground environment. Some of the accidents described previously would result in releases of liquids in the underground facility. However, because the proposed experiments would be physically separated from the disposal rooms, liquid spills would not be expected to significantly affect the long-term performance of the TRU waste repository.

Water would not chemically react with salt or release toxic fumes. Chemical reaction of the scintillation liquid and salt is unknown, but would be investigated prior to introducing the liquid into the underground facility to ensure that proper precautions would be taken and controls would be implemented, if needed, to prevent contact with the salt. Sulfuric acid, should it be spilled onto the salt floor, would not react violently but could emit toxic fumes. Sulfuric acid fumes are poisonous by inhalation, are an extreme eye irritant, can rapidly destroy tissue, and can cause severe burns. The chemical reaction would be lessened somewhat by the relatively low strength of the acid (7 percent). Sulfuric acid is also capable of igniting combustible materials, but the likelihood would be relatively low due to the low strength of the acid and relative absence of finely divided combustibles. Hydrogen chloride, a likely reaction product, is also toxic by inhalation and is a powerful irritant to the skin, eyes, and mucous membranes. The chemical reaction would also liberate heat. The amount of heat liberated would depend on the amount of sulfuric acid that came in contact with the salt.

Exposures of nearby underground workers to the fumes could result in serious burns or respiratory damage, or could even be lethal. Thus, engineered and administrative controls would need to be implemented to prevent spills of sulfuric acid onto the salt. Immediately dangerous to life and health (IDLH) values for sulfuric acid (80 milligrams per cubic meter, or about 20 parts per million) or hydrogen chloride (about 150 milligrams per cubic meter, or 100 parts per million) could be reached in an underground room, but such levels are unlikely to be reached in adjacent rooms or panels or at aboveground locations due to the dilution effects of the ventilation system. With proper controls in place, and considering the low strength of the acid, the likelihood of significant impacts from accidental spillage of sulfuric acid onto the salt is judged to be extremely low. Dilution provided by the ventilation system, secondary containment systems, hazardous chemical detection and alarm systems, and respiratory protection could be implemented to mitigate liquid spills. Experimental workers would also be required to receive underground access training, including emergency evacuation procedures, as well as training about the specific hazards of each hazardous chemical.

Experiments involving explosives are also proposed. The explosives are anticipated to be small, such as blasting caps and M-80 type explosives; thus, the impacts would be localized. Workers beyond the immediate vicinity of an accidental explosion would not be harmed, nor would workers at the surface or members of the public. The explosive force would also be small enough that there would be no impacts to the disposed TRU waste or to the WIPP facility's ability to provide long-term containment of the waste. Appropriate explosives storage systems would be provided and workers involved with explosives would be required to receive appropriate training for handling and working with explosives.

An additional hazard that would be introduced into the WIPP facility by the proposed experiments is the extremely low temperature of the liquid nitrogen. Contact between experimental workers and the liquid nitrogen could result in severe burns and even death. Direct contact between the workers and liquid nitrogen-carrying piping or other cryogenic components could also cause severe burns. The cryogenic systems proposed for WIPP are not anticipated to be significantly different than other cryogenic systems used in various industries. Consequently, there are numerous standards and safe working practices available that would mitigate the risks to experimental workers from accidental contact with liquid nitrogen or cryogenic systems. Such measures would include barriers to prevent direct contact with cryogenic components, insulation, secondary containment, protective clothing, and operator procedures and training.

Earthquakes involving the proposed experiments would result in lower radiological impacts than earthquakes involving TRU wastes for the same reasons given for fires and handling accidents. Earthquakes are potential initiating events that could lead to fires, handling accidents, roof collapse, and other potential release scenarios. For example, a strong enough earthquake could fail the support structure for the scintillation liquid tank and lead to a release of the combustible liquid. The same earthquake or an independent event could lead to an ignition source being applied to the released liquid and a subsequent fire. The consequences of an earthquake would generally be the same as the consequences of the fires and handling events discussed above. There would be no impacts from radioactive or hazardous chemical releases on workers at surface facilities or the general public from an earthquake-induced failure of the proposed experiments.

4.2.2 No Action Alternative

Under this alternative, no experiments would be emplaced at WIPP. Therefore, no accident impacts due to such experiments would occur.

4.3 LAND USE

4.3.1 Proposed Action

Under the Proposed Action, impacts on land use would be minimal. All project construction and operation would be consistent with the management objectives and planned actions for the use of the withdrawal area established in DOE’s Land Management Plan. Most of the activities associated with the astrophysics and basic science experiments would be restricted to the existing experiment gallery within the subsurface, which is reserved for the exclusive use of WIPP. The small additional amount of salt excavated would use existing systems and be placed on the existing salt storage area, so no additional land would be required. The small office and laboratory building proposed for the surface would be located within the fenced, innermost “Property Protection Area,” which includes existing surface facilities. The array of detectors proposed for the surface also would be buried within the Land Withdrawal Area and would be removed during decommissioning. All electricity and utilities would be provided by systems currently in place or by solar panels. The bermed area, planned once WIPP is closed, would not be enlarged due to the proposed experiments.

4.3.2 No Action Alternative

Because under this alternative, no experiments would be emplaced at WIPP, no land use impacts would occur due to such experiments.

4.4 GEOLOGY AND HYDROLOGY

4.4.1 Proposed Action

Geologic and hydrologic impacts due to the activities described in the Proposed Action would be minimal. The additional trailer-like building would be within the already disturbed, fenced, innermost "Property Protection Area" and, therefore, would not result in impacts to the regional setting or surface geology. The proposed array of surface detectors would be buried within the Land Withdrawal Area and would be removed during decommissioning. Impacts to the subsurface geology would be limited to the excavation of up to one additional panel equivalent. Though WIPP currently is planned for only 10 panel equivalents, excavation of up to 75 panel equivalents were considered in WIPP SEIS-II with no substantial impacts.

All experimental activities would occur within the Salado Formation, including any proposed excavated areas. This highly impermeable formation is essentially hydrologically isolated from overlying layers. Therefore, hydrologic impacts would be unlikely.

Because all experimental equipment and materials would be removed before ultimate WIPP closure, the experiments would not impact post-closure activities or long-term performance of the repository.

4.4.2 No Action Alternative

Under this alternative, no experiments would be emplaced at WIPP. Therefore, no geologic or hydrologic impacts due to such experiments would occur.

4.5 BIOLOGICAL RESOURCES

4.5.1 Proposed Action

The Proposed Action would result in negligible impacts to biological resources. Construction and operation of all but one of the astrophysics and other basic science experiments would occur in underground facilities located 655 meters (2,150 feet) beneath the surface where there are no biological resources. The principal surface facility proposed is a small office and laboratory building to be located within a fenced area. Construction of the building would not have adverse impacts on populations of nonsensitive plants or animals. The ground surface at the site proposed for the building is already disturbed, and the area required for construction of the building would be less than 0.4 hectare (1 acre).

The emplacement of the array of surface detectors could impact some biological resources; however, the location of the detectors would be flexible, and they could be relocated to areas where their emplacement would not greatly impact these resources. To ensure that such mitigation occurred, DOE could require those constructing the arrays to emplace them only after identifying proposed locations where they would like to have the detectors buried, then having the proposed locations reviewed by a qualified biologist.

Small amounts of additional excavated salt would be placed on the existing salt storage area.

Federally listed, threatened and endangered species, and federal candidate species as well as state-listed species occur in Eddy County. However, DOE has not observed any of these species at the WIPP site during biological surveys conducted over the past several years (DOE 1997). Should potential habitat for such species be identified at the site proposed for the building, appropriate consultation, monitoring, and mitigation measures would be undertaken.

4.5.2 No Action Alternative

No experiments would be emplaced at WIPP under the no action alternative. Therefore, no biological impacts due to such experiments would occur.

4.6 CULTURAL RESOURCES

4.6.1 Proposed Action

Many of the 60 archaeological sites recorded in the withdrawal area are eligible or potentially eligible for listing on the NRHP. The Proposed Action, though, would have minimal effects on the ground surface. The principal anticipated disturbance may be the construction of a small meeting place and laboratory from which experiment scientists from the various experiments could monitor activities below the surface. Any support buildings would be located within a fenced area already disturbed by WIPP activities. No new areas of surface disturbance would be undertaken. Consequently, impacts to cultural resource properties are not anticipated as a result of the Proposed Action. Previous research of the WIPP site cultural resources has identified and evaluated individual properties and mitigated, as necessary, potential impacts from the construction of surface features in the Property Protection Area. No Native American Traditional Cultural Properties or burial grounds have been identified to date (DOE 1997).

In addition to the construction of the meeting place and laboratory, installation on the surface of the array of detectors could impact cultural sites. This experiment, though, is in the early planning stages and the exact location and number of detectors has not been determined. In any case, impacts to cultural and historic sites could be mitigated by having a qualified archeologist review (1) the plans to emplace each detector, and (2) the means to be used to emplace each to ensure that cultural sites are not disturbed. If, in the opinion of the archeologist, the location of the activities would impact a cultural site, the detector could be moved to a different location.

Measures for ensuring the protection of known archaeological and historic resources, or others that may be inadvertently discovered during ground-disturbing activities, are discussed in the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1996c). These measures include identifying, inventorying, evaluating, and treating cultural resources under the National Historic Preservation Act of 1966. DOE would avoid, to the maximum extent possible, sites found eligible for inclusion on the NRHP. Where avoidance is not possible, mitigation measures would be developed under the Joint Powers Agreement with the State of New Mexico.

