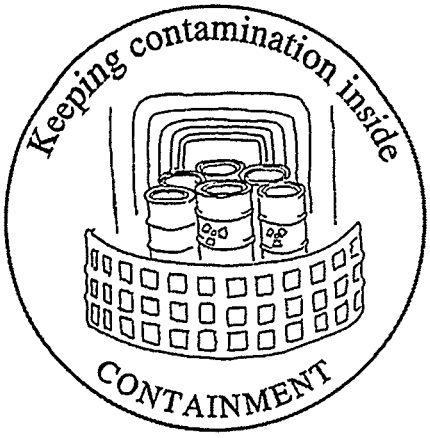
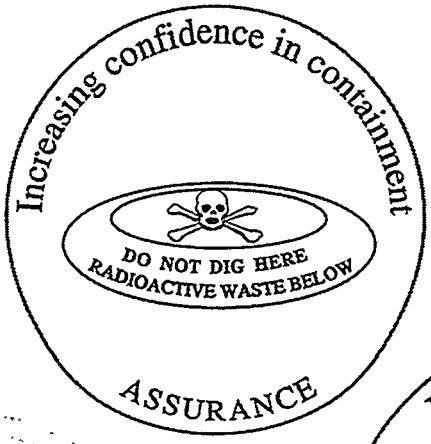
Citizens' Guide

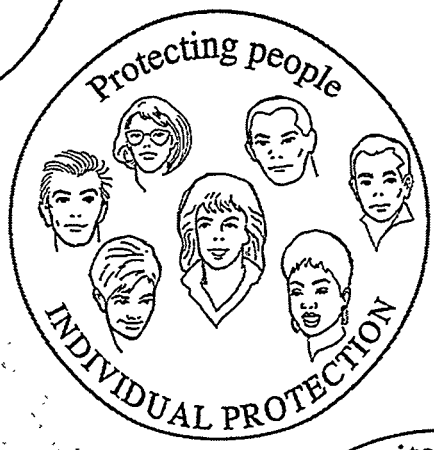
to the Waste Isolation Pilot Plant

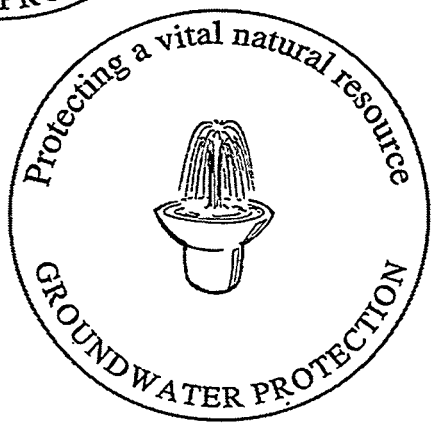
Compliance Certification Application to the EPA

DOE/CAO-96-1207









November 1996

"The bottom line is that we evaluated what might happen in a multitude of situations, both with and without humans intruding into the repository. In every scenario, we found the WIPP to be effective in isolating the waste and satisfying regulatory requirements. Current and future generations will be better off once we have transuranic waste safely disposed of in the WIPP. It is the right thing to do — for ourselves and our children's children.

George E. Dials,
Manager of the
Carlsbad Area Office

Message from the manager:

Safeguarding future generations

We at the U.S. Department of Energy (DOE) Carlsbad Area Office have reached a crucial milestone in our goal of opening the Waste Isolation Pilot Plant (WIPP) for disposal of transuranic nuclear waste. The DOE has submitted an application to the U.S. Environmental Protection Agency (EPA) for a certificate showing that the WIPP complies with strict environmental regulations designed to safeguard humans and the environment for at least 10,000 years.

Congress gave the EPA authority to regulate the WIPP site for disposal of transuranic waste under the 1992 WIPP Land Withdrawal Act. The EPA has one year to review the Compliance Certification Application (CCA) before determining whether we have successfully documented the WIPP's compliance with federal environmental standards.

Our application presents the conclusions of more than 20 years of scientific and engineering work specifically dedicated to disposal of transuranic waste at the WIPP. The application thoroughly documents how the natural characteristics of the WIPP site, along with engineered features, comply with the regulations. In the application, we respond fully to the federal standards and to the EPA's certification criteria.

This *Citizens' Guide* provides an overview of the CCA and its role in moving toward final disposal of transuranic waste. For more information about the application, please call us at 1-800-336-9477.

DISCLAIMER

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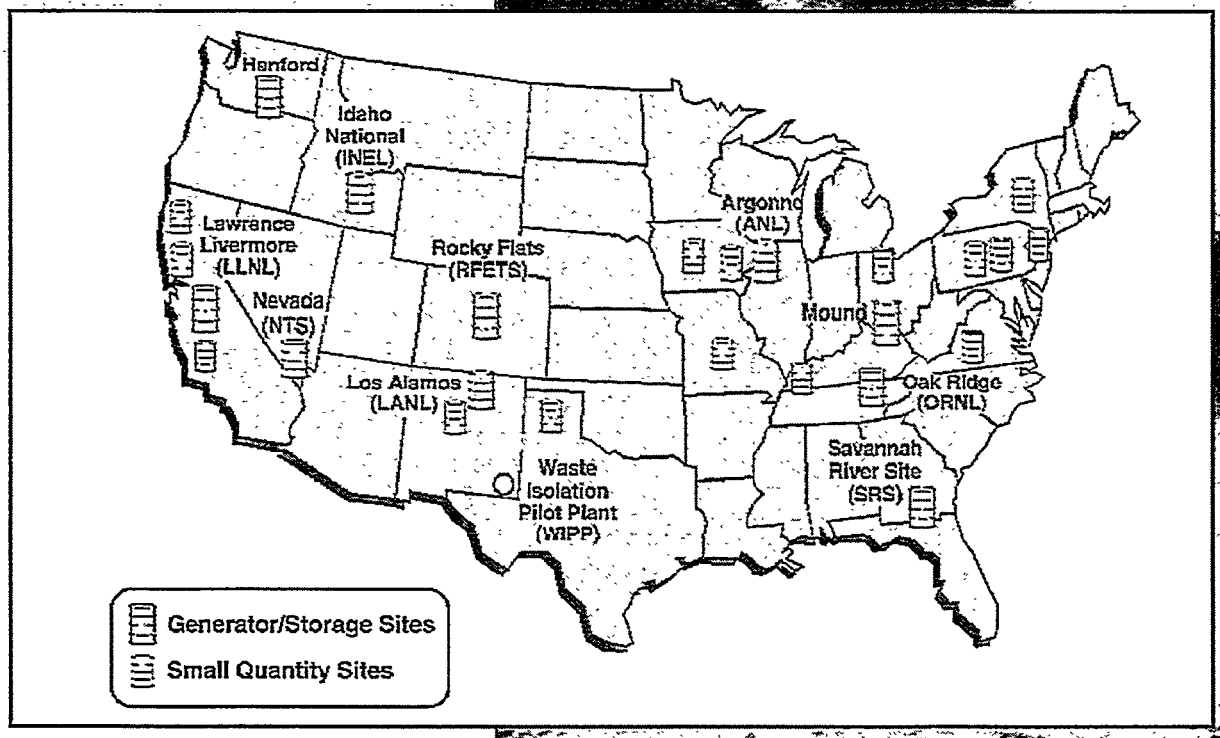


Transuranic waste is stored in drums and boxes at sites across the United States. It was produced mainly through the development and production of nuclear weapons.

Temporary transuranic waste storage:

A national problem

Radioactive "transuranic" waste presents risks to about 60 million people who live within 50 miles of more than 20 storage sites across the United States.

Most of the radiation of primary concern from this waste can be contained by placing the material in sealed bags or boxes. But transuranic elements can pose serious hazards to people if ingested or inhaled. A small portion of this waste (3 percent) emits penetrating radiation and requires shielding to protect workers and other people nearby.

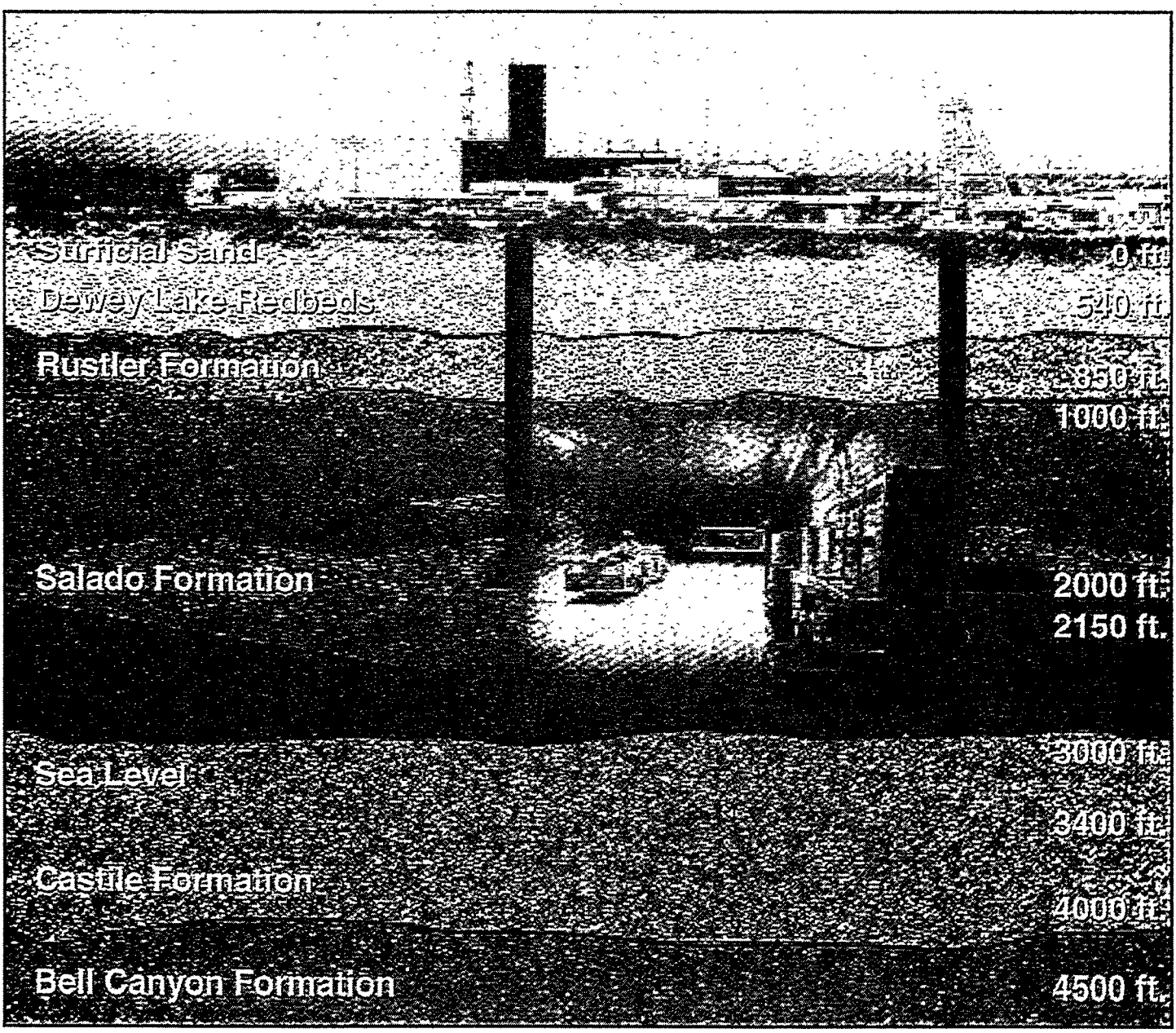
Most transuranic waste is in metal drums at sites owned by the U.S. Department of Energy (DOE). The waste contains radioactive elements such as plutonium, americium, neptunium, and californium. These man-made elements are called "transuranic" because they are heavier than uranium–the heaviest naturally occurring element.

