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Report to Congressional Requesters

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RADIOACTIVE WASTE

Status of Commercial Low-Level Waste Facilities

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Resources, Community, and
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May 5, 1995

The Honorable Christopher J. Dodd
The Honorable Joseph I. Lieberman
United States Senate

This report responds to your requests that we review certain aspects of states' efforts to implement the Low-Level Radioactive Waste Policy Act of 1980, as amended. This act requires states to provide for the disposal of the low-level radioactive waste that is generated commercially within their borders.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Secretary of Energy; the Chairman, Nuclear Regulatory Commission; the Director, Office of Management and Budget; and state officials interested in the disposal of low-level radioactive waste. We will also make copies available to others upon request.

Please contact me at (202) 512-3841 if you or your staffs have any questions. Major contributors to this report are listed in appendix III.

Victor S. Rezendes
Director, Energy and
Science Issues

Executive Summary

Purpose

Thousands of businesses, medical facilities, and universities and over 100 nuclear power plants produce waste materials contaminated with radioactivity. These waste products, called commercially generated low-level waste, have typically been disposed of by burial in shallow trenches at a few locations around the country. States plan to develop 11 new disposal facilities. These planned facilities are the result of efforts by states to implement federal legislation that makes them, either acting alone or in compacts, responsible for developing new disposal facilities.

Senators Christopher J. Dodd and Joseph I. Lieberman asked GAO to assess states' progress in developing new disposal facilities, potential economic and environmental effects of these facilities, and alternatives to the current approach to developing new facilities.

Background

In 1979, after states had closed three of six privately developed disposal facilities because of environmental problems, congressional committees considered making the federal government responsible for siting new regional disposal facilities. Later, the National Governors' Association and others favored making the states responsible for this activity because the siting of disposal facilities involves primarily state and local issues. The Low-Level Radioactive Waste Policy Act of 1980 reflected the latter view. This act gave the states, either separately or in compacts, responsibility for developing new disposal facilities. Congressional consent was required for a compact to become effective. As an inducement to states to form compacts and develop regional disposal facilities, the act stated that compacts could, beginning January 1, 1986, restrict the use of their disposal facilities to wastes generated within their respective regions.

Because of states' slow progress in forming compacts and developing new disposal facilities, the Congress, in 1985, added milestones and financial penalties to the act to stimulate progress. For example, each state's disposal facility was expected to be operational, and disposal rights at the three existing disposal facilities would end by, January 1, 1993.[1]

Throughout the 1980s and the early 1990s, commercially generated low-level waste was routinely disposed of in three facilities in Nevada, South Carolina, and Washington. However, Nevada closed its facility on January 1, 1993. The facility in Washington was closed to generators in all but 11 states in two compacts on January 1, 1993, and on July 1, 1994,

[1]One additional milestone, the so-called take-title provision, was held unconstitutional by the U.S. Supreme Court in 1992 (New York v. United States, 112 S.Ct.2408).

South Carolina closed its facility to all waste generators outside an 8-state compact of southeastern states.[2]

Results in Brief

As of January 1995, 11 states had plans to develop disposal facilities for commercially generated low-level waste, and the state of Washington planned to continue operating its existing disposal facility. Altogether, these 12 facilities would serve waste generators in 47 states. The states that are developing these new facilities estimate that they will complete the facilities between 1997 and 2002; however, only four candidate sites have been selected, and no facility is being constructed. Moreover, the remaining states do not have plans to develop disposal facilities. The slow progress appears largely due to the controversial nature of nuclear waste disposal.

Studies performed between 1987 and 1993 by the Department of Energy (DOE) and others concluded that a smaller number of larger new facilities could accommodate the current volume of waste at less cost than a greater number of smaller facilities. These studies, however, did not take into account uncertainties that could affect the volume of low-level waste, such as when utilities might retire and then dismantle nuclear power plants. The environmental effects of having 11 new facilities are unclear. On the other hand, because waste generators in 33 states have lost access to existing disposal facilities and must store their own waste, environmental risks at their storage facilities may increase.

Alternatives to the current program, such as shifting responsibility from the states to the federal government or to the private sector, appear to present significant challenges. For example, the federal government or a private company would likely have trouble getting a state or locality to accept a disposal facility. Also, supporters of the current program say that considering other approaches could undermine states' support for and progress in implementing the state-compact approach. For these reasons, caution is warranted in considering changes to the existing state-compact approach.

[2]On April 13, 1995, the governor of South Carolina proposed to the state's General Assembly that operation of the state's disposal facility be extended for up to 10 years. Reopening this facility to waste generators around the nation would require approval of both the General Assembly and the compact of eight states. On May 2 the compact commission considered but did not pass a motion to extend access to the facility.