4.6.2 No Action Alternative

No experiments would be emplaced at WIPP under the no action alternative; therefore, no cultural resource impacts due to such experiments would occur.

4.7 SOCIOECONOMICS

4.7.1 Proposed Action

The WIPP SEIS-II analysis indicated that the 1,095 direct employees of WIPP could result in an average annual total employment of 3,538 in the economic ROI. Using a scaling methodology, the 30 additional employees brought to the area to maintain the astrophysics and other experiments would result in an increase of about 3 percent to the annual total employment, or an increase of about 106 jobs.

Assuming that the 30 additional scientists maintaining the experiments were paid the average wage of a current WIPP employee (in 1994 dollars), though, the additional staff could increase the average annual labor income estimate from WIPP SEIS-II from $126 million to $130 million. Impacts to Carlsbad infrastructure, housing, schools, and other community facilities would be negligible compared to the increases from WIPP operations described in WIPP SEIS-II.

4.7.2 No Action Alternative

Under this alternative, no experiments would be emplaced at WIPP. Therefore, the socioeconomic impacts described for the Proposed Action would not occur.

4.8 NOISE

4.8.1 Proposed Action

Noise impacts due to the Proposed Action would be minimal. The majority of the activities would occur in an industrial environment within the WIPP repository. The only appreciable noise levels would occur while the experiments were being constructed. Noise levels for workers would be similar to those at other industrial sites and would be mitigated as at other industrial sites. OSHA regulations would apply and be followed.

4.8.2 No Action Alternative

Under the no action alternative, no experiments would be emplaced at WIPP. Therefore, the noise impacts would not occur.

4.9 AIR QUALITY

4.9.1 Proposed Action

Various aspects of the Proposed Action would result in small additional releases of four criteria pollutants: nitrogen dioxide, sulfur dioxide, carbon monoxide, and PM_{10}. During any construction or modification activities, care would be taken to minimize fugitive dust emissions. No additional releases of lead or ozone would be expected. Sources would be the same as those described in WIPP SEIS-II. Xenon-136 could be released, but it is a noble gas that is radioactively stable; it is not an inhalation hazard.

Any additional excavation required for experiments could result in releases of particulates and PM_{10}. The primary sources of PM_{10} emissions would be wind erosion from the salt piles, releases of salt through the underground ventilation system, and releases from transferring salt from the repository to the salt piles. As stated in Section 2.1.3, additional excavation associated with the Proposed Action would not exceed that necessary for a standard disposal panel. WIPP SEIS-II assumed that the equivalent of 10 panels would be excavated for TRU waste disposal (DOE 1997). Thus, the source term for PM_{10} emissions of salt dust under the Proposed Action could increase by as much as 10 percent, assuming that the salt emissions increase proportionately to the amount of salt removed. This assumption is valid for the largest source of emissions, wind erosion from the salt pile, because the salt removed from excavation of the experiment gallery would increase the area of the salt pile. However, this overestimates the increase from salt handling and ventilation system releases, which are a function of the rate of salt removal from the repository. The salt excavation rate from the repository would not increase, unless additional excavation crews were employed so that excavation of the experiment gallery could proceed simultaneously with excavation of the TRU waste disposal panels. Conservatively increasing the PM_{10} emissions of salt dust by 10 percent would result in a revised maximum PM_{10} concentration of 0.72 micrograms per cubic meter (annual average) and 86 micrograms per cubic meter (24-hour average). These concentrations are 1.4 percent and 57 percent, respectively, of the regulatory limits defined in the Primary Federal Ambient Air Quality Standard (40 CFR Part 50).

The other major source of the criteria pollutants nitrogen dioxide, sulfur dioxide, carbon monoxide, and PM_{10} would be from hydrocarbon fuel combustion. Emissions from fuel combustion would occur during operation of two backup diesel generators and during operation of aboveground and underground diesel equipment. Emissions from operation of the backup diesel generators would not be affected by the activities related to the astrophysics experiments. However, emissions from operation of aboveground and underground diesel equipment would increase due to the additional excavation and salt transfer operations required to construct the experiment gallery and associated surface facilities. It was conservatively assumed that the increases in pollutant emissions would be proportional to the increase in salt removed from the repository. This would result in a 10 percent increase above the levels reported in WIPP SEIS-II (DOE 1997). The revised maximum concentrations are given for aboveground diesel equipment (Table 4-3) and for underground diesel equipment (Table 4-4). As shown, the increased maximum concentrations of gaseous criteria pollutants that would result from implementing the Proposed Action are all well below their respective regulatory limits.

As discussed in Section 4.1, use of radioactive material would be small and radionuclides released to the atmosphere would be negligible. Radionuclide releases from experiment activities would be much less than 0.1 percent of the limit specified in the National Emission Standards for Hazardous Air Pollutants (40 CFR 61, subpart H).

Table 4-3. Criteria Pollutant Air Quality Impacts from Aboveground Diesel Equipment Emissions

Pollutant	Averaging Time	Maximum Concentration (micrograms per cubic meter)	Regulatory Limit (micrograms per cubic meter)	Percent of Regulatory Limit
Nitrogen dioxide	Annual	0.055	84 [a]	0.065
	24-hour	36	168 [a]	22
Sulfur dioxide	Annual	0.0063	47 [a]	0.013
	24-hour	3.7	234 [a]	1.6
	3-hour	35	1,170 [b]	3.0
Carbon monoxide	8-hour	42	8,900 [a]	0.47
	1-hour	200	13,400 [a]	1.5
PM_{10}	Annual	0.0034	50 [c]	0.0068
	24-hour	2.3	150 [c]	1.5

a. New Mexico Ambient Air Quality Standard (ACQR 201) corrected for altitude.
b. Secondary Federal Ambient Air Quality Standard (40 CFR Part 50) corrected for altitude.
c. Primary Federal Air Quality Standard (40 CFR Part 50).

4.9.2 No Action Alternative

No experiments would be emplaced at WIPP under the no action alternative; therefore, no air quality impacts due to such experiments would occur.

Table 4-4. Criteria Pollutant Air Quality Impacts from Underground Diesel Equipment Emissions

Pollutant	Averaging Time	Maximum Concentration (micrograms per cubic meter)	Regulatory Limit (micrograms per cubic meter)	Percent of Regulatory Limit
Nitrogen dioxide	Annual	0.12	84 [a]	0.14
	24-hour	25	168 [a]	15
Sulfur dioxide	Annual	0.008	47 [a]	0.017
	24-hour	1.7	234 [a]	0.7
	3-hour	14	1,170 [b]	1.2
Carbon monoxide	8-hour	14	8,900 [a]	0.16
	1-hour	121	13,400 [a]	0.9
PM_{10}	Annual	0.0086	50 [c]	0.017
	24-hour	1.8	150 [c]	1.2

a. New Mexico Ambient Air Quality Standard (ACQR 201) corrected for altitude.
b. Secondary Federal Ambient Air Quality Standard (40 CFR Part 50) corrected for altitude.
c. Primary Federal Air Quality Standard (40 CFR Part 50).

4.10 ENVIRONMENTAL JUSTICE

4.10.1 Proposed Action

Disproportionately high and adverse human health or environmental effects on minority or low-income populations would not be expected as a result of the construction and operation of the astrophysics and basic science experiments. Except for a small building proposed for the surface and emplacement of surface detectors, activities associated with the Proposed Action would occur underground; therefore, aboveground populations would not be substantially impacted by the Proposed Action. There are no special circumstances that would result in any greater impact to minority or low-income populations than to the population as a whole. Consequently, there would be negligible effects on minority and low-income populations within an 80-kilometer (50-mile) radius of the WIPP site.

4.10.2 No Action Alternative

Under the no action alternative, no environmental justice impacts would occur because no changes to the WIPP facility or operations would occur.

4.11 CUMULATIVE IMPACTS

This section focuses on the cumulative impacts that could result once the incremental impacts of the Proposed Action are added to the impacts of other past, present, and reasonably foreseeable future actions. These actions include all those discussed in Section 5.9 of WIPP SEIS-II (DOE 1997) by reference.

The WIPP site was withdrawn in the Land Withdrawal Act for the purpose of TRU waste disposal and related activities, and DOE has no plans to dispose of other types of waste at WIPP. Currently, the only other activities being considered for the WIPP site are those described in the Proposed Action and other similar experiments.

Future mining and drilling to extract mineral resources known to exist within the Land Withdrawal Boundary in the vicinity of WIPP would be prohibited by the Land Withdrawal Act in the foreseeable future. The EPA has found that allowing activities on two existing leases that would permit drilling underneath the WIPP site would not affect WIPP performance, and one well has already been drilled pursuant to those leases. DOE is also exploring the possibility of obtaining a Toxic Substances Control Act permit to dispose of the small amount (less than 700 cubic meters [25,000 cubic feet])[5] of polychlorinated biphenyl-commingled TRU waste without treatment. This waste was included in the CH-TRU waste Additional Inventory and was analyzed in WIPP SEIS-II.

DOE is proposing to characterize up to 6,000 drum equivalents of CH-TRU waste a year within existing structures at the WIPP site. The Department analyzed the impacts of this proposal in the *Supplement Analysis and Determination for the Proposed Characterization for Disposal of Contact-Handled Transuranic Waste at the Waste Isolation Pilot Plant (WIPP)* (DOE 2000). Based on that analysis, DOE concluded in the "Revision to the Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste" (65 Fed. Reg. 82985, [2000]) that the proposed action "would not involve actions that are substantially different from those analyzed in prior NEPA analyses or have impacts beyond those already evaluated."