Storage in drums was never meant to be permanent. Temporary containers for above-ground storage will deteriorate long before the prevalent radionuclides in transuranic waste are eliminated through radioactive decay. The dominant form of plutonium, for example, will require nearly one quarter of a million years to decay by 99.9 percent. Therefore, these materials must be isolated and controlled for many generations.

The DOE must act to minimize threats to public health, worker safety, and the environment. Based on sound science and rational use of public resources, permanent disposal of transuranic wastes is necessary to minimize health risks.

The **transuranic waste** earmarked to go to the WIPP consists of clothing, tools, rags, and other such items contaminated with trace amounts of man-made radioactive elements--mostly plutonium. Although not as hazardous as high-level waste, the presence of even small amounts of long-lived radioactive elements in transuranic waste requires its isolation from the human environment for thousands of years.

Chapter Four of the CCA covers transuranic waste characterization and defines acceptable ranges of physical, chemical, and radiological features of material to be disposed of in the WIPP repository.



The Waste Isolation Pilot Plant (WIPP) repository is 2,150 feet beneath the desert surface in southeastern New Mexico. For comparison, the tallest building in the United States is the 1,454-foot Sears Tower in Chicago. In the repository, a group of seven waste disposal rooms makes a panel. One panel has been mined, seven more panels are planned. Four vertical shafts connect the underground to the surface. Two shafts are for air circulation, one is for salt removal, and one will be used for bringing in the waste. All shafts will eventually be sealed.

WIPP permanent disposal:

The solution

The DOE plans to dispose of transuranic waste nearly half a mile underground at the WIPP in southeastern New Mexico. The WIPP facility is designed to take advantage of natural geological and hydrological features along with specially engineered barriers to block waste movement from the repository. Successful operation will establish the repository as part of the solution to the national problem of nuclear waste disposal.

After more than 20 years of careful study, with thorough independent oversight and public scrutiny, the DOE is confident that the geologic repository can isolate transuranic waste. The DOE expects that this isolation will be effective for many thousands of years and will pose low risk to people living in the region. While the continuing risks of current above-ground storage are not high compared with many common hazards of daily life, this temporary storage is not suitable for the long run. Disposing of the waste in the WIPP facility will reduce long-term risks by permanently isolating the waste from people and their environment.

The rationale for isolating nuclear wastes through deep geologic disposal is based on a large body of U.S. and international research. The National Academy of Sciences observed in 1957 that: *"The best means of long-term disposal . . . is deep geological emplacement. . . ."* The Academy reaffirmed and expanded on this view in 1983 and in 1996. The WIPP repository is carved out of a bedded salt formation, with the following features that make it ideal for transuranic waste disposal:

- *Dry environment* – Large salt beds are found only in geologic regions that lack significant flows of groundwater. This deep, relatively dry underground environment greatly reduces the possibility that wastes

"The committee is confident in its judgment that DOE should be able to demonstrate that radionuclide releases at WIPP will be within the limits allowed by EPA, for both the undisturbed and disturbed cases, even with the severe criteria defined in 40 CFR 194."

— *WIPP: A Potential Solution for the Disposal of Transuranic Waste*
The National Academy of Sciences,
October 1996

could be carried out of a repository by natural processes. The salt bed at the WIPP site has been stable for 225 million years. It can be expected, with high confidence, to remain that way for many thousands of years into the future.

- *Waste immobilization* – Salt tends to "heal" itself after being mined because it gradually creeps under the pressure from overlying earth and fills any openings. After several hundred years, the salt at the WIPP is expected to close in upon the waste and permanently lock it deep below the surface.

Since the mid-1970s, the DOE and its scientific adviser, Sandia National Laboratories, have studied the WIPP site to make sure it is a safe place to isolate transuranic waste. The WIPP addresses the following two key national needs:

- *Reducing risk* – As long as transuranic waste remains at storage sites, there will be some level of risk to populations near these sites. Also, workers who must maintain current sites and monitor wastes are frequently exposed to low levels of radiation.
- *Providing disposal* – The WIPP is a first-of-its-kind deep geologic disposal facility and will provide a model for radioactive waste disposal. In addition to the existing inventory of stored transuranic waste, estimated at about 2.32 million cubic feet, the WIPP will be the disposal site for more than 3.7 million cubic feet of transuranic waste expected to be generated during the next 35 years as DOE sites are closed. Under current law, the DOE is allowed to store 6.2 million cubic feet of transuranic waste at the WIPP.

"These [transuranic waste] packages are stored in earth-covered mounds, concrete culverts and other types of facilities. An estimated 70 percent of the drums have been in storage for more than 10 years, and 20 to 30 percent of the drums stored in mounds contain corrosion pinholes or are badly deteriorated. Some of this waste must be repackaged before it can be shipped for disposal."

From the League of Women Voters book called *The Nuclear Waste Primer: A Handbook for Citizens*

Closing in on the solution

Before disposing of waste at the WIPP, the DOE must comply with EPA regulations by documenting that waste can be isolated from the human environment for at least 10,000 years. Independent scientific research organizations, citizens groups, and several regulatory agencies have examined and commented on the DOE's plans. Those studies and interactions provide a foundation for the DOE's Compliance Certification Application (CCA) to the EPA.

The CCA contains comprehensive documentation of wide-ranging research into numerous factors that could affect the ability of the repository to isolate transuranic waste permanently. The EPA must evaluate the site design and the planned operations before deciding whether the site is adequately safe, the disposal methods are sound, and the DOE is complying with a wide array of environmental regulations.

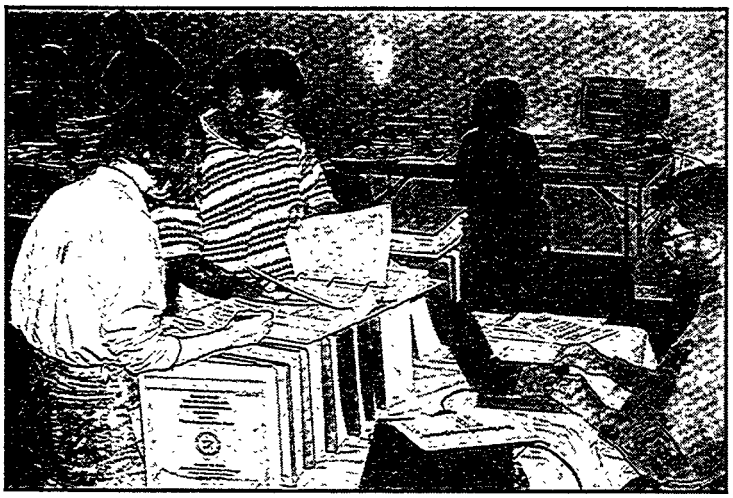
This *Citizens' Guide* provides an overview of the CCA, lists additional information sources, and suggests ways to participate in decision-making.

Chapter Two of the CCA covers site characterization and local and regional geology, and provides an environmental baseline for analyses. Information in the chapter forms a basis for discussion of natural features, events, and processes that might affect long-term repository performance.

The Compliance Certification Application:

Satisfying the rules on transuranic waste disposal

The DOE submitted the Compliance Certification Application (CCA) on October 29, 1996, completing 22 years of pioneering work in site design and environmental protection. The CCA demonstrates to the EPA and to the public that this deep underground repository will safely isolate transuranic waste from the human environment for at least 10,000 years.



Many reviewers spent weeks making final edits on the CCA, which consists of 21 volumes and includes more than 50 appendices and 700 references.

The document responds to two major regulations: "40 CFR 191" and "40 CFR 194." The regulations are summarized below.

Regulatory standards

In late 1993, the EPA published its *Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule (40 CFR 191)*, which establishes standards that the DOE must meet before placing transuranic waste in the WIPP repository. These standards apply to four health and environmental objectives:

- *Containment requirements* direct the DOE to consider natural features and man-made components of the repository that isolate radioactive waste for at least 10,000 years.
- *Assurance requirements* prescribe additional activities intended to increase confidence that the repository will isolate the waste for many generations.

- *Individual protection requirements* set limits on radiation exposure to people who might live near the WIPP site in the future.
- *Groundwater protection requirements* are meant to ensure that if water were found near the site, it would meet federal drinking water standards.

Criteria for meeting environmental standards

In early 1996, the EPA published its *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations, Final Rule (40 CFR 194).* The criteria, specific to the WIPP, clarify the requirements of the radioactive waste disposal standards (40 CFR 191) and require the DOE to provide specific types of information.