GAO's Analysis

Slow Progress by States

In the 1980 act, the Congress expected states to have new disposal facilities for low-level waste by January 1, 1986. Since 1980, 42 of 52 states have established nine compacts.[3] Two compacts of 11 western states are using an existing disposal facility in Washington. Another compact of eight southeastern states is using a disposal facility in South Carolina while North Carolina develops a new facility for the compact. The six remaining compacts plan to develop seven disposal facilities. In addition, Texas, Maine, and Vermont have formed a 10th compact that is awaiting congressional approval. The three states intend to use a disposal facility that Texas plans to develop. Two states not affiliated with compacts intend to develop their own disposal facilities, and the other five unaffiliated states have not announced definitive plans for implementing the 1980 act, as amended.

Although 11 new disposal facilities are planned, only four candidate sites have been selected, and no facility is being constructed. Currently, states responsible for establishing new facilities expect to complete them between 1997 and 2002. However, previous estimated completion dates have been missed. States' slow progress appears largely due to the controversial nature of nuclear waste disposal. That is, the time and effort states have required to form compacts, select states to develop new facilities, develop legislation and regulations, and select sites for facilities appear to be symptomatic of widespread concern about such facilities among the affected public and political officials at various state and local levels.

Potential Economic and Environmental Effects

There are no good, current data on the economic and environmental effects of states' plans for disposal facilities nationwide. Most states have not estimated the total or unit disposal costs of their planned facilities. Studies by DOE and others concluded that a smaller number of larger new disposal facilities could accommodate the volume of waste that has been generated in recent years at less cost than a greater number of smaller facilities. In recent years, the volume of waste has been about one-fourth as great as before 1980. These studies, however, have limited usefulness in determining a cost-effective number of sites. For example, no studies had up-to-date cost data that could be used to estimate costs for disposal

[3]The act included the District of Columbia and Puerto Rico as states.

facilities in the range of sizes that might be required. Also, the studies did not account for uncertainties affecting the future volume of low-level waste, such as when utilities will retire and then dismantle their nuclear power plants. Collectively, nuclear power plants generate about half of the volume of low-level waste, and dismantling retired plants is expected to generate sizable quantities of waste. Thus, utilities' decisions on when to shut down plants and dismantle them will affect the volume of low-level waste in the coming decades.

Only California had completed its review of the environmental effects of its proposed facility and site, but its conclusions have been challenged and are under independent review. Therefore, limited information is available on the likely environmental effects of disposal at the planned facilities. However, environmental risks may increase at the facilities of the waste generators in 33 states that have lost access to disposal facilities because existing facilities have closed to them, as provided by the act. Until new facilities are ready, these waste generators, which produce about 42 percent of all commercially generated low-level waste, will have to store their waste.

Alternative Approaches

Questions have been raised about whether other approaches to managing low-level waste might be more effective than the state-compact approach. Supporters of the current program, however, say that exploring other approaches could undermine both the progress that many states have made and the long-standing support of most states for the current approach. Moreover, other approaches to managing this waste appear to have drawbacks. For example, making the federal government responsible for disposing of the waste would not solve the problem of obtaining political and public acceptance of disposal facilities.

Recommendations

GAO is making no recommendations.

Agency Comments

To ensure the accuracy, completeness, and objectivity of this report, GAO provided copies of the entire draft or of sections to knowledgeable federal officials, including the program manager for DOE's National Low-Level Waste Management Office and Nuclear Regulatory Commission (NRC) staff in four NRC offices—the Office of State Programs, Division of Waste Management, Office of Nuclear Materials Safety and Safeguards, and Office of the General Counsel. These officials generally agreed with the

facts as presented in GAO's report, and NRC officials noted that the report accurately characterized the current situation in developing low-level waste disposal facilities. NRC and DOE officials also provided several technical and editorial comments, which GAO incorporated as appropriate to clarify and update the report.

Contents

Abbreviations

DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission

Introduction

Each year over 100 utility-owned nuclear power plants and thousands of commercial enterprises, such as pharmaceutical manufacturers, hospitals, universities, and industrial firms, generate various types of radioactive contaminated waste. While waste in the form of used (spent) fuel from nuclear power plants is classified as "high-level" because of the amount of radioactivity in the fuel, almost all other commercial waste is designated as "low-level" because the levels of radioactivity in these wastes are relatively lower.[1] Low-level radioactive waste items include such things as rags, paper, liquid, glass, protective clothing, as well as hardware, equipment, and resins exposed to radioactivity or contaminated with radioactive material at nuclear power plants.