DOE is also considering construction of a laboratory facility within Eddy County to consolidate current laboratory efforts that are spread throughout DOE facilities there. The new facility would be used to monitor air quality and groundwater samples.

The activities described in this EA, plus the current and foreseeable activities described above, could cumulatively affect biological resources, cultural resources, and socioeconomics. The most likely activities described in this EA would be located in an already disturbed area; therefore, cultural and biological resource impacts would not be expected. If the surface detector array were constructed or other biological or cultural resource impacts were identified, DOE would avoid those impacts by relocating the facilities to less sensitive areas.

Overall, socioeconomic impacts from the experimental activities, such as impacts to schools and city infrastructure, would be negligible because the number of additional personnel would be small. As noted above, the construction of a new laboratory facility would consolidate current activities, not introduce new activities. Therefore, impacts to infrastructure would be slight, while some additional labor income could be expected.

Cumulative impacts in other resource areas are not expected. Therefore, the effects of the Proposed Action, when combined with those due to current and foreseeable activities, would not result in cumulatively significant impacts.

4.12 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The activities discussed in the Proposed Action would result in no greater negative impact to short-term uses and long-term productivity than those described in Section 5.11 of WIPP SEIS-II. The Land Withdrawal Act already forbids extraction of mineral and hydrocarbon resources from the 41-square-kilometer (16-square-mile) Land Withdrawal Area for perpetuity. After decommissioning and permanent marking, the aboveground area of the WIPP site would be restored by contouring, grading, seeding, and other methods to return it to its natural condition.

Allowing the experiments discussed in this EA or similar experiments within an unused section of the WIPP facility would enhance the short-term uses of WIPP by enabling the facility to serve multiple needs.

[5] As estimated in the 1996 *Transuranic Waste Baseline Inventory Report* (DOE 1996d).

4.13 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The additional irreversible and irretrievable commitment of resources due to the Proposed Action would be negligible because all activities would occur either within the innermost fence of the WIPP site (for construction of a small building) or underground, largely in vacant and unused repository space.

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CHAPTER 5

LIST OF PREPARERS AND CONTRIBUTORS

This list identifies individuals who were principal preparers and contributors to this EA. Harold Johnson of the DOE CBFO directed the preparation of the EA. Lucinda Low Swartz managed the project and provided technical support. Frank Douglas served as the facilitator for the scoping effort and provided document preparation support. Donald George served as deputy project manager and provided project management support in Carlsbad, New Mexico.

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	Technical Experience:	Fourteen years of experience in project management and technical support for environmental program, including experience in NEPA, Clean Water Act compliance, waste acceptance and certification, long-term waste disposal, national TRU waste management, and operational readiness reviews.
	EA Responsibility:	Deputy Project Manager. Assisted in scoping efforts and communication with the WIPP contractor as well as assisted in public interactions in Carlsbad.
Steve Goheen	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	Ph.D., Materials Science and Engineering, Northwestern University
	Technical Experience:	Experience in hazardous chemistry, including developing standard protocols for the analysis of organic compounds in nuclear wastes.
	EA Responsibility:	Provided support in the area of chemistry.
Jim Griggs	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	M.S., Industrial and Systems Engineering, Ohio University
	Technical Experience:	Twenty-five years of experience in domestic and international nuclear safeguards, including work as a plant safeguards specialist at a uranium enrichment plant, performing regulatory analysis for the Nuclear Regulatory Commission, and designing a computerized information system for a commercial nuclear power plant.
	EA Responsibility:	Provided support in the areas of nuclear accountability and non-proliferation.
Tracy A. Ikenberry	*Affiliation*:	Dade Moeller and Associates
	Education:	M.S., Radiology & Radiation Biology, Colorado State University
	Technical Experience:	More than 15 years of experience in a wide range of environmental and occupational health physics activities, including radiological assessment, environmental monitoring, regulatory analysis and implementation, and accident/safety analysis. Certified Health Physicist, Diplomate, American Board of Health Physics, 1988.

	EA Responsibility:	Provided support for occupational and public health safety, risk analysis, and accident analysis.
Tim Jarvis	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	Ph.D., Environmental Toxicology, Colorado State University
	Technical Experience:	Twenty-five years of experience in waste management; regulatory issues; and environment, safety, and health. He also has 15 years of experience in the mining industry, including soft and hard rock mining, as well as underground and surface mining for coal, gold, bentonite, uranium, salt, and trona.
	EA Responsibility:	Provided mining engineering support.
Russell Jones	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	Ph.D., Metallurgy, University of California at Berkeley
	Technical Experience:	Experience in the area of environmental effects on crack growth of materials. He has made significant contributions to understanding the relationships between grain boundary chemistry and environmental interactions and to understanding environmental effects of the crack growth behavior of fusion reactor materials.
	EA Responsibility:	Provided materials engineering support.
Harold Johnson	*Affiliation*:	U.S. Department of Energy
	Education:	J.D., Law, Mercer University
	Technical Experience:	Thirteen years of experience in writing, reviewing, and approving NEPA documents.
	EA Responsibility:	DOE Document Manager.
Richard Kouzes	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	Ph.D., Physics, Princeton University
	Technical Experience:	Twenty-five years of experience in technology leadership and management; research development and administration; electronically facilitated scientific and engineering collaboration; radiation detection, nuclear spectroscopy, and precision mass measurements; and experimental research in solar neutrino physics.
	EA Responsibility:	Provided support in the area of nuclear and particle astrophysics.

David Lechel	*Affiliation*:	Lechel, Inc.
	Education:	M.S., Fisheries Biology, Michigan State University
	Technical Experience:	Twenty-four years of experience in project management and preparation of multidisciplinary environmental studies, regulatory analysis, and monitoring in support of remedial actions and construction activities.
	EA Responsibility:	Quality assurance reviewer.
Harry Miley	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	Ph.D., Physics, University of South Carolina
	Technical Experience:	Seventeen years of experience in particle astrophysics, including team leader for the Radionuclide Aerosol Sampler/Analyzer project and the High-Sensitivity, Low-Profile Neutron Detector project, a system for detection of plutonium diversion at traffic choke points. Also worked on the design and construction of the Double-Beta Decay project.
	EA Responsibility:	Provided technical support in the area of particle astrophysics.
Elizabeth A. Nañez	*Affiliation*:	Battelle
	Education:	B.S., Industrial Engineering, Texas Tech University
	Technical Experience:	More than 5 years of experience in environmental engineering and NEPA technical support, including public involvement support and comment response document management.
	EA Responsibility:	Provided public involvement support.
Ted M. Poston	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	M.S., Fisheries, University of Washington
	Technical Experience:	Twenty-five years experience in environmental assessment and research with an emphasis in community noise analysis/assessment, aquatic ecology, risk assessment (NEPA), environmental surveillance, eco-toxicity, radioecology, and fisheries.
	EA Responsibility:	Provided support in the area of noise.
Christine Ross	*Affiliation:*	Battelle
	Education:	A.A., Microcomputer Management, Specializing in Multimedia, Albuquerque Technical Vocational Institute
	Technical Experience	More than 5 years of experience in graphic and desktop publishing work.

	EA Responsibility:	Provided graphics throughout the document.
Wayne Ross	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	M.S., Mechanical Engineering, Stanford University
	Technical Experience:	More than 30 years of experience in nuclear waste treatment, characterization, disposal, and systems integration.
	EA Responsibility:	Provided support in the area of waste repository science.
John Smoot	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	Ph.D., Hydrogeology, University of Idaho
	Technical Experience:	More than 10 years of experience in research and program management across the spectrum of the nuclear fuel cycle, including uranium mining, nuclear material safeguards, warhead dismantlement transparency, and the disposal of high- and low-level radioactive waste.
	EA Responsibility:	Provided support in the areas of non-proliferation and geophysics.
Karen Steinmaus	*Affiliation*:	Battelle Pacific Northwest Division
	Education:	M.S., Computer Science, University of Washington M.S., Geology, University of Minnesota
	Technical Experience:	Twenty years of experience in the fields of remote sensing, geographic information systems technology, multisensor data fusion, and information management.
	EA Responsibility:	Provided support for remote sensing and monitoring as well as for remote data collection and transmission.
Lucinda Low Swartz	*Affiliation*:	Battelle
	Education:	J.D. (Law), Washington College of Law, The American University
	Technical Experience:	Twenty years of experience in environmental law and regulation, most recently specializing in NEPA compliance strategies for particular proposed actions.
	EA Responsibility:	Project Manager. Technical reviewer of document for conformity to NEPA, CEQ, and DOE regulations and guidance.
Amy S. Tate	*Affiliation*:	Battelle
	Education:	B.A., English, University of New Mexico
	Technical Experience:	Seven years of experience in writing and editing.

	EA Responsibility:	Assisted in the technical editing and quality control of the document and managed document production.
Desiree Thalley	*Affiliation:*	Battelle
	Education:	B.A., Journalism, University of New Mexico
	Technical Experience:	Fifteen years of experience in writing and editing.
	EA Responsibility:	Lead technical editor.
Michael Tremble	*Affiliation*:	Ecosystems Management
	Education:	M.S., Biology, University of London
	Technical Experience:	Fifteen years of experience in biological surveys, assessments, planning, and environmental documentation.
	EA Responsibility:	Provided support in the areas of biological resources, land use, and environmental justice.