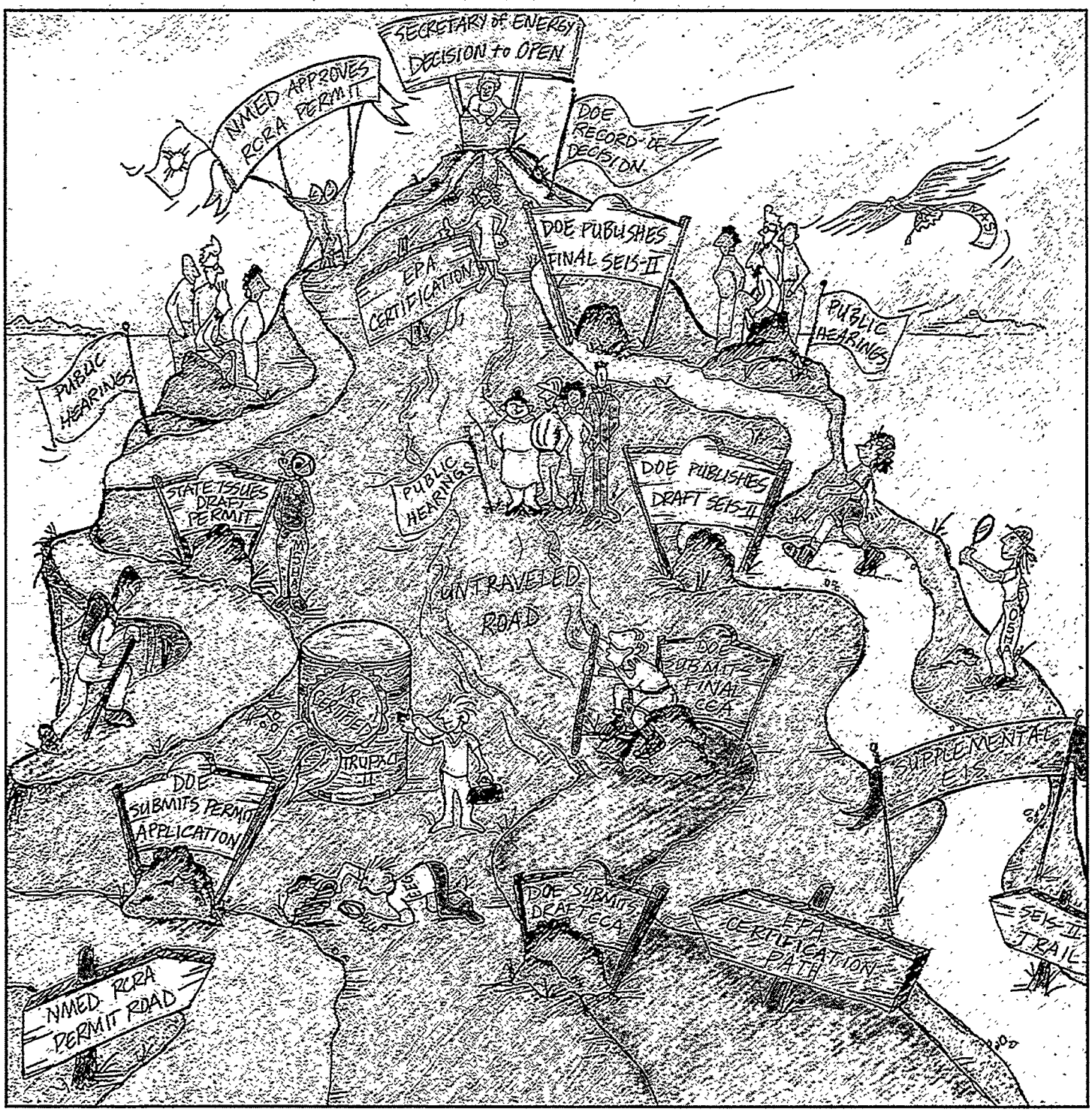
What is the Compliance Certification Application?

The CCA is the DOE's response to the EPA's environmental protection requirements for the Waste Isolation Pilot Plant in southeastern New Mexico. The document consists of:

- Main text - about 2,000 pages
- Appendices - about 22,000 pages
- References - about 60,000 pages

To facilitate review and save paper, the document will be produced in a CD-ROM format. The text will be hyperlinked with the capability to do word searches. Many references will be included on the disk. In addition, it will be placed on the WIPP home page at: http://www.wipp.carlsbad.nm.us. Both the CD-ROM and placement on the web page are expected to be completed prior to the end of December 1996.

Chapter One of the CCA provides an overview of the document, discusses the physical and regulatory history of the site, and explains reasons for producing the Compliance Certification Application.



REGULATORY MOUNTAIN

The DOE must climb a regulatory "mountain" prior to a decision to open the WIPP. Three of the major regulatory processes are: the Compliance Certification Application (CCA), the *WIPP Disposal Phase Supplemental Environmental Impact Statement* (SEIS-II), and the Resource Conservation and Recovery Act Permit (RCRA). Because the regulation requiring it has never before been implemented, the process for the CCA presents the most unknowns.

Regulation and oversight:

Looking over the DOE's shoulder

Numerous agencies and organizations scrutinize the WIPP.

U.S. Environmental Protection Agency (EPA): The EPA issues standards and criteria for limiting radiation releases and determines (certifies) whether the WIPP meets those requirements.

The State of New Mexico: The New Mexico Environment Department (NMED) oversees the WIPP through the New Mexico Hazardous Waste Act, which implements the Resource Conservation and Recovery Act permitting process. Various state groups provide oversight, oversee emergency preparedness training, and monitor transportation and mine safety.

The TRUPACT-II shipping container is designed specifically to transport transuranic waste. The container is certified by the Nuclear Regulatory Commission and meets the standards of the U.S. Department of Transportation.

Nuclear Regulatory Commission (NRC): The NRC certifies the waste shipping containers.

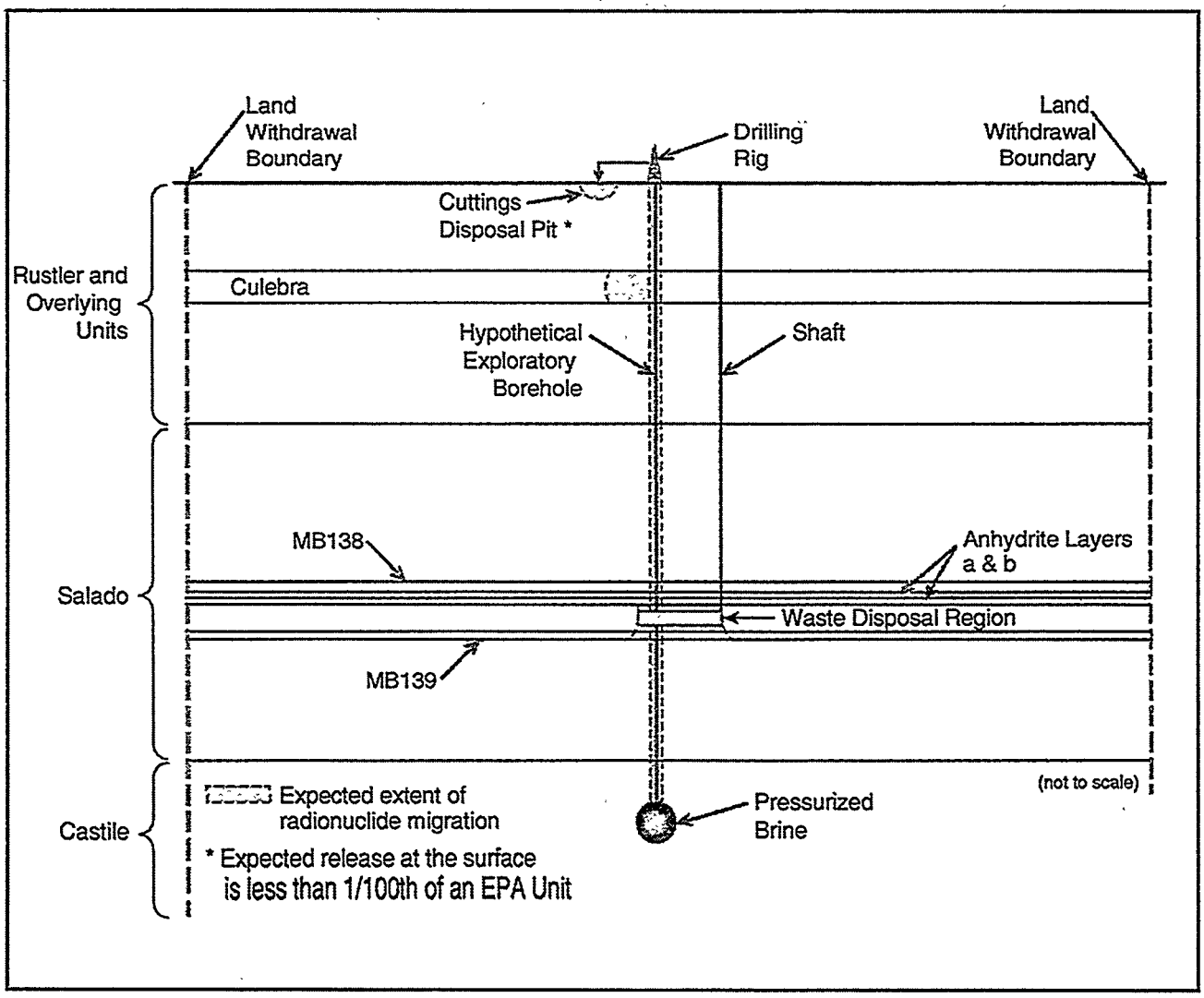
Environmental Evaluation Group (EEG): The EEG conducts independent review and evaluation of the WIPP.

National Academy of Sciences (NAS): The NAS Committee on the Waste Isolation Pilot Plant provides independent scientific and technical guidance to the DOE.

Other state and tribal governments: States and tribes oversee transportation and emergency response capability.

Other government agencies: The Occupational Safety and Health Administration and the Mine Safety and Health Administration oversee work practices.

Citizen groups: Citizen groups have voiced questions and concerns about the WIPP and have participated in many hearings and conferences regarding the project.

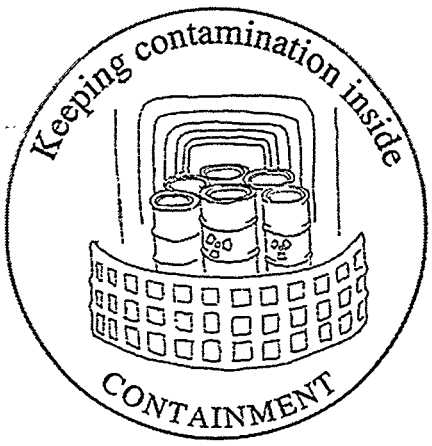


A HYPOTHETICAL HUMAN INTRUSION SCENARIO

This diagram, illustrating one scenario evaluated for the CCA, shows a hypothetical borehole that might be drilled through the repository during the next 10,000 years and into a pressurized brine pocket in the Castile Formation below. As a result, radioactive materials could be released two ways: into a rock layer called the Culebra and via drill cuttings carried to the surface. This and other release pathways were evaluated in the DOE's demonstration of the WIPP's compliance with EPA standards. Performance assessment results indicate that the natural and engineered barriers of the WIPP will contain transuranic waste even if the repository is penetrated by multiple boreholes.

Containment requirements:

Isolating waste for 10,000 years



The objective of a deep geologic repository is to reduce risks to future generations by isolating radioactive material from the human environment for at least 10,000 years. Extremely cautious assumptions have been used in engineering and planning the WIPP repository.