In 1993, operations at utilities' nuclear power plants accounted for about 50 percent of the volume of commercially generated low-level radioactive waste, but this volume contained about 95 percent of the radioactivity in low-level waste. Examples of other commercial uses of radioactive materials that either directly or indirectly produce low-level radioactive waste include the following:

- Medical procedures involving radiation or radioactive material. More than 100 million of these procedures are performed each year.
- Testing and development of about 80 percent of new drugs.
- Sterilization of consumer products, such as cosmetics, hair products, and contact lens solutions using radioactive materials.
- Production of consumer products, such as smoke detectors, and industrial products, such as instruments to inspect for defects in highways, pipelines, and aircraft.

The radioactivity in most commercially generated low-level waste decays to safe levels within 100 years, but some waste remains hazardous for longer than 500 years. Because these wastes are potentially harmful to workers, the general public, and the environment, they must be stored and disposed of safely.

Throughout the 1980s and the early 1990s, commercially generated low-level waste was routinely disposed of in three facilities at or near Beatty, Nevada; Barnwell, South Carolina; and Richland, Washington. However, Nevada closed its facility on January 1, 1993. The facility in Washington was closed to generators in all but 11 states on January 1, 1993, and on July 1, 1994, South Carolina closed its facility to waste generators in all but 8 southeastern states.

[1]Low-level radioactive waste also does not include waste products from processing uranium ore.

Background on Disposal of Commercially Generated Low-Level Radioactive Waste

The generation of significant amounts of nuclear wastes began during World War II and because nuclear operations then and for years afterward were controlled by the federal government, the government assumed responsibility for the disposal of these wastes. Eventually, however, the federal Atomic Energy Commission began permitting commercial entities to possess, own, and use radioactive materials and to dispose of low-level waste. With the increase in commercial uses of radioactive materials, the Congress, in 1959, authorized the Commission to transfer to states authority and responsibility for regulating most commercial users other than nuclear power plants. States that desired to assume such authority and responsibility could do so by establishing regulatory programs that were adequate to protect the public health and safety and compatible with the Commission's regulatory program. Such states are referred to as agreement states.[2]

With increased commercial use of radioactive materials and an expanding regulatory role for states, private companies, rather than the federal government, began to provide disposal facilities for commercially generated low-level waste. By 1971 there were six privately operated disposal facilities located in Illinois, Kentucky, Nevada, New York, South Carolina, and the state of Washington. All of these disposal facilities except the facility in Illinois were regulated by agreement states. Only the facility in Washington was developed on federal land; specifically, on the Hanford Reservation, now managed by the Department of Energy (DOE). (Figs. 1.1 and 1.2 show the disposal facility in Barnwell, South Carolina.)

[2]In 1995 there were 29 agreement states.

Figure 1.1: Approach to One of the Disposal Trenches at the Barnwell Disposal Facility

Figure 1.2: Almost 9 Months of Waste at the Barnwell Disposal Facility

By March 1979 the disposal facilities in Illinois, Kentucky, and New York had been closed for a variety of reasons, including leakage at the sites. Then, in July 1979, the governor of Nevada ordered the Beatty facility shutdown after two incidents involving trucks carrying radioactive waste into the facility. Thereafter, the governors of Nevada, South Carolina, and Washington wrote to the Nuclear Regulatory Commission (NRC) for assurance that rules governing shipments would be enforced. The Beatty facility reopened in late July 1979. In October 1979, the governor of Washington ordered that state's disposal facility to shut down after deficiencies were found in waste shipments bound for the facility. Among other things, a truckload of radioactive cobalt was leaking. Also in 1979, the governor of South Carolina said that the state's disposal facility was receiving up to 90 percent of all commercially generated low-level waste and that decontamination of the disabled Three Mile Island nuclear power plant would generate waste amounting to almost 50 percent of the total volume the state had received in 1978. For this reason, the governor said that South Carolina would not accept waste from the disabled plant.

Concerned about the potential loss of disposal capacity, several congressional committees held hearings in 1979. Initially, the committees considered legislation that would make the federal government responsible for the disposal of commercially generated low-level waste. The governors of the three states with operating disposal facilities, however, opposed this approach because they wanted states to have an opportunity to examine alternatives to federal disposal. By the end of the year, Washington and Nevada had reopened their disposal facilities, and the Congress had deferred consideration of legislation to the next year. Subsequently, a task force convened by the National Governors' Association recommended that responsibility for the disposal of low-level waste be assumed by the states. Other state government organizations supported this approach.

Low-Level Waste Policy Act and Amendments

Late in 1980, the Congress established a new policy regarding the disposal of commercially generated low-level waste by enacting the Low-Level Radioactive Waste Policy Act of 1980 (P.L. 96-573). The act made each state responsible for making disposal capacity available and stated that low-level radioactive waste can be most safely and efficiently managed on a regional basis. To implement this policy, the Congress encouraged states to form compacts to meet their collective disposal needs and to minimize the number of new disposal sites. Congressional consent was required for a compact to become effective. As an inducement to states to form

compacts and develop regional disposal facilities, the act stated that compacts could, beginning January 1, 1986, restrict the use of their disposal facilities to wastes generated within their respective regions. The Congress expected states to have new disposal facilities capable of handling their own low-level waste by that date.