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CHAPTER 6

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CHAPTER 7

GLOSSARY

background radiation	Radiation from: (1) naturally occurring radioactive materials, as they exist in nature prior to removal, transport, or enhancement or processing by man; (2) cosmic and natural terrestrial radiation; (3) global fallout as it exists in the environment; (4) consumer products containing nominal amounts of radioactive material or emitting nominal levels of radiation; and (5) radon and its progeny in concentrations or levels existing in buildings or the environment that have not been elevated as a result of current or past human activities.
basin	A topographic or structurally low area compared to the immediately adjacent areas.
Bell Canyon Formation	A sequence of rock strata that forms the topmost unit of the Delaware Mountain Group.
caliche	Calcium carbonate ($CaCO_3$) deposited in the soils of arid or semiarid regions.
cask	A massive shipping container providing shielding for highly radioactive materials and holding one canister.
Castile Formation	A Permian age rock unit of evaporites (interbedded halite and anhydrite) that immediately underlies the Salado Formation, the rock unit in which disposal rooms are excavated.
concentration	The amount of a substance contained in a unit quantity (mass or volume) of a sample.
conservative	When used with predictions or estimates, leaning on the side of pessimism. A conservative estimate is one in which the uncertain inputs are used in the way that provides a reasonable upper limit of the estimate of an impact.
containment	Retention of a material or substance within prescribed boundaries.
critical habitat	The specific areas within the geographical area occupied by a species at the time it is listed as threatened or endangered on which are found those physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection. It also includes specific areas outside the geographical area occupied by the species at the time it is listed if these areas are determined to be essential for the conservation of the species.
Culebra Dolomite	The lower of two geologic units of water-bearing dolomite within the Rustler Formation.

cumulative impacts	Cumulative impacts are those impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
curie	A unit of radioactivity equal to 37 billion (3.7×10^{10}) disintegrations per second.
decommissioning	The removal from active service of a facility.
decontamination	The removal of unwanted material (especially radioactive material) from the surface or from within another material.
dolomite	A sedimentary rock consisting primarily of the mineral dolomite: $CaMg\ (CO_3)_2$.
EIS	Environmental impact statement; a document required by the National Environmental Policy Act for proposed major Federal actions involving potentially significant environmental impacts.
endangered species	Plants and animals that are threatened with extinction, serious depletion, or destruction of critical habitat. Requirements for declaring a species endangered are contained in the Endangered Species Act.
energy	The capacity for doing work.
environment	The sum of all external conditions and influences affecting the life development and, ultimately, the survival of an organism.
equilibrium	A state of rest in a chemical or mechanical system. Chemical: The state of a reaction in which its forward and reverse reactions occur at equal rates so that the concentrations of the reactants do not change with time. Mechanical: Forces in one direction are equal and opposite to those in the opposing direction. Flow of salt to fill the excavated cavity is an attempt by the salt to reattain a state of mechanical equilibrium.
evapotranspiration	Loss of water from the earth’s surface to the atmosphere by a combination of evaporation from the soil, lakes, streams, and transpiration from plants.
fault	A fracture or a zone of fractures along which there has been displacement parallel to the fracture.
fissile	Describes a nuclide that undergoes fission upon absorption of neutrons of any energy.
formation	A mappable geologic body of rock identified by lithic characteristics and stratigraphic position. Formations may be combined into groups or subdivided into members.

geology	The science that deals with the earth; the materials, processes, environments, and history of the planet, especially the lithosphere, including the rocks, their formation, and structure.
groundwater	All subsurface water, especially that contained in the saturated zone below the water table.
habitat	The part of the physical environment in which a plant or animal lives.
halite	A mineral composed of sodium chloride, NaCl.
immediately dangerous to life and health	A term that represents a maximum airborne concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.
isotope	An atom of a chemical element with a specific atomic number and atomic weight. Isotopes of the same element have the same number of protons but different numbers of neutrons. Isotopes are identified by the name of the element and the total number of protons and neutrons in the nucleus. For example, uranium-235 is an isotope of uranium with 92 protons and 143 neutrons and uranium-238 is an isotope of uranium with 92 protons and 146 neutrons.
Los Medaños	The area in southeastern New Mexico surrounding the Waste Isolation Pilot Plant site. In English, it means "dune country."
low-income population	A population where 25 percent or more of the population is identified as living in poverty.
Magenta Dolomite	The upper of the two dolomite layers within the Rustler Formation that are locally water-bearing.
magnitude (earthquake)	A measure of the total energy released by an earthquake. It is commonly measured in numerical units on the Richter scale. Each unit, e.g. 7, is different from an adjacent unit by a factor of 30.
maximally exposed individual	A hypothetical member of the public who is exposed to a release of radioactive or chemically hazardous material in such a way (by combination of location, dietary habits, etc.) that the individual will likely receive the maximum dose from such a release.
Nash Draw	A shallow 8-kilometer- (5-mile-) wide valley open to the southwest located to the west of the Waste Isolation Pilot Plant site.
National Environmental Policy Act	The act designed to promote inclusion of environmental concerns in Federal decision-making.
National Register of Historic Places	A list maintained by the National Park Service of architectural, historic, archaeological, and cultural sites of local, state, or national importance.

physiographic	Geographic regions based on geologic setting.
potash	The common industrial term for potassium in various chemical combinations with sodium, magnesium, chlorine, and sulfate.
radiation	Ionizing radiation; e.g., alpha particles, beta particles, gamma rays, X-rays, neutrons, protons, and other particles capable of producing ion pairs in matter. As used in this document, radiation does not include nonionizing radiation.
radioactive decay	The spontaneous transformation of one nuclide into a different nuclide or into a different state of the same nuclide. The process results in the emission of nuclear radiation (alpha, beta, or gamma radiation).
radioactivity	The property or characteristic of radioactive material to undergo spontaneous transformations ("disintegrations" or "decay") with the emission of energy in the form of radiation. It means the rate of spontaneous transformations of a radionuclide. The unit of radioactivity is the curie (or becquerel). (1 curie = 3.7×10^{10} becquerel).
radionuclide	A nuclide that emits radiation by spontaneous transformation.
recharge	In groundwater hydraulics, the addition of water to the zone of saturation; also, the amount of water added.
Record of Decision	The document, publicly available, by which a Federal department or agency decides on an alternative presented and evaluated through the environmental impact statement process.
repository	A facility for the disposal of radioactive waste.
resources	Mineralization that is concentrated enough, in large enough quantity, and in a physical and chemical form such that its extraction may be economical in the future.
rock burst	A sudden and often violent breaking of a mass of rock from the walls of a tunnel, mine, or deep quarry, caused by failure of highly stressed rock and the rapid or instantaneous release of accumulated strain energy.
runoff	The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and either infiltrates or eventually returns to streams.
Rustler Formation	The evaporite beds, including mudstones, of Permian age that immediately overlie the Salado Formation in which the Waste Isolation Pilot Plant disposal levels are built.
Salado Formation	The Permian Age evaporite unit within which wastes would be disposed of in the Waste Isolation Pilot Plant repository.
scintillation liquid	A liquid that emits visible light when bombarded with particles or irradiated with ultraviolet light or X-rays.

seismicity	All of the earthquakes that may occur in a region, regardless of magnitude.
shaft	A man-made hole, either vertical or steeply inclined, that connects the surface with an underground excavation.
surface water	A creek, stream, river, pond, lake, bay, sea, or other waterway that is directly exposed to the atmosphere.
threatened species	Any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act.
transuranic waste	Waste materials (excluding high-level waste and certain other waste types) contaminated with alpha-emitting radionuclides that are heavier than uranium with half-lives greater than 20 years and occur in concentrations greater than 100 nanocuries per gram. Transuranic waste results primarily from plutonium reprocessing and fabrication as well as research activities at U.S. Department of Energy defense installations.
Waste Isolation Pilot Plant	The facility near Carlsbad, New Mexico, that is a disposal site for transuranic waste generated as part of the nuclear defense research and production activities of the federal government.

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APPENDIX A

COMMENTS AND RESPONSES

This appendix contains the comments that were received during the 30-day public comment period on the draft EA (October 23 through November 22, 2000) and their responses. Comments were obtained during public meetings held in Santa Fe, New Mexico, on November 14, 2000, and in Carlsbad, New Mexico, on November 16, 2000, as well as from letters and electronic mail messages. The comment entries are organized according to comment categories.

In compliance with the provisions of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) regulations, public comments on the draft EA were assessed individually and collectively. Some comments resulted in changes or modifications that have been incorporated into the final EA. Comments not requiring modifications to the EA resulted in a response to correct the commenter's misinterpretation, to clarify the scope of the EA, or to answer technical questions.

A.1 AIR QUALITY

Comment Number C-35

Comment Section 4.9 of the draft environmental assessment addresses impacts on air quality; however, these impacts are not quantified. A table of the expected emissions of nitrogen dioxide, sulfur dioxide, carbon monoxide, and PM_{10} should be included so that the reviewers may come to their own conclusions of whether these emissions are negligible. In addition, the draft environmental assessment should address the impacts of the fugitive emissions that are quantified in the document as "negligible" for the same reasons.

Response The requested analysis has been conducted; the results are in Section 4.9.

Comment Number C-36

Comment During construction of any additional facilities at the WIPP site, care should be taken to minimize emissions of fugitive dust.