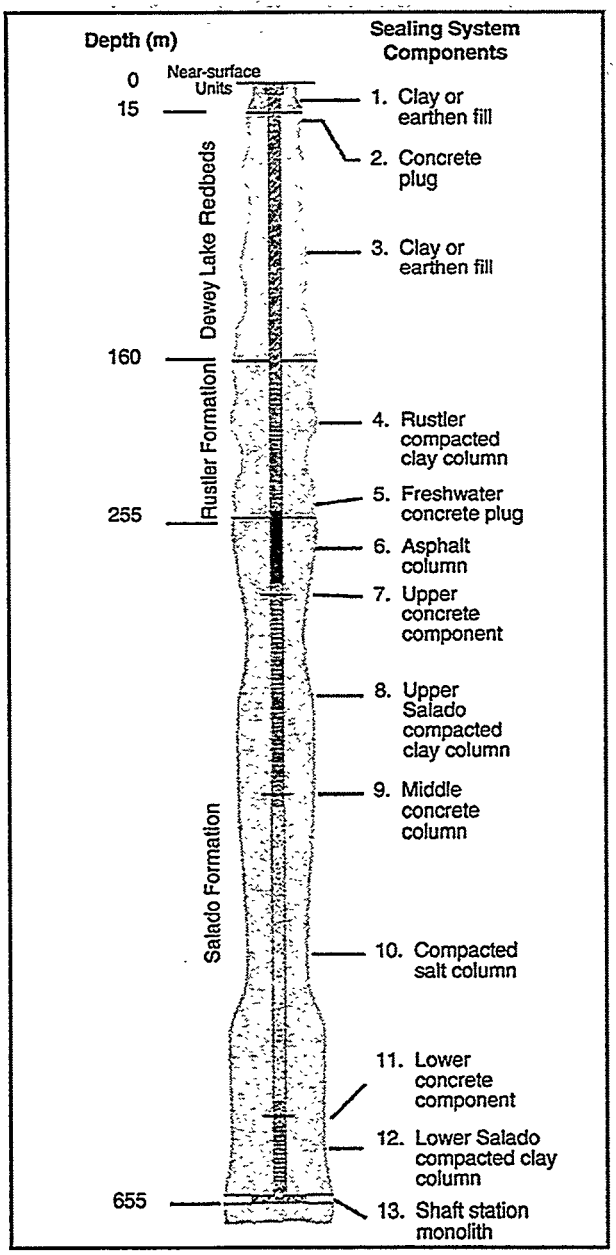
To ensure that the WIPP facility will perform as designed requires answering several challenging and partly speculative questions. If the repository is undisturbed, will it contain virtually all of the radioactive material that has been placed in it? What would happen if someone were to drill through the repository while exploring for natural resources? What are the most cost-effective engineered barriers and durable warning markers?

In submitting its compliance application to the EPA, the DOE has provided its responses to these questions. The EPA's standards require the DOE to "demonstrate a reasonable expectation" that total releases of radioactive material from the WIPP will fall below specified limits during the 10,000 years following closure of the repository. This is done through a risk-based performance assessment--a process through which the DOE determines whether or not the repository system will perform as expected. To estimate risk, the following three questions must be asked:

- *What can go wrong?*
- *How likely is it to go wrong?*
- *What are the consequences?*

The answers are given values and plotted on graphs that show whether the WIPP is in compliance with regulatory standards.

The key to the process is deciding on an appropriate set of scenarios that describe possible ways in which the repository could fail and then identifying what could go wrong.



The repository shafts will be permanently sealed after the disposal phase has been completed.

A multitude of scenarios were used to make computer projections of how the WIPP and its disposed transuranic wastes will interact with their surroundings. Experiments and investigations at the WIPP have identified natural features, events, and processes that could affect the WIPP's performance during the 10,000-year period. Projections were made assuming that the repository would be undisturbed, and also that it would be intruded upon by humans during the 10,000-year time frame.

Undisturbed performance

An undisturbed scenario, as defined by the EPA, includes reasonably foreseeable natural processes and excludes human intrusion and unlikely disruptive natural events. Evaluation of past and present geologic processes in the region show that none are likely to have the potential to breach the repository within 10,000 years.

The behavior of the undisturbed disposal system is based primarily on the following:

- Rock deformation surrounding the repository and the shaft seals;
- Fluid flow through the repository zone; and
- Decomposition of the waste and waste packages.

The salt rock around the repository deforms as soon as excavation begins, creating a disturbed rock zone. This occurs in all deep salt mines. The salt rock was chosen as a medium for geologic disposal of radioactive waste because of its ability to creep, thereby healing fractures

and filling open spaces. This salt creep eventually will completely heal the fractured rock surrounding the shaft, preventing any brine from escaping to the surface under undisturbed conditions. The concrete, clay, and asphalt components of the shaft seal system will provide an immediate and effective barrier to fluid flow through the shafts.

Excavating the repository has resulted in some brine flow, despite the low permeability of surrounding rock. Thus, some brine is expected to continue flowing slowly through the more permeable areas above and below the repository, as well as into the repository. This brine could slowly dissolve radioactive elements. However, the brine is not predicted to carry any dissolved transuranic elements to the accessible environment through this pathway.

This brine flow will be coupled with the presence of gas, initially consisting of air trapped at the time of closure, and will eventually include other gases that form as a result of waste decomposition. The generation of gases will increase pressure in the repository, resulting in a slowing of brine

Engineered Barriers

The DOE, in siting and designing the WIPP repository, took advantage of the natural waste-isolating features of the site and developed engineered barriers that complement and strengthen those natural features. These barriers are described below:

Shaft Seals - Once the repository has been filled, the entire column of each shaft will be backfilled with materials that prevent vertical flow of fluid. Materials include concrete, clay, asphalt, compacted salt, grout and earthen fill (see opposite page). The shaft seal system is designed to limit fluid flow through the shafts.

Panel Closures - Panel closures will limit the interaction of brine and gases among waste disposal panels. These closures will consist of a rigid concrete barrier and an isolation wall made of concrete construction block with an isolation zone between them.

Borehole Plugs - Several unplugged boreholes, presently being used to collect information for the WIPP, exist within the WIPP Land Withdrawal Area. To curtail the potential for movement of contaminants to the human environment, the DOE has designed plugs to block the flow of liquid in either direction.

Backfill - To further limit the movement of radionuclides, magnesium oxide will be placed in the free spaces surrounding the waste containers. Magnesium oxide is intended to chemically stabilize the radionuclides and minimize their solubility.

inflow, limiting decomposition and gas generation. Increased pressure in the repository is not expected to be significant because fracturing within the more brittle anhydrite layers will provide a pathway for gas to leave the repository. In any case, these gases are not physically capable of transporting radionuclides.

Brine flowing out of the repository through the anhydrite layers might transport radionuclides, but the quantity reaching the accessible environment is predicted to be well below EPA limits. Radionuclides are not predicted to travel vertically through the salt or the shaft seal system.

Disturbed performance

A "disturbed scenario" for the WIPP repository, as defined by regulation, could be caused by a natural event, such as a flood, climate change, or earthquake. However, scientific modeling and research have shown that events such as these are not probable causes of a radioactive release. Human intrusions, most likely sporadic drilling that might inadvertently go through the repository during exploration for resources, are considered a more realistic concern.

- *Drilling* - The likelihood of human intrusion depends on unknown factors such as future technology and resource needs. These uncertainties make it impossible to scientifically estimate the number of human disturbances. Thus, the EPA requires that an arbitrary deep drilling rate be assumed for the 10,000-year period, based on drilling rates in the surrounding area during the last 100 years. The DOE also assumes that the use of permanent markers with messages and warnings will reduce the rate of human intrusion. The EPA's regulations allow the DOE to assume these markers to be effective for 600 years after they are emplaced. They are designed, however, to last for 10,000 years.

- *Mining* - The DOE assumed that mining in layers above the repository would also occur once during the

10,000-year period. That intrusion was evaluated in 10 different hypothetical cases -- once in each of the 10 centuries of the regulatory period -- on the assumption that an early intrusion might have different impacts from those of a later intrusion. The assumption of mining was evaluated in computer models, and the impact it might have on the repository was predicted. These consequences were incorporated into the performance assessment, which considered mining along with additional features, events and processes that are WIPP-specific, but were guided by other radioactive waste management programs around the world.

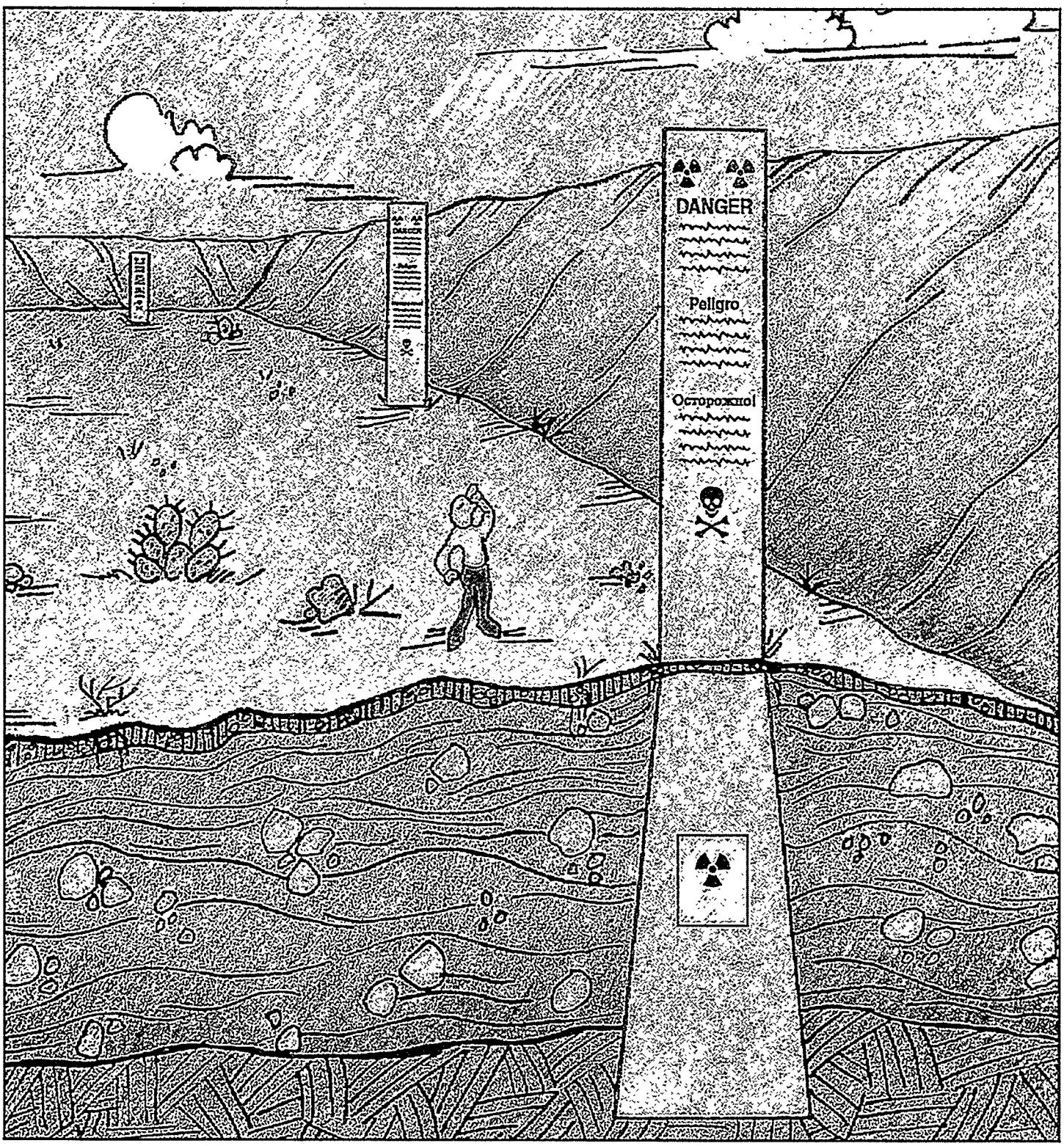
Results of the performance assessment projections indicate that human intrusions provide the only plausible way for releases of radionuclides from the disposal system. All result from short-term releases of radioactive materials from drilling boreholes.