Although nearly 40 states had formed seven regional compacts by the end of 1983, it had become clear that no new disposal facilities would be ready for at least another 5 years. As a result, the Congress passed and, on January 15, 1986, the President signed into law, the Low-Level Radioactive Waste Policy Amendments Act of 1985 (P.L. 99-240). At the same time, the Congress granted consent to the seven regional compacts. The amendments represented a compromise for competing parties. On one side, waste generators in states that would be left without access to disposal facilities—generators that were relying on the existing disposal facilities in Nevada, South Carolina, and Washington—got a 7-year extension of the period during which they could ship waste to existing disposal facilities. On the other hand, these three states, which wanted to close their facilities to waste generators outside their respective compacts, received additional assurances that other states or compacts of states would develop their own disposal facilities.

Among these additional assurances were six deadlines and milestones by which states should make decisions and commit to certain actions towards developing new disposal facilities. The amendments prescribed limited responsibilities for DOE and NRC. The amendments also established financial penalties, or surcharges, on the waste disposed of in existing facilities if certain milestones were not met. In addition to basic disposal charges, waste generators were to pay nonpenalty surcharges based on the volume of wastes disposed of at the three operating disposal facilities. The six deadlines and milestones are described in figure 1.3.

Figure 1.3: Deadlines and Milestones Contained in the 1985 Amendments Act

July 1, 1986	A state must have either joined a compact with other states or certified its intention to develop its own disposal facility.
January 1, 1988	Each compact was to have identified either a host state where its disposal facility would be located or a facility developer and developed a siting plan.
January 1, 1990	A state must have submitted either a facility license application to NRC or the appropriate state agency or, in lieu of an application, a governor's certification to NRC on how the state would manage its low-level waste after December 31, 1992.
January 1, 1992	A state must have submitted a facility license application.
January 1, 1993	Each state's disposal facility was expected to be operational, and disposal rights at the three existing disposal facilities would end. If a state's facility was not ready, the state and other members of the state's compact had either to begin taking title to and possession of the waste generated in the states or to assume liability for any damages that might result from the waste. Also, the state(s) had to forfeit rights to rebates of previous surcharge payments made by waste generators because of the state's failure to meet earlier milestones in accordance with the 1985 act.
January 1, 1996	If a state's disposal facility is not operational, the state and other states in the compact must, if they have not already done so, begin taking title to and possession of their generators' waste at the request of the generators.

New York and two of its counties challenged several provisions of the amendments, including the take-title provision contained in the last milestone. Nineteen other states supported this challenge. Under the take-title provision, states or compacts that failed to provide for the disposal of all waste generated within their borders by January 1, 1996, were required, upon request, to take title to and possession of the waste and become liable for damages suffered by the generators as a result of the state's failure to do so. In 1992, the U.S. Supreme Court ruled in New York v. United States, 112 S.Ct. 2408 that this provision was unconstitutional. The court concluded that the Congress has power under the Constitution to preempt state regulation or to encourage states to provide suggested regulatory systems for disposal of the low-level waste generated within their borders, but the Constitution does not confer upon the Congress the ability to compel the states to do so in a particular way. The court held that the take-title provision was severable from the remainder of the act.

Objectives, Scope, and Methodology

Concerned about the environmental and economic effects of implementing the Low-Level Radioactive Waste Policy Act of 1980, as amended, Senators Christopher J. Dodd and Joseph I. Lieberman requested that we review the status of the low-level waste program, the economic and environmental effects of the planned disposal facilities, and alternatives to the approach specified in the act, as amended.

To respond to the requesters, we interviewed

- state officials and members of the Low-Level Radioactive Waste Forum—an association of representatives of states and compacts established to help implement the act;
- waste generators and their associations, other professional associations, environmental groups, and members of academia;
- representatives from citizens' advisory groups and citizens groups that have opposed efforts by Connecticut, Nebraska, and Massachusetts to select sites for new disposal facilities;
- New York and North Carolina county officials in communities close to where sites have been considered; and
- officials in DOE, NRC, and the Environmental Protection Agency (EPA) who are responsible for issues in the commercially generated low-level waste area.

In addition, we obtained and analyzed available documentation on the subject area and attended various meetings sponsored by the Low-Level Radioactive Waste Forum, EPA, NRC, and the National Institutes of Standards and Technology.

We also obtained and analyzed reports prepared by a presidential task force, DOE