Response Text has been added to Sections 2.1.3 and 4.9.1 to state that fugitive dust emissions would be minimized.

Comment Number C-50

Comment Section 4.1.1 Proposed Action, paragraph one on page 4-6 and Section 4.2.1 Proposed Action on numerous pages: statements declare that the ventilation airflow is split between the experimental area and the disposal area. A figure should be added depicting the split between the two areas. There should also be a statement somewhere in the EA, referencing this figure, supporting the conclusion that activities in the experiment gallery will have no impact on the Confirmatory VOC Monitoring Plan required by the NMED hazardous waste facility permit.

Response New Figure 2-8 has been added showing the split ventilation airflow in the WIPP underground. In addition, a footnote has been added to Section 4.1.1 stating that activities in the experiment gallery would not impact the VOC monitoring plan referred to by the reviewer.

Comment Number C-52

Comment Section 4.9 AIR QUALITY, on pages 4-17 through 4-18, a statement should be made relating to the potential release of Xenon-136, due to the great quantity of the material proposed for use.

Response This statement has been added to Section 4.9.

By their very nature experimental activities are difficult to anticipate and variable in execution. As an underground facility, WIPP has a unique record of performing underground evaluations and experimentation due to the extensive site characterization that was performed prior to waste receipt. WIPP has the processes and procedures in place to confidently evaluate the potential hazards involved with a proposed experiment and to ameliorate them in ways that would be protective of human health and the environment. For example, pressurized gases are controlled through procedures, and job hazard analyses have been conducted to ensure that onsite staff and responders are properly prepared to deal with possible accidents.

WIPP has an enviable safety record, and it is not compromised in any way when experimental activities are performed.

A.2 EA ANALYSIS

Comment Number C-05

Comment Section 2.1.4, Operation of Experiments, assumes that 15 experiments will require two individuals to be in the repository 5 days a week, for a total of 30 people. The EA should specify whether 5 days a week is equal to 40 hours a week.

The EA is unclear about what will happen when it will become necessary for workers to be working for more than 40 hours a week, e.g., some outer space events require round-the-clock work at WIPP. Dose calculations for all contingencies should be included in the final EA, e.g., 40 hours a week, 80 hours a week, and 24/7.

Response Nearly all of the experiments would be monitored remotely once in place. The monitoring may occur 24 hours a day, 7 days a week, but the scientists would not be in the facility during that time. Instead, computers and pagers would be used to inform them of events occurring underground. For this reason, DOE believes the 5-day-a-week assumption used for analysis is a conservative assumption. The workers would not be in the facility more than 5 consecutive days a week for a total of more than 40 hours a week. Section 2.1.4 has been modified to note that 5 days a week means 40 hours over 5 consecutive days per week.

Comment Number C-06

Comment Section 2.1.5: Include and describe regulatory and legal "drivers" for closure and decommissioning, on the surface and underground, and within the experiment gallery.

Response A text box has been added to Section 2.1.5 describing these activities for WIPP generally. They would not change due to the use of the experiment gallery.

Comment Number C-07

Comment Figure 3-2, Minority Population, WIPP ROI, and Figure 3-3, Low-Income Population, WIPP ROI. Please update these graphics - they are over a decade old.

Response Section 3.9 has been revised to state that the best available block group data were presented in the draft EA and that Census 2000 block group data were not available at the time the final EA was published. New tables (Tables 3-2 and 3-3) have been added to Section 3.9 that contain more recent data, although they are at the county level and not at the block group level. Therefore, the new data are more recent but not as detailed.

Comment Number C-12

Comment The draft EA does not meet the legal requirements for adequately describing the proposed experiments, their impacts, and all reasonable alternatives.

Response DOE believes the EA meets the legal requirements for adequately describing the proposed experiments, their impacts, and all reasonable alternatives. The EA describes 15 experiments in five categories (particle physics experiments, other astrophysics and physics experiments, mine safety and geophysical studies, nonproliferation and nuclear accountability experiments, and chemical and material processing experiments) that are currently proposed to be conducted in the WIPP facility or that DOE expects may be proposed in the future (see Section 2.1.1). The five categories represent the range of experiments that DOE believes are reasonably foreseeable. DOE analyzed the potential impacts associated with the conduct of this range of experiments at WIPP in the EA.

Additional analysis has been conducted for air quality impacts; the results of the analysis are contained in Section 4.9 of the final EA.

No additional experiments have been described in the EA in response to this comment. However, should experiments other than the 15 experiments described be proposed for WIPP, DOE would determine the extent to which these other experiments and their associated impacts and risks were within the range of the experiments and impacts considered in this EA. If the other experiments fell outside the range of experiments already analyzed or if the potential impacts had not been adequately analyzed, DOE would prepare additional NEPA documentation before determining whether to allow the experiments to be conducted at WIPP.

Comment Number C-13

Comment The draft EA does not adequately analyze the probability or impacts of a roof fall and floor heaving in the experiment gallery or in Panel 1. Bring in Jack Parker (Michigan), salt mine expert.

Response As noted in Section 4.2.1.3 of the draft EA, "there is a risk of roof falls and cave-ins onto experimental workers and equipment" and as is common in evaporite mines, there also is the potential for floor heave. However, the Salado Formation and the WIPP facility are probably the best-monitored and -understood excavations in salt in the world. Many of the experimental rooms have been open for close to 20 years, and in that time there have been only two roof falls in unheated rooms (SPDV 1 and 2). In both cases, the failures were understood and predicted, and no measures were taken to prevent them. Floor heave is a common occurrence in Panel 1, largely because of the room width, the proximity of MB139, and the age of the panel.

In relating this experience to the proposed experiment gallery, a number of factors should be considered. First, while several of the proposed experimental rooms have spans similar to a standard panel waste disposal room, none are appreciably larger and many are smaller. Second, much of the ground movement associated with the panel rooms is a result of the presence of MB139 close to the floor and Clay G close to the back. Third, any potential for roof falls associated with the ground movement has been successfully contained by the support systems employed. Finally, the current rooms are not designed for a long operational life, and indeed the design life has been successfully exceeded by a large amount.

In designing experimental rooms, all of this accumulated knowledge would be used to ensure an adequate operational life without damaging ground movement. While it is difficult to generalize due to the different design lives and geometries for the various experiments, certain design principles can be specified. First, designs would account for excavation sizes and layout (for example, by not placing rooms too close together). Second, where necessary, rooms can be placed at somewhat different horizons to account for the influence of partings and seams on ground movement, which can be most beneficial if used correctly. Third, where needed, design strategies such as shaping can and would be used to enhance stability. Fourth, rooms can be designed to account for creep closure (for example, by oversizing in the horizontal plane), and, if necessary, access can be provided to allow ongoing maintenance of long-lived rooms. Finally, proven ground control materials and techniques (bolting, cabling, etc.), which provide adequate safety, are available.

The design of experimental rooms would be based on experimental needs and known *in situ* salt behavior, and the design would be carried out by professional engineers with extensive validated experience at WIPP. While Mr. Parker has expertise in commercial salt mining applications, his knowledge of WIPP is not current, and any relevant augmentation would have to be provided by these same WIPP experts. No changes have been made to the EA as a result of this comment.

Comment Number C-16

Comment Include mine ventilation pathways and monitors (diagrams).

Response Figure 2-8 showing ventilation pathways and monitors has been added to Section 2.1.3.

Comment Number C-17

Comment Table 4-2: Include a summary table about each experiment, indicating how long the experiment would last and the hazards involved, for assessment of different impacts.

Response Each experiment would be operated for a different length of time, depending, in part, on when it was funded, was fully designed, and met WIPP criteria for emplacement. For this reason, the length of time each would operate is unknown. For purposes of analysis, analysts assumed that each was emplaced immediately and operated for the remaining planned lifetime of WIPP, 35 years.

The descriptions of the proposed experiments in Section 2.1.1 have been revised to give more details about the potential hazards from the experiments. However, detailed analyses are dependent upon the specifics of each experiment. Detailed calculations of specific factors such as bearing loads, ventilation rates, hoisting impacts, etc., would be performed when an experiment proposal warrants that level of detail.

Comment Number C-37

Comment Section 2.1.5, Decommissioning, should require that no waste be generated in decommissioning process. In 35 years, a zero waste policy should be in effect. DOE should anticipate a zero waste policy and plan accordingly.

The second sentence of the second paragraph should include the EPA requirements for closing WIPP.

Response WIPP currently has a waste minimization policy in effect. Decommissioning would be conducted to minimize the waste. A text box has been added to Section 2.1.5 discussing the activities that will be conducted during WIPP closure and decommissioning. The establishment of a zero waste policy is beyond the scope of this EA.

Comment Number C-54

Comment On the one hand, DOE says that the salt in the WIPP underground will enclose the waste; on the other hand, DOE is proposing to allow long-term experiments to be conducted underground. How will the openings in the experiment gallery be maintained to allow these experiments to be conducted long-term?

Response While it is difficult to generalize about design principles due to the different design lives and geometries for the various experiments, certain design principles can be specified. First, designs would account for excavation sizes and layout (for example, by not placing rooms too close together). Second, where necessary, rooms can be placed at somewhat different horizons to account for the influence of partings and seams on ground movement, which can be most beneficial if used correctly. Third, where needed, design strategies such as shaping can and would be used to enhance stability. Fourth, rooms can be designed to account for creep closure (for example, by oversizing in the horizontal plane), and, if necessary, access can be provided to allow ongoing maintenance of long-lived rooms. Finally, proven ground control materials and techniques (bolting, cabling, etc.), which provide adequate safety, are available. The design of experimental rooms would be based on experimental needs and known *in situ* salt behavior, and the design would be carried out by professional engineers with extensive validated experience at WIPP.