The solubility of radionuclides is an important factor in the likelihood of their eventually being carried to the surface. The magnesium oxide backfill is intended to reduce the solubility of radionuclides (see box, page 15).

The performance assessment indicates that if radionuclides escape from the salt bed due to human intrusion, most long-term transport of these materials would occur in the Culebra Formation (see diagram on page 12). Such a release would be maximized through an unlikely combination of two nearby boreholes, and would involve a small fraction of the waste emplaced at the WIPP. Moreover, the flow of brine away from the site would occur only in the small fraction of this rock that is relatively permeable. The Culebra dolomite is expected to retard their movement because radionuclides will cling to the dolomite. Therefore, release of radionuclides through the Culebra Formation is predicted to be well within EPA containment limits, even if this rock layer is eventually disturbed by mining.

The **Culebra** is the second oldest member of the Rustler Formation. The Culebra consists of dolomite, a sedimentary rock that is mostly calcium magnesium carbonate - with some clay minerals.

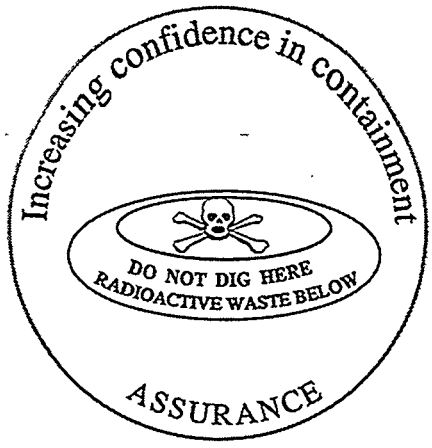
Chapter Three of the CCA covers technical information about engineered systems designed for meeting the EPA's waste containment requirements. Chapter Six details compliance with containment standards. The chapter covers technical information about performance assessment modeling of the undisturbed and disturbed scenarios.



This illustration of a permanent marker next to a berm located around the repository shows two ways future generations may learn about the underground disposal site. Other passive controls include information centers, buried disks, and records at several locations.

Assurance requirements:

Protecting short- and long-term site integrity



Although it is difficult to predict with certainty the behavior of the repository, it is even more difficult to predict human behavior. What if all institutional memory is lost and a future generation drills for resources? What if the world's major languages are no longer spoken and people cannot read the permanent markers?

The EPA's view is that the geologic features and engineered barriers at the WIPP site should be augmented with "assurance" measures intended to reduce uncertainty in calculations of long-term performance. For example, the DOE added engineered barriers to address physical uncertainties in repository performance, and institutional controls to compensate for human uncertainties. Assurance requirements are meant to increase confidence that radiation exposures from the repository will be virtually zero, even under the most unlikely circumstances.

Assurance involves several different components, as specified by EPA standards. The CCA addresses each of these requirements separately. They include active institutional controls, multiple barriers, monitoring, passive institutional controls, resource extraction disincentives, and waste removal measures (if necessary).

Active institutional controls

During the first 100 years after the WIPP is filled with waste and then closed, fences, guards, warning signs, perimeter inspections, and surveillance will be used to deter unauthorized use of the site. These measures are called active institutional controls.

The CCA contains detailed descriptions, maps, and plans for active institutional controls. The EPA specifies that no

more than 100 years of active controls can be assumed in predictions of long-term performance of the repository. The program is slated to begin immediately after the facility closes, but many active controls will be in place during waste disposal. Active controls are designed to overlap and reinforce each other enough to be highly effective in preventing human intrusion.

Multiple barriers

The WIPP repository will incorporate both natural and engineered barriers. Natural barriers include the surrounding salt formation, for example. Engineered barriers include panel closure systems, backfill, and shaft and borehole seals. (See text box on page 15.)

The **Salado Formation** is a 225-million-year-old deposit of rock salt about 2,000 feet thick in near-horizontal beds.

EPA criteria required that the DOE conduct a study to evaluate the costs and benefits of engineered barrier alternatives. The study was done by a working group composed of technical professionals from various fields who screened potential engineered alternatives compiled from previous studies, regulatory requirements, and suggestions from experts. After receiving public comment on this topic, the DOE concluded in 1995 that magnesium oxide backfill material could provide desirable long-term chemical stability for the waste. Waste processing was also considered, but evaluations indicated that the benefits would not justify the costs and the potential risks.

Monitoring

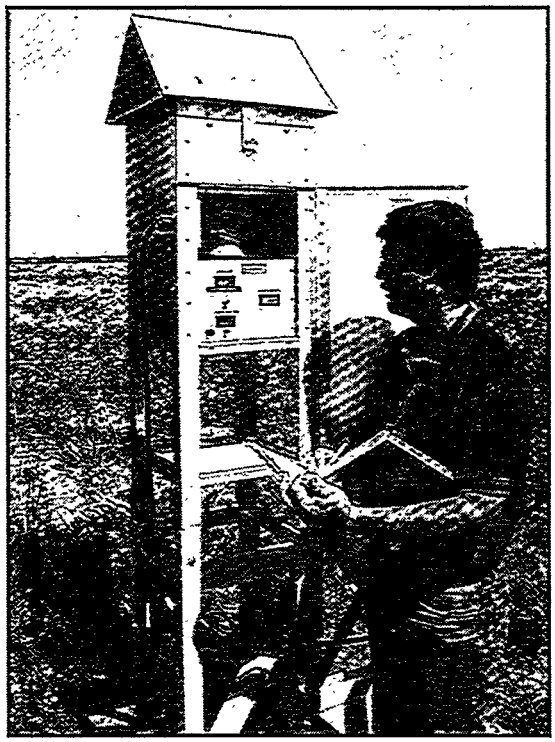
The EPA requires that the WIPP site be monitored to detect any substantial and detrimental deviations from expected repository performance. The monitoring program spans 150 years (50 years preclosure and 100 years post-closure), but could be extended if necessary. The CCA describes planned monitoring programs, including:

- *Volatile Organic Compound Monitoring* to check predictions regarding the release into the surrounding environment of toxic chemicals that vaporize easily;

- *Groundwater Surveillance* to measure groundwater flow, and to test for releases from the repository;
- *Geomechanical Monitoring* to measure the rate at which the salt beds and rock strata move to close man-made openings;
- *Drilling Activity Observation* to detect human disturbances in the vicinity during and after waste emplacement; and
- *Subsidence Monitoring* to check for changes in land surface contours every ten years during and after disposal operations.

Passive institutional controls

A comprehensive system of permanent markers and records will be used to warn future generations about the radioactive waste 2,150 feet below the surface. These passive institutional controls are designed to be effective without continual maintenance. They provide additional assurance that knowledge and information about the disposal site and its contents are passed on to future generations. The DOE has designed a system assuming that society in general will retain knowledge about these wastes and that the overlapping and reinforcing marker system will deter systematic or persistent exploitation of the site, but may not prevent all possibilities of human intrusion.



A WIPP employee gathers information from one of several air monitoring stations around the repository site in southeastern New Mexico.

Two groups of experts, the Futures Panel and the Markers Panel, were established to examine issues related to designing an effective system of permanent markers. Ideas from both panels were used to develop passive controls for the WIPP facility.

For at least 600 years after active controls end, in accordance with EPA criteria, these measures will warn future generations about the danger of disturbing the repository. The DOE will use multiple levels of passive

institutional controls to make human intrusion into the disposal site unlikely, including those described below.

- *Monuments:* Granite structures, extending 22 feet below ground and 25 feet above the surface, will be inscribed with messages in seven languages about the location and nature of the transuranic waste, and with warnings not to drill or dig.
- *Berm:* A 33-foot-high earthen barrier around the edges of the repository will be 98 feet wide at the base, tapering to 13 feet wide at the top. Radar reflectors and large permanent magnets will be buried inside.
- *Warning Markers*: Nine-inch disks made of a variety of durable materials will be placed below the surface in random locations and within the berm. They will contain information about the location and nature of the waste.
- *Information Centers:* More detailed information, in pictograms and words, will be inscribed on the granite walls of two information centers: one above ground and one below.
- *Archives*: Records will be stored at many locations around the world, including the National Archives in Washington, DC. This information will cover the location, design, contents, and hazards associated with the WIPP repository. Documents will include maps, environmental records, the CCA, repository drawings, and records of waste container contents.

Testing will be conducted on the permanent marker system during disposal operations and the active controls period. For example, a section of the berm will be constructed and some monuments will be built. Linguists will evaluate the messages to ensure that they will be intelligible for many centuries.

Resource extraction disincentives

The EPA discourages the location of repositories in areas in which valuable natural resources are present. Exceptions are made when the favorable characteristics of the site outweigh any increased risks. The DOE has documented in the CCA that even though there are natural resources (as presently perceived) in the WIPP vicinity, the favorable characteristics of the site compensate for any increased risks associated with potential future resource development.

The DOE considers active institutional controls to be an effective disincentive or deterrent to future resource extraction during the time these controls are in place. While the DOE has not assumed that passive controls will prevent all possibilities of inadvertent human intrusion, these controls are expected to deter persistent, systematic exploration and resource extraction around the disposal site.

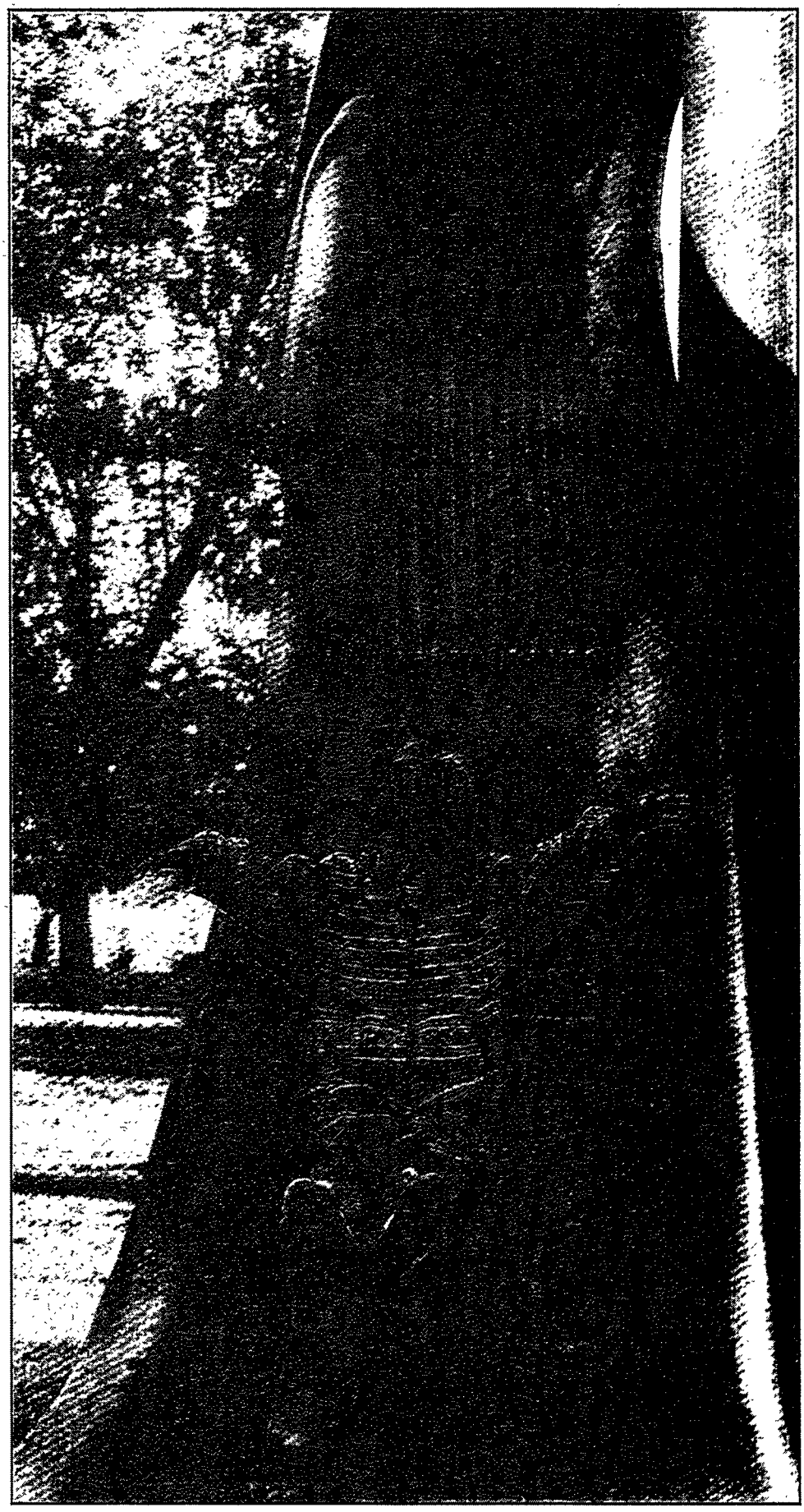
Waste removal

EPA rules require the DOE to document that waste could be removed for a reasonable period of time after disposal. The rationale for this requirement is to preclude use of some disposal technologies that would not allow future generations to recover the waste should they decide to do so. The EPA states that "any current concept for a geologic repository meets this requirement without any additional procedures or design features." The WIPP site meets this requirement.

The CCA describes a feasible system for waste removal using available mining technologies. If a decision were made to remove the waste in the future, the necessary planning, research, and preparation would be done before any waste is removed.

Chapter Seven of the CCA covers implementation of assurance requirements. Chapter sections describe active and passive institutional controls, multiple barriers, monitoring, resource extraction disincentives, and waste removal feasibility.

Individual protection requirements are intended to safeguard current and future generations.



Individual protection:

Protecting people from radiation exposure

Public health, safety, and environmental protection are the DOE's primary concerns. In addition to demonstrating the ability to meet containment and assurance requirements (discussed on pages 13-23 of this guide), the DOE must also comply with other strict EPA requirements aimed at protecting individuals.

The DOE is required to "demonstrate a reasonable expectation" that the undisturbed performance of the WIPP for 10,000 years will not expose any member of the public to radioactivity above a limit set by the EPA. The amount of radioactivity absorbed by an individual is called a "dose." The EPA's annual dose limit for a member of the public, assuming that the repository is undisturbed, is 15 millirems. In comparison, the exposure from a chest X-ray is about 10 millirems.

A **millirem** is a unit used in radiation protection to measure the amount of damage to human tissue from a dose of ionizing radiation.

Exposure to radiation from natural and artificial sources is part of living on Earth. Natural sources include the sun and various minerals. Artificial sources include medical X-rays and past atmospheric testing of nuclear weapons. Each year, the average U.S. citizen is exposed to about 360 millirems of radiation from natural and artificial sources.

To establish a high degree of confidence in the DOE's compliance with the radiation exposure limits, the WIPP performance assessment assumed an extremely unlikely situation. It assumed that a person lives at a location where potential radiation would be highest and drinks two liters of radioactively contaminated groundwater per day. Even given these assumptions, the maximum annual dose to which the WIPP might expose any member of the public is projected to be 0.47 millirems, about 30 times lower than the 15-millirem limit.

Chapter Eight of the CCA covers compliance with individual and groundwater protection requirements. The chapter considers potential pathways the contamination might follow and shows how the DOE fulfills the regulatory criterion for identification of drinking water sources in the area.

Groundwater protection:

Complying with safe drinking water standards

The EPA has set strict standards to protect groundwater from contamination by wastes in the WIPP repository. The DOE must demonstrate that 10,000 years of undisturbed performance will not cause radioactivity in any underground source of drinking water to exceed federal safe drinking water standards.

These standards specify what constitutes a water source, in terms of quantity and quality. The first step in complying with groundwater protection standards was to identify any underground sources of drinking water. Only one underground body of water in the Carlsbad area meets drinking water standards: the Capitan aquifer, which supplies the town of Carlsbad with drinking water. The aquifer's wells are located more than 20 miles west and upstream of the WIPP repository.

However, to provide additional confidence, the DOE developed a scenario in which the contaminants would reach a source of drinking water. Under this scenario, the exposures would be within EPA limits.

Chapter Eight of the CCA covers compliance with individual and groundwater protection requirements.

Quality Assurance:

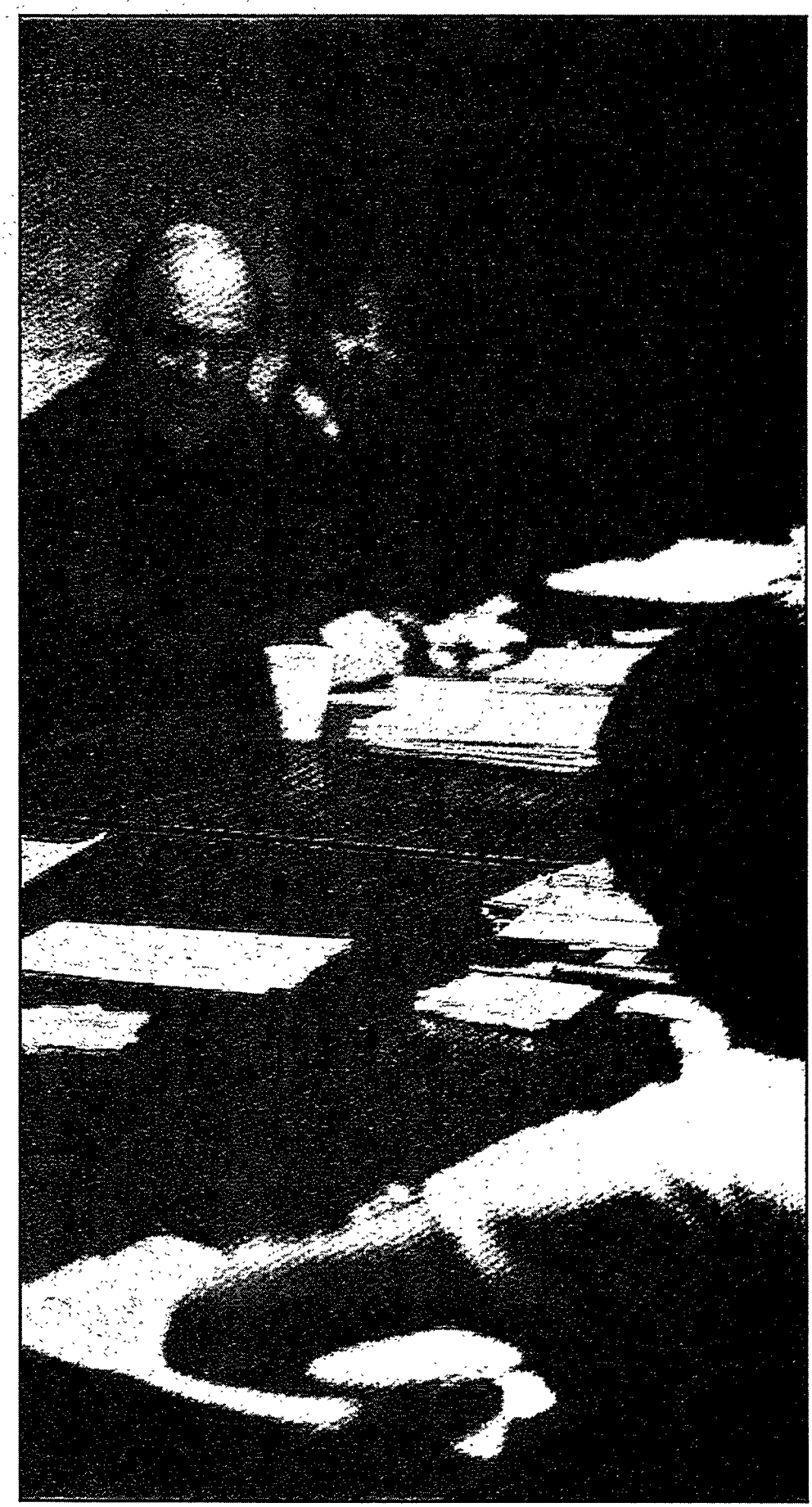
Verifying quality work

"Quality Assurance" helps ensure that the DOE's work has been properly planned, carried out, and documented. The DOE uses specific practices to make sure uniform standards of quality are used in all experiments and related activities that demonstrate environmental compliance.