A.3 EDITORIAL

Comment Number C-01

Comment In the first paragraph of Section 1.1, there should be a statement about the fact that there are two kinds of waste at WIPP - contact handled (CH) waste and remote handled (RH) waste. This statement should include the dose one could receive from the waste containers.

Response As requested by the public, a text box has been added to Section 1.1 defining RH- and CH-TRU waste. However, very few of the experiments under consideration in this EA would involve CH- or RH-TRU waste, and the experiment gallery is a great distance from any activities that involve the disposal of transuranic waste. The only dose that workers in the experiment gallery would receive from the CH- or RH-TRU waste would be that received when they leave the elevator at the bottom of the elevator shaft.

Section 4.1.1 of the EA states that the health impacts from such exposure would be about 0.04 person-rem (assuming 35 years of operation) or about 2E-05 latent cancer fatalities.

Comment Number C-02

Comment Figure 2-1 needs length measurements.

Response Figure 2-1 has been modified to show the dimensions of the lead detector.

Comment Number C-04

Comment Figure 2-7 requires a north directional arrow.

Response Figure 2-7 has been modified to include a north directional arrow.

Comment Number C-08

Comment Table 4-1. Summary of Potential Hazards That Could Be Introduced by the Proposed Science Experiments (continued), on page 4-4, Xenon-136 should be added to the list of Cause/Source for the Toxicity/inadequate oxygen levels (oxygen displacement) row.

Response Xenon-136 has been added to Table 4-1 as suggested.

Comment Number C-09

Comment In Table 4-1, add oxygen deficiency where appropriate in the Cause/Source column for potential hazards.

Response Table 4-1 lists “oxygen deficiency” under “Cause/Source” where appropriate.

Comment Number C-33

Comment Conversions between the metric and the English units are incorrect at several places in the document. For example, 30,690 square feet is shown equivalent to 2,118 square meters (should be 2,853 square meters) (Section 2.1.2) and 137,280 square feet equal to 41,600 square meter (should be 12,760 square meters) (Section 2.1.3).

Response These measurements and conversions have been corrected, and other conversions have been checked for accuracy and found to be correct as is.

Comment Number C-34

Comment The location for the Neutrino Factory detector in the text (p. 2-9) is shown to be east of the experiment gallery, whereas the figure referred to in the text, Figure 2-6, shows it to be west of the experimental gallery.

Response The neutrino factory detector drift slopes downward to the northwest toward Fermi National Accelerator Laboratory, as shown in Figure 2-6, and the detectors in the drift are oriented in a downward direction (i.e., pointing toward Fermi). In the draft EA, the arrow in Figure 2-6 pointing toward the southwest was indeed pointing in the wrong direction; the figure has been revised to indicate that the “front” of the detector (at the low end of the sloping drift) is oriented to the northwest, toward Fermi.

A.4 ENDORSEMENT

Comment Number C-27

Comment The WIPP facility should be used to its maximum potential, assuming such activities do not create safety problems for TRU waste disposal.

Response Thank you for your comment.

A.5 EXPERIMENTS

Comment Number C-03

Comment All experiments described within Section 2.1.1 should include hazard statements. All experiments should be required to provide triple containment. The EA should study magnetic and RAD field interaction, mine tremor and sensor studies, other mine safety/geological studies.

Response Section 2.1.1 has been revised to include hazard statements. The appropriate level of containment would be determined based upon the hazards analysis of each type of experiment, prior to approval of an experiment's design. Magnetic and RAD field interaction, mine tremor and sensor studies, and other mine safety/geological studies would be conducted, if necessary, on an experiment-by-experiment basis, once the experiments are better defined.

Comment Number C-10

Comment DOE needs to clarify management of hazardous waste and spills.

Response The contracts between the sponsors and DOE for use of the facility would state that removal of hazardous materials and associated costs from the repository is the responsibility of the scientists conducting the experiments. If a spill should occur, DOE hazardous waste managers would ensure the spill is cleaned up, but the sponsors would be required to reimburse for the expense of the cleanup. The management of potential spills would be completed in accordance with existing WIPP emergency management and spill control procedures. The operator and/or underground operations personnel would conduct equipment, storage container, and spill management equipment inspections on a daily basis. Weekly inspections would also be conducted by environmental personnel.

The WIPP staff would evaluate project hazards and design containment requirements for every project at the site. As a part of meeting its NEPA and hazardous materials management commitments, DOE would evaluate each experimental project plan prior to implementation to assess the need for containment based on the size or volume and nature of the potential hazard. All hazardous materials would be double-contained. The scintillation vessel or tank would provide primary containment, and the secondary containment would be provided by a spill container(s) or basin(s) included in the design of the scintillation tank(s) used in each experiment. Materials stored underground or on the surface would be similarly double-contained.

No changes have been made to the EA as a result of this comment.

Comment Number C-11

Comment The Draft EA is overly broad. The EA must be limited only to experiments (“proposed actions” under NEPA) that can be described and evaluated in detail, as required by NEPA and the CEQ regulations. These experiments cannot be used to usher in other experiments.

Response The EA describes 15 experiments in five categories (particle physics experiments, other astrophysics and physics experiments, mine safety and geophysical studies, nonproliferation and nuclear accountability experiments, and chemical and material processing experiments) that are currently proposed to be conducted in the WIPP facility or that DOE expects may be proposed in the future (see Section 2.1.1). The five categories represent the range of experiments that DOE believes are reasonably foreseeable. DOE analyzed the potential impacts associated with the conduct of this range of experiments at WIPP in the EA.

Should experiments other than the 15 experiments described in the EA be proposed for WIPP, DOE would determine the extent to which these other experiments and their associated impacts and risks were within the range of the experiments and impacts considered in this EA. DOE would evaluate each individual experiment prior to implementation to specifically define hazards, establish spill hazards and spill containment, provide spill response training, and update existing procedure to reflect potential hazards associated with that specific experiment. If the other experiments fell outside the range of experiments already analyzed or if the potential impacts had not been adequately analyzed, DOE would prepare additional NEPA documentation before determining whether to allow the experiments to be conducted at WIPP. No changes have been made to this EA as a result of this comment.

Comment Number C-14

Comment Some experiments (INPAC and OMNIS, for example) would place heavy loads on the floor, which overlies the incipiently fractured anhydrite and clay layers of "marker bed 139." For example, the OMNIS experiment would require placing 20 modules of 450 metric tons each, constructed of lead and/or iron. No analysis of the impact of such heavy loads on the floor of the experimental area has been presented.

Response The most extreme load from the experiments noted in the EA would come from the OMNIS lead modules. These would occupy rows 5 meters wide and nearly 4 meters wide (Section 2.1.1.1). With a density for lead of 11,340 kg/m^3, this represents an added pressure on the floor of 45,360 kg/m^2, which is equivalent to 0.445 MPa or 65 psi. This additional pressure would have an insignificant effect on the floor of the experimental rooms. No changes have been made to the EA as a result of this comment.

WIPP maintains an extensive geotechnical program with well-qualified staff under the direction of a registered Professional Engineer. This program provides comprehensive monitoring and evaluation of ground conditions at WIPP. Validated models are available to assess the performance of planned excavations, and proven ground control techniques and materials are in use. For many years, this program has included independent oversight by recognized experts in salt rock mechanics. Should the circumstances of a particular experiment warrant the use of such oversight, it can readily be provided.

The WIPP staff would evaluate project hazards and design containment requirements for every project at the site. As a part of meeting its NEPA and hazardous materials management commitments, DOE would evaluate each experimental project plan prior to implementation to assess the need for containment based on the size or volume and nature of the potential hazard. All hazardous materials would be double-contained. The scintillation vessel or tank would provide primary containment, and the secondary containment would be provided by a spill container(s) or basin(s) included in the design of the scintillation tank(s) used in each experiment. Materials stored underground or on the surface would be similarly double-contained.

The management of potential spills would be completed in accordance with existing WIPP emergency management and spill control procedures. The operator and/or underground operations personnel would conduct equipment, storage container, and spill management equipment inspections on a daily basis. Weekly inspections would also be conducted by environmental personnel.

Comment Number C-15

Comment The experience of WIPP excavations shows that due to salt creep the roof sags, the floor heaves up and the walls heave into the excavation. After a few years the excavations require roof support through the installation of roof bolts, cables and wire meshing; milling of the floor and reconstituting it with crushed salt to keep it flat; and maintenance of the walls. The maintenance operations, particularly to keep the roof stable, would be very difficult, if not impossible, to perform with large tanks and other structures in place. The EA does not address how excavations of various sizes (both horizontally and vertically) will be maintained for 35 years.

Response Maintenance of the experiment gallery would be part of the design criteria of the experiments. The experiment gallery would be maintained in the same way as other areas of WIPP where workers would be present for its full lifetime. For instance, the drifts used as hallways in the repository are maintained by inspecting for salt creep, heaving in the floors, etc., and maintenance is done to ensure they do not present safety risks. The same would be done in the experiment gallery. Text has been added to Section 2.1.3 describing these maintenance activities.