The Carlsbad Area Office of the DOE has established and maintains a Quality Assurance program in accordance with EPA regulations, other applicable regulations, and DOE orders and requirements. This program also applies to the Carlsbad Area Office's contractors and to the DOE sites around the country where transuranic waste was generated or is stored. The EPA requires Quality Assurance to be applied to:

- Waste characterization (description and analysis);
- Environmental monitoring, monitoring of disposal system performance, and sampling and analysis activities;
- Field measurements of geologic factors, groundwater, meteorology, and topographic features;
- Computations, computer codes, models, and methods to demonstrate compliance with EPA criteria;
- Design of the disposal system and actions taken to comply with design specifications;
- Collection of data and information to support the compliance application;
- Other systems, structures, components, and activities important to the containment of waste; and
- Procedures for obtaining expert judgment on issues that cannot reasonably be determined through experiments or modeling.

Chapter Five of the CCA describes engineering and scientific standards for assessing the quality of experimental methodology and data interpretation.



Peer review panel members discuss the use of permanent markers to deter human intrusion into the WIPP at a Passive Institutional Controls Peer Review Panel meeting held in 1996.

Peer review:

Checking with independent experts

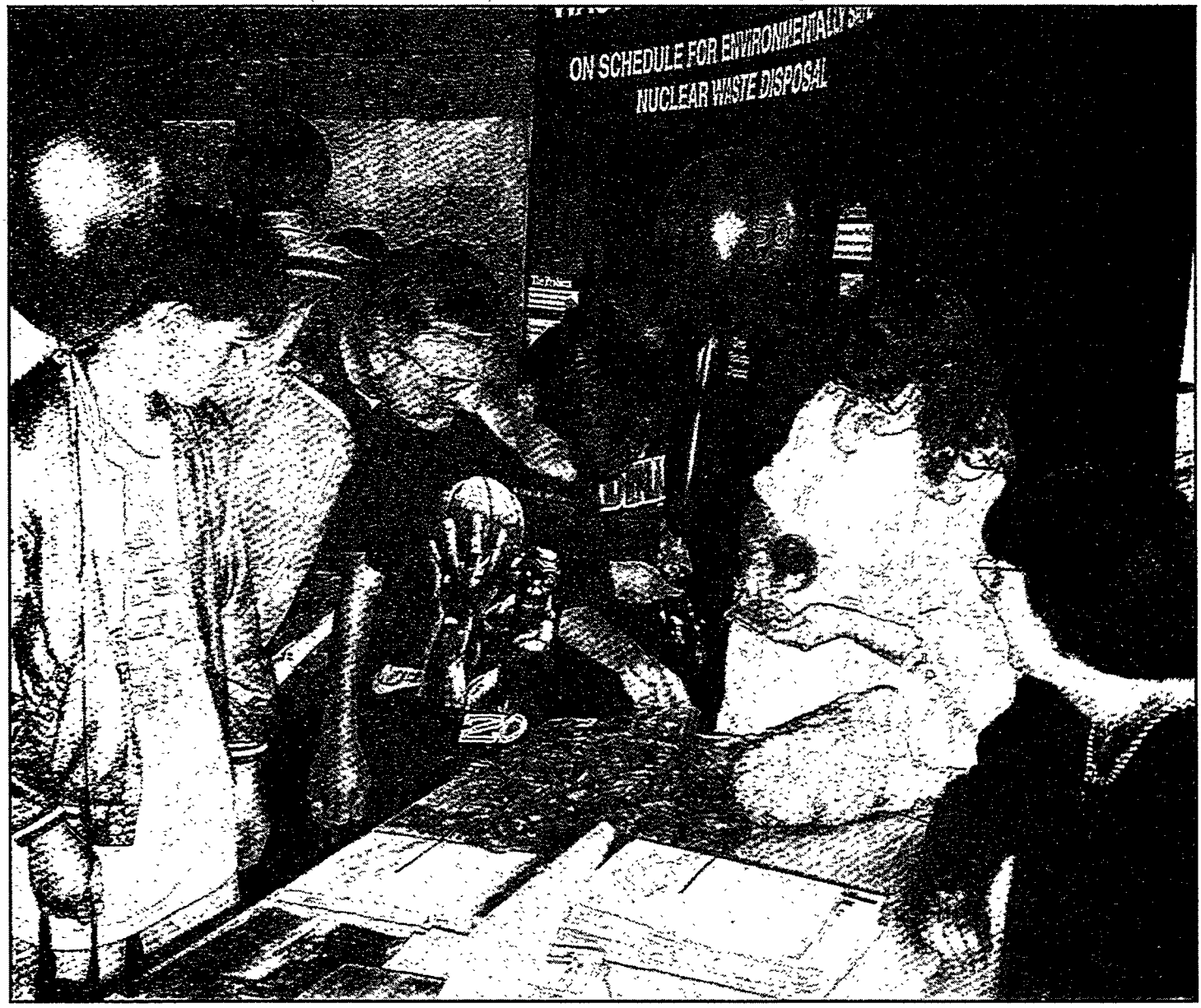
In crucial areas of research related to the WIPP repository, the DOE's work was subjected to thorough peer review. A peer review is a documented, critical evaluation by outside technical experts who were not involved in the original work and who are sufficiently free from funding considerations to assure that the work is impartially reviewed. A peer review involves an in-depth critique of assumptions, calculations, extrapolations, conclusions, alternative interpretations, methodology, and waste acceptance criteria employed.

Waste acceptance criteria define the physical, radiological, and chemical limits the waste must satisfy to be disposed of at the WIPP.

The DOE convened several peer review panels, each composed of individuals independent of the work being reviewed, and possessing experience and qualifications at least equivalent to those required to do the original work. Reviews were conducted on the adequacy of the following:

- *Conceptual models* – important scenarios and features, events, and processes examined in the performance assessment;
- *Waste characterization analyses* – identification of all waste characteristics that influence waste containment;
- *Engineered barriers alternatives* – the benefits and drawbacks of alternative engineered barriers;
- *Passive institutional controls* – measures taken to preserve knowledge about the location, design, and contents of the waste repository; and
- *Data qualification* – data validation in the following containment system areas: engineered systems, natural systems, and waste form and disposal room processes.

Chapter Nine of the CCA covers the results of peer review of models, waste characteristics, the engineered barrier study, and four other major peer reviews. Findings and recommendations from peer reviews are also discussed.



Children and adults alike asked many questions about the WIPP facility at a 1996 open house event at the Argonne National Laboratory in Illinois. Informing the public through exhibits, tours, and speaking engagements is an important part of the Carlsbad Area Office's outreach program.

The public role:

Getting involved

Public involvement is important to the DOE. The public's concerns and opinions are carefully considered in the DOE's pursuit of environmental compliance.

By listening to citizens' concerns, the DOE has enhanced WIPP viability by changing several research programs and operational plans. For example, rainfall was not seen as a serious threat in an arid desert. However, in response to public concern, the DOE assumed a climate change and evaluated possible effects on the facility of extremely high rainfall. Even this unlikely condition is not projected to cause a release of radioactive material in computer modeling projections.

As another example, earlier research suggested no benefit from "backfilling" to surround waste in disposal rooms. Public comment, however, prompted a second look at the potential benefits of alternative backfill materials. Backfilling methods that enhance repository performance were considered, and the selected material, magnesium oxide, is intended to increase long-term stability of the waste.

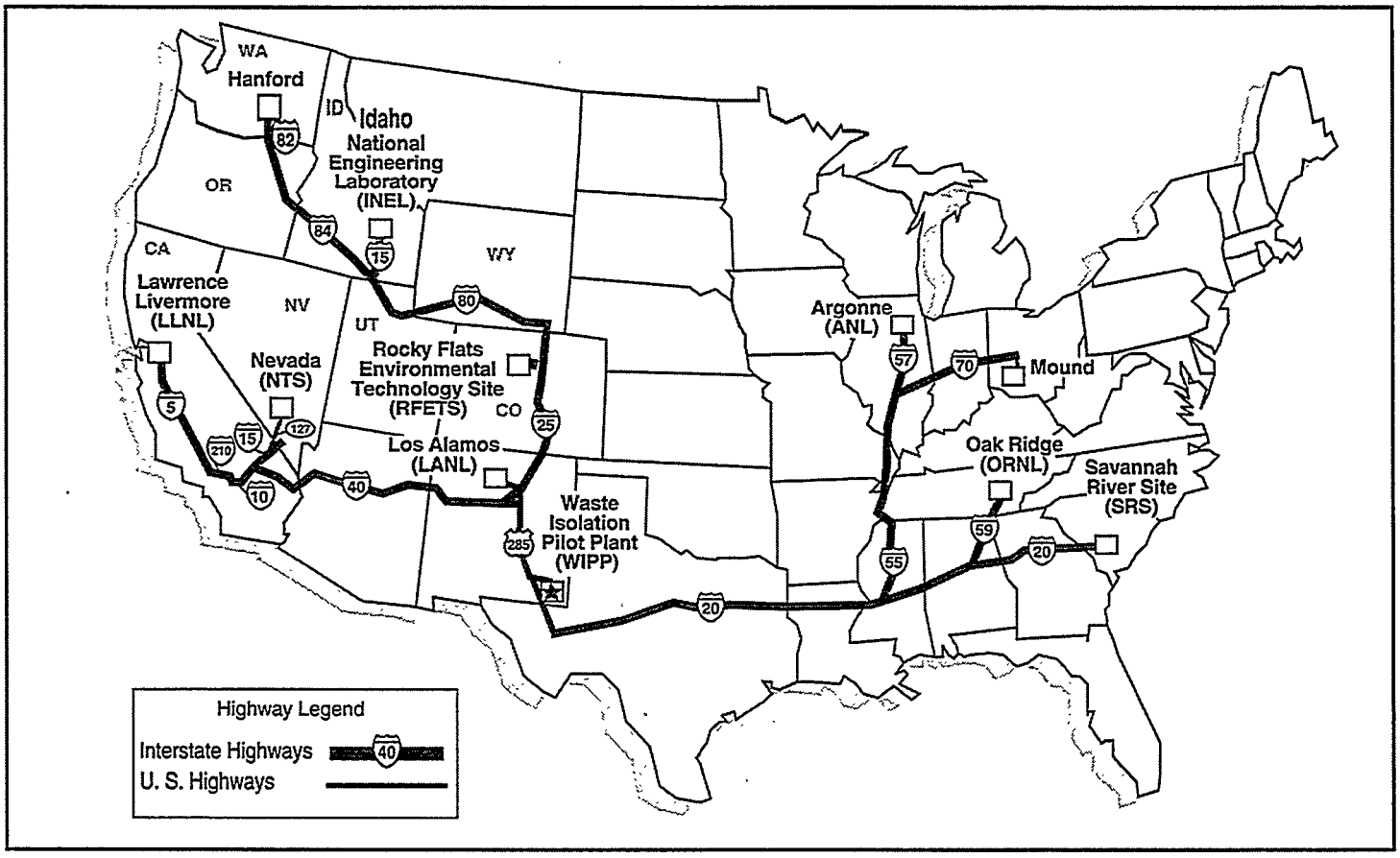
Public information and involvement have been an important part of the compliance certification process. The DOE convened focus groups in New Mexico on engineered barrier alternatives, a required component of the CCA. In addition, numerous articles and press releases have described various aspects of the application process. This *Citizens' Guide* is another example of the DOE's commitment to providing information and supporting public involvement in this important issue.

Further, in February 1993, the EPA conducted public hearings in Carlsbad, Albuquerque, and Santa Fe, New Mexico on proposed amendments to the environmental

radiation protection standards. The EPA also conducted public hearings in New Mexico in March 1995 on the proposed compliance certification criteria for the WIPP.

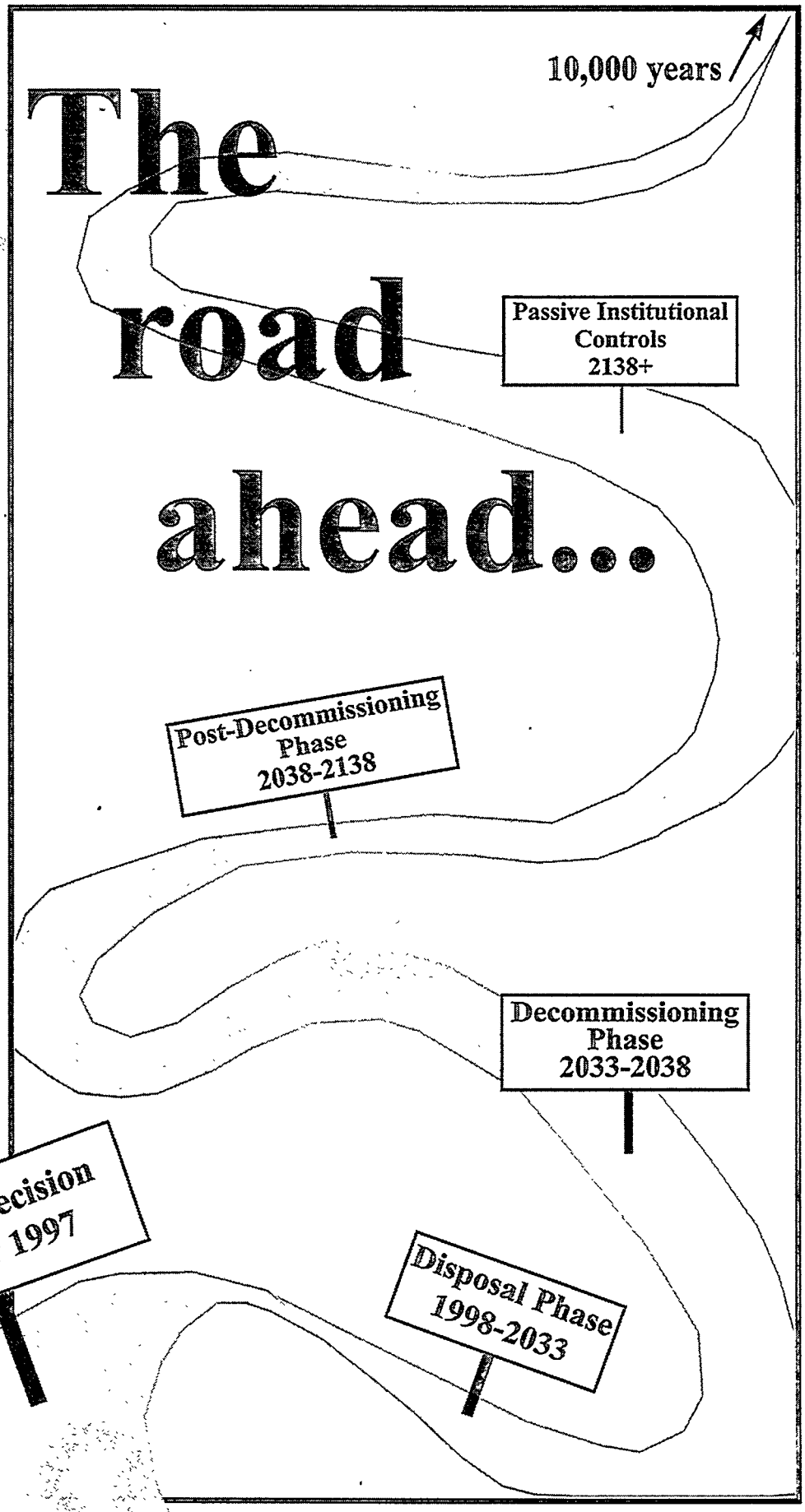
The EPA will conduct public hearings and meetings regarding its certification of WIPP compliance with environmental standards. Public hearings and meetings will be publicized through the EPA's information line, the *Federal Register*, and regional newspapers. The DOE will also publicize the dates and locations of these events in its newsletters and publications, on the WIPP Home Page, and through the WIPP Information Center toll-free hotline.

With generator sites throughout the country and transportation routes that pass through 22 states, the DOE encourages involvement by people nationwide.



Seven ways to get more DOE information about the WIPP

1. *The WIPP toll-free hotline* operators answer questions and offer DOE documents, fact sheets, newsletters, and information about upcoming public events and other opportunities listed below. The number is 1-800-336-WIPP (1-800-336-9477).
2. *The WIPP Home Page* contains a variety of information about the WIPP. The address is http://www.wipp.carlsbad.nm.us.
3. *The WIPP Speakers Bureau* offers speakers on a variety of WIPP and radioactive waste disposal issues.
4. *WIPP Tours* take people 2,150 feet underground and through the WIPP facility. A citizens' tour for individuals is available each month. Group tours also may be scheduled.
5. *WIPP Exhibits* on various WIPP topics can be requested for major events; for large conferences, the WIPP truck with empty TRUPACT-II containers may be scheduled.
6. *WIPP Reading Rooms* contain technical materials and documents about the WIPP. A list of these reading rooms is on the inside back cover of this guide.
7. *The WIPP Mailing List* offers the Carlsbad Area Office Monthly Calendar, the *TRU Progress* newsletter, and other informational materials.



This time line shows the future of the WIPP site, assuming a favorable decision by the Secretary of Energy to open the facility for disposal operations.

Next steps:

Going forward with opening the WIPP

The successful completion of the CCA is a crucial step in opening the WIPP for the safe disposal of transuranic waste. Under the Land Withdrawal Act of 1992, as amended in 1996, the EPA will have one year to review the CCA and decide whether to certify the WIPP repository.

During that year the EPA has planned public hearings in New Mexico to receive comments. Also, the EPA could ask the DOE for more detailed information about the application's contents.

Under recent congressional changes to the Land Withdrawal Act, the WIPP site could open as early as November 1997, contingent upon:

a) Favorable outcomes for the three major regulatory requirements: the Compliance Certification Application, the *WIPP Disposal Phase Supplemental Environmental Impact Statement*, and the Resource Conservation and Recovery Act permit;

b) The Secretary of Energy's decision, expected in October 1997, on whether to open the WIPP repository;

c) The successful resolution of any lawsuits challenging the suitability of the site as a repository for transuranic waste;

d) Successful preparation of the first waste shipments to the WIPP site; and

e) Adequate funding by Congress to characterize, certify, transport, and dispose of transuranic waste...

Related reading

Environmental Evaluation Group. "Review of the WIPP Draft Application to Show Compliance with EPA Transuranic Waste Disposal Standards." (EEG-61), New Mexico.

League of Women Voters. "The Nuclear Waste Primer: A Handbook for Citizens." Lyons & Burford, Publishers, 1993.

National Academy of Sciences. "The Waste Isolation Pilot Plant: A Potential Solution for the Disposal of Transuranic Waste." 1996.

U.S. Congress. Waste Isolation Pilot Plant Land Withdrawal Act. (P.L. 102-579).

U.S. Congress. Waste Isolation Pilot Plant Land Withdrawal Amendments Act. National Defense Authorization Act for Fiscal Year 1997, Subtitle F. (P.L. 104-201), September 23, 1996.

U.S. Department of Energy. Engineered Alternatives Cost/Benefit Study: Final Report. (DOE/WIPP 95-2134, Rev. 0), DOE Carlsbad Area Office, Carlsbad, NM, September 1995.

U.S. Department of Energy. "The National Transuranic Waste Management Plan." (DOE/NTP-96-1204, Rev. 0), DOE Carlsbad Area Office, Carlsbad, NM, September 30, 1996.

U.S. Department of Energy. "Waste Acceptance Criteria for the Waste Isolation Pilot Plant." (DOE/WIPP-069, Rev. 5), DOE Carlsbad Area Office, Carlsbad, NM, April 1996.

U.S. Department of Energy. "Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement." (Summary and fact sheets available), 1996.

U.S. Environmental Protection Agency. 40 CFR 191. Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule. (Federal Register, Vol. 58, No. 242), December 20, 1993.

U.S. Environmental Protection Agency. 40 CFR 194. Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations. (Federal Register, Vol. 61, No. 28), February 9, 1996.

U.S. Environmental Protection Agency. "Compliance Application Guidance for 40 CFR Part 194." (EPA 402-R-95-014), EPA Office of Radiation and Indoor Air, Washington, DC, March 29, 1996.

U.S. Environmental Protection Agency. "Response to Comments Document for 40 CFR Part 194." (EPA 402-R-96-001). EPA Office of Radiation and Indoor Air, Washington, DC, January 1996.

WIPP reading rooms

Thomas Brannigan Memorial Library
200 E. Picacho Ave.
Las Cruces, NM 88002

Carlsbad Public Library
101 S. Halagueño St.
Carlsbad, NM 88220

Defense Nuclear Facilities Safety Board Library
625 Indiana Ave., N.W., Suite 700
Washington, DC 20004

DOE/Forrestal Building
Public Reading Room
HR-78, Room 1E-190
FOI - USDOE
1000 Independence Ave., S.W.
Washington, DC 20585

New Mexico State Library
The Southwest Room
325 Don Gaspar
Santa Fe, NM 87501-2777

Office of Scientific and Technical Information
DOE Public Reading Room
55 Jefferson Ave.
Oak Ridge, TN 37831

Pannell Library
New Mexico Junior College
5317 Lovington Highway
Hobbs, NM 88240

Raton Public Library
244 Cook Ave.
Raton, NM 87740

Martin Speare Memorial Library
New Mexico Institute of Mining and Technology
Campus Station
Socorro, NM 87801

WIPP Public Reading Room
Environmental Restoration Program
Navajo Nation - EPA
FD Building
FO433
Fort Defiance, AZ 86504

Zimmerman Library
Government Publications Department
University of New Mexico
Albuquerque, NM 87138