As noted in Section 4.2.1.3 of the draft EA, "there is a risk of roof falls and cave-ins onto experimental workers and equipment" and as is common in evaporite mines, there also is the potential for floor heave. However, the Salado Formation and the WIPP facility are probably the best-monitored and -understood excavations in salt in the world. Many of the experimental rooms have been open for close to 20 years, and in that time there have been only two roof falls in unheated rooms (SPDV 1 and 2). In both cases, the failures were understood and predicted, and no measures were taken to prevent them. Floor heave is a common occurrence in Panel 1, largely because of the room width, proximity of MB139, and the age of the panel.

In relating this experience to the proposed experiment gallery, a number of factors should be considered. First, while several of the proposed experimental rooms have spans similar to a standard panel waste disposal room, none are appreciably larger and many are smaller. Second, much of the ground movement associated with the panel rooms is a result of the presence of MB139 close to the floor and Clay G close to the back. Third, any potential for roof falls associated with the ground movement has been successfully contained by the support systems employed. Finally, the current rooms are not designed for a long operational life, and indeed the design life has been successfully exceeded by a large amount.

In designing experimental rooms, all of this accumulated knowledge would be used to ensure an adequate operational life without damaging ground movement. While it is difficult to generalize due to the different design lives and geometries for the various experiments, certain design principles can be specified. First, designs would account for excavation sizes and layout (for example, by not placing rooms too close together). Second, where necessary, rooms can be placed at somewhat different horizons to account for the influence of partings and seams on ground movement, which can be most beneficial if used correctly. Third, where needed, design strategies such as shaping can and would be used to enhance stability. Fourth, rooms can be designed to account for creep closure (for example, by oversizing in the horizontal plane), and, if necessary, access can be provided to allow ongoing maintenance of long-lived rooms. Finally, proven ground control materials and techniques (bolting, cabling, etc.), which provide adequate safety, are available.

The design of experimental rooms would be based on experimental needs and known *in situ* salt behavior, and the design would be carried out by professional engineers with extensive validated experience at WIPP.

Such analyses are dependent upon the specifics of each experiment. Detailed calculations of specific factors such as bearing loads, ventilation rates, hoisting impacts, etc., would be performed when an experiment proposal warrants that level of detail.

Comment Number C-18

Comment For remote monitoring, how will information be transmitted to the surface? What will be the effects on the facility's shafts?

Response The experiment gallery would have its own separate computer network and domain. Currently, there is fiber optic cable installed in the waste shaft, and 4 of the 24 lines would be allocated to the experiments. There would be no modification to the shafts. No changes have been made to the EA as a result of this comment.

Comment Number C-19

Comment Will the existence of these experiments at the end of 35 years become a reason to keep the WIPP underground -- that is, WIPP completes its primary mission, and the experiments become the mission?

Response WIPP's mission is to dispose of 175,600 cubic meters (6.2 million cubic feet) of transuranic waste. When this mission is complete, WIPP will be decommissioned and any experiments running at that time would be terminated and removed from the facility. No changes have been made to the EA as a result of this comment.

Comment Number C-21

Comment Include information about the experiments in the information centers that will be part of the “Markers.”

Response Thank you for your suggestion. Decommissioning of the facility and preparation of the markers is 35 years away. Much discussion about what should be included on those markers will occur during that time. Your suggestion will be taken into consideration. No changes have been made to the EA as a result of this comment.

Comment Number C-22

Comment In the event of an explosion caused by materials brought in, would materials go up the shaft?

Response The explosions discussed as presenting a hazard would be no larger than a large firecracker. That type of explosion would not result in materials moving up the shaft. In fact, the greatest hazard, perhaps, would be the accidental release of nitrogen that would displace the oxygen in the repository. Should such an accident occur (and the potential is very, very slight), then oxygen and nitrogen would move up the shaft. Both, though, are part of our natural environment. No changes have been made to the EA as a result of this comment.

Comment Number C-23

Comment Will workers wear oxygen?

Response Not necessarily. Workers in the experiment gallery would be given the same safety training and equipment as others working in the repository. Also, monitors and other safety controls throughout the facility would be emplaced based upon hazards analyses for the experiments in the experiment gallery. The monitors and controls would be designed to allow workers to evacuate should a problem occur. No changes have been made to the EA as a result of this comment.

Comment Number C-24

Comment Section 2.2 No Action Alternative. A statement should be included stating that salt is currently stored in the experiment gallery at WIPP.

Response Salt is currently stored in some portions of the gallery formerly planned for underground experiments, but not in the area described in this EA as the experiment gallery. That area currently is vacant. No changes have been made to the EA as a result of this comment.

Comment Number C-25

Comment CCNS strongly suggests that long-term stewardship principles be required in the planning, operations, and decommissioning plans for these experiments.

Response Those principles would be required. The experiments would not leave any materials behind, even if they continued until WIPP decommissioning. All materials would have to be removed and properly disposed of. No changes have been made to the EA as a result of this comment.

The existing WIPP Conduct of Operations process implements the long-term stewardship process that will govern all experimental processes just as it affects all current operational activities at WIPP. Conduct of Operations concepts are implemented through existing procedures and will be integrated into all experimental activities. Planning, operations, maintenance, auditing and corrective actions, and decommissioning are all a part of the overall Conduct of Operations process that are fully implemented at the site.

Comment Number C-26

Comment The draft EA does not consider alternative locations (such as Yucca Mountain) for the experiments, as required by NEPA.

Response The only proposal pending before DOE is whether to allow WIPP to be used for the conduct of the range of experiments analyzed in the EA. DOE is not proposing to conduct the experiments; rather, the agency is only deciding whether to allow its underground facility to be used for experiments proposed by others. Thus, DOE has no basis on which to decide that the experiments should be conducted elsewhere. For this reason, DOE did not analyze the potential impacts of conducting these experiments at other locations.

Comment Number C-30

Comment Nine experiments are proposed to be conducted underground at WIPP. While general space requirements for each of these are provided in the EA, there is no attempt to plan a layout of all these experiments in the 9,146 square meter experimental gallery. While the EA states (Section 2.1.1.1, page 2-9, and Section 2.1.3, page 2-15) that additional excavations up to the size of a full WIPP panel may be necessary to accommodate the proposed experiments, there is no attempt to plan the layout. The final EA should show the layout of all the experiments planned, and with the help of the drawings, should show the dimensions of the new excavations and where these will be. Also, greater detail is needed on the ventilation requirements and planning.

Response DOE does not know which experiments would actually be funded and emplaced, nor does it know the exact configuration that the scientists conducting the experiments would request. Therefore, there is no way to present a layout at this time. However, a new Figure 2-8 showing ventilation pathways has been added to Section 2.1.3.

Comment Number C-31

Comment Very little thought appears to have been given to the requirement for hoisting of equipment, materials, and personnel for these experiments. The EA assumes (Section 2.1.3, page 2-15) that the requirement for lowering tons of lead, iron, liquids, equipment and modular rooms would last only for a period of 4 to 5 years. The experiments described in Section 2.1.1 do not, however, all begin at the same time. There appears to be a need for substantial hoisting resources to last the full 35 years of experiments. The EA casually mentions (Section 2.1.3, page 2-15) that the existing WIPP hoisting facilities will be used for these needs, “as they are available around disposal activities.” This is not good enough. The WIPP plan is to start receiving 17 shipments per week of CH-TRU and 4.4 shipments of RH-TRU waste, per week, as soon as possible. A proper analysis of the hoisting needs of the proposed experiments vis-à-vis the needs of the waste disposal operations is needed.

Response Although the specific requirements of each individual experiment are not yet available, DOE has evaluated the potential bounding impacts on hoist usage associated with the experimental programs. As previously stated, experiments would not impact waste operations. Based on these criteria, an assessment of hoist usage was developed to examine potential hoisting needs. It was assumed that the materials hoist services would only be available to experimental personnel during the back shift to move and set up experiments. For assessment purposes, it was also assumed that the hoist would only be available 50 percent of the time during the back shift to support hoist maintenance and inspection activities. Thus, only five complete trips could be completed in a 10-hour shift. This analysis shows that the experimental needs could be accommodated using the existing hoist.

DOE would make the facility available only to the extent that doing so would not interfere with the disposal of waste. No additional hoist would be added and WIPP officials would not allow the needs of the scientists to interfere with WIPP's primary mission. Those scientists intending to use the facility would have to design their experiments such that their use of the hoist would not interfere with waste emplacement activities. No changes have been made to the EA as a result of this comment.

Comment Number C-32

Comment Several experiments would require huge amounts of liquids to be stored underground. For example, the GENIUS experiment would place up to 450 metric tons of liquid nitrogen. The OMNIS experiment would require 106,000 liters of mineral oil (scintillation liquid). The EXO experiment would use 9 metric tons of Xenon-136 under up to 20 atmospheres of pressure. The INPAC experiment would require a 381.5 cubic meter cylinder filled with ultra-pure water. The EA should include a discussion of the handling of these liquids. Would pipelines be installed to pump the liquids in? How will the liquids be removed from the underground when the experiments are finished?

Response DOE plans to transport containerized liquids to the underground using the hoisting mechanisms in place at WIPP. The use of pipelines to transfer liquids would pose at least two problems. First, the required purity of some of the liquids that would be used in the experiments would likely require several pipelines, rather than just one, to avoid potential contamination of pure fluids by other fluids transferred in the same pipeline. Second, the use of a pipeline to transfer liquids underground would result in high fluid pressures at the underground outlet, which would pose an unnecessary safety hazard, and would require additional engineering controls to reduce the fluid pressure to a point that would allow safe handling at the underground outlet. No changes have been made to the EA as a result of this comment.

A.6 GEOLOGY

Comment Number C-53

Comment Consider how you will maintain the underground facility for 20 to 35 years. In some rooms, facilities already reach marker beds. Scientists should know the risks of working in the WIPP underground.

Response The scientists are aware of the risks of working in a salt repository. Many of them have worked in similar repositories elsewhere in the world. The experiment gallery would be maintained in the same way as other areas of WIPP where workers would be present for its full lifetime. For instance, the drifts used as hallways in the repository are maintained by inspecting for salt creep, heaving in the floors, etc., and maintenance is done to ensure they do not present safety risks. The same would be done in the experiment gallery. No changes have been made to the EA as a result of this comment.

A.7 NEPA PROCESS

Comment Number C-20

Comment If you come up with experiments that are beyond the analysis of this EA, I recommend you perform other NEPA analysis and include public meetings.

Response If an experiment is outside of the scope of this EA, a separate NEPA document describing the impacts of the experiment would be necessary, and it is possible that public hearings would be held then. No changes have been made to this EA as a result of this comment.

Comment Number C-28

Comment It appears that the legal framework to allow any activity other than the disposal of defense transuranic waste in the WIPP underground may not currently exist. It would be wise to clarify this point and, if necessary, initiate actions to obtain such authority at an early stage of this decision making process.

Response DOE believes the Land Withdrawal Act clearly allows these activities, as stated in Section 1.2 of the EA. No changes have been made to the EA as a result of this comment.

Comment Number C-29

Comment The LWA, Section 4(3)(e), requires that any amendments to the land management plan be "submitted promptly to the Congress and the State." While Section 1.4.2 of the EA shows that various departments of the New Mexico government are aware of the proposals, there is no indication that the Congress has been notified.

Response Should DOE implement the proposed action, it will evaluate whether amendments to the land management plan are needed to implement those actions. DOE will amend the plan when appropriate and seek the required approvals.

Comment Number C-41

Comment Section 1.4.1 WIPP NEPA Compliance, starting on page 1-7 and ending on page 1-9: there should be a NEPA reference for closure of the facility. There must be such a document. This document should be inclusive in the narrative.

Response SEIS-II is the only existing document that addresses closure activities for WIPP. A text box summarizing closure and decommissioning activities, as described in SEIS-II, has been added to Section 2.1.5 of the EA. However, a NEPA document specifically addressing site closure would likely be prepared immediately prior to closure to examine the impacts in more detail.

Comment Number C-43

Comment Section 1.4.2 Stakeholder Outreach and Involvement Activities, on page 1-9: NMED should be considered for inclusion on Table 1-2. Government Agencies Consulted due to the fact that hazardous, low level mixed radioactive, and low level radioactive wastes may be generated during the experiments. However, the paragraph mentioning NMED following Table 1.2 may suffice.

Response Table 1.2 has been modified as suggested by the reviewer. The paragraph mentioning NMED has also been left in the text.

A.8 OPPOSITION

Comment Number C-39

Comment I quite oppose astrophysics and other basic science experiments being done at the WIPP, because it diverts too much attention from storing nuclear waste at the WIPP safely, with increased chances of lost trucks, nuclear accidents in which people lose their lives, and so on.

Response Thank you for your comment.

A.9 OTHER

Comment Number C-38

Comment We have no specific comments to offer on the draft EA. However, the proposed activities may have an impact on current operations and these activities must be considered under applicable regulations.

Response Thank you for your comment. DOE intends to work with EPA's Region 6 to ensure activities are compliant with all applicable regulations. No changes have been made to the EA as a result of this comment.

A.10 WASTE GENERATION

Comment Number C-40

Comment Section 1.3 Permits Required, page 1-7: there should be a clause to indicate that hazardous, low level mixed radioactive, and low level radioactive wastes may potentially be generated as a result of the experiments, and that these wastes shall be managed by WIPP and shipped off site, per existing generator regulations specified in 40 CFR §262.

Response DOE does not anticipate that such wastes would be generated. Still, text has been added to Section 1.3 stating that DOE would comply with regulations for managing any such waste.

Comment Number C-42

Comment Table 1-1. Required Permits and Approvals for Ongoing Activities at WIPP, page 1-8: the relevant NMED document is properly entitled the “Hazardous Waste Facility Permit.” The footnote referencing RCRA may be eliminated.

Response These changes have been made to Table 1-1.

Comment Number C-44

Comment Section 2.1.1.1 Range of Possible Experiments, pages 2-3 through 2-9: each category (LANL WIMP Dark Matter HpSi Detector, Observatory for Multi-flavor Neutrino

Interactions from Supernovae [OMNIS], Surface Experiment Related to OMNIS, Enriched Xenon-136 Observatory [EXO], Germanium in Liquid Nitrogen Underground System [GENIUS], Institute for Nuclear and Particle Astrophysics and Cosmology [INPAC], Majorana Project, and Neutrino Factory Detector at WIPP), should have statements for the potential to produce wastes.

Response Because many of the experiments are in the theoretical planning stages, it is difficult to state specifically what wastes would be produced. Instead, the EA discusses the types of wastes that could be produced in a general sense, given the types of experiments proposed to date. However, before any experiment would be placed in the WIPP underground, a hazards analysis would be performed for that experiment. This analysis would provide specific information about (1) the types of waste that could be produced, and (2) waste handling methods to be used. Section 2.1.3 of the EA has been revised to state that a hazards analysis would be performed for each experiment before it began.

Comment Number C-45

Comment Sections 2.1.1.4 Nonproliferation and Nuclear Accountability Experiments and 2.1.1.5 Chemical and Material Processing Experiments, page 2-12: statements should be made pertaining to the potential to produce wastes.

Response Because many of the experiments are in the theoretical planning stages, it is difficult to state specifically what wastes would be produced. Instead, the EA discusses the types of wastes that could be produced in a general sense, given the types of experiments proposed to date. However, before any experiment would be placed in the WIPP underground, a hazards analysis would be performed for that experiment. This analysis would provide specific information about (1) the types of waste that could be produced, and (2) waste handling methods to be used. Section 2.1.3 of the EA has been revised to state that a hazards analysis would be performed for each experiment before it began.

Comment Number C-46

Comment Section 2.1.2 WIPP Experimental Gallery, page 2-13: a statement regarding the establishment of a less than 90-day waste accumulation area should be included in the narrative.

Response A less-than-90-day satellite waste accumulation area would be located near the experiment gallery once the need for such an area was determined. A statement to that effect has been added to Section 2.1.2.

Comment Number C-47

Comment Figure 2-7. Closeup of Experimental Gallery, page 2-14: the figure should indicate the location of the less than 90-day waste accumulation area.

Response A less-than-90-day waste accumulation area would be located near the experiment gallery. The exact location of the waste accumulation area would be determined when DOE knows which experiments would be conducted in the experiment gallery and how the experiments would be arranged physically. Figure 2-7 has not been revised as a result of this comment.

Comment Number C-48

Comment Section 2.1.5 Decommissioning, page 2-15: a statement should be included in the narrative to indicate that the experiment gallery will also be decommissioned in compliance with requirements in the NMED hazardous waste facility permit.

Response This change has been made to Section 2.1.5.

Comment Number C-49

Comment Section 4.1.1 Proposed Action, paragraph four on page 4-1: an inclusive statement should be amended to identify potential waste production.

Response Because many of the experiments are in the theoretical planning stages, it is difficult to state specifically what wastes would be produced. Instead, the EA discusses the types of wastes that could be produced in a general sense, given the types of experiments proposed to date. However, before any experiment would be placed in the WIPP underground, a hazards analysis would be performed for that experiment. This analysis would provide specific information about (1) the types of waste that could be produced, and (2) waste handling methods to be used. Section 2.1.3 of the EA has been revised to state that a hazards analysis would be performed for each experiment before it began.

The WIPP staff would evaluate project hazards and design containment requirements for every project at the site. As a part of meeting its NEPA and hazardous materials management commitments, DOE would evaluate each experimental project plan prior to implementation to assess the need for containment based on the size or volume and nature of the potential hazard. All hazardous materials would be double-contained. The scintillation vessel or tank would provide primary containment, and the secondary containment would be provided by a spill container(s) or basin(s) included in the design of the scintillation tank(s) used in each experiment. Materials stored underground or on the surface would be similarly double-contained.

The management of potential spills would be completed in accordance with existing WIPP emergency management and spill control procedures. The operator and/or underground operations personnel would conduct equipment, storage container, and spill management equipment inspections on a daily basis. Weekly inspections would also be conducted by environmental personnel.

Comment Number C-51

Comment Section 4.2 ACCIDENTS, on pages 4-6 through 4-14, a subsection should be created to discuss the potential of spills and /or releases of wastes stored in the less than 90-day waste accumulation area.

Response DOE is unsure what specific wastes would be stored in such an area because the experiments are currently only proposed and information on many of them is limited. For this reason, the less-than-90-day satellite waste accumulation area has not yet been identified.

However, the EA does analyze the potential impacts of spills, leakages, or other releases that could occur from the experiments themselves; DOE believes that any potential impacts from spills in a waste accumulation area would be considerably less than the potential impacts already analyzed in the EA. No changes have been made to the EA as a result of this comment.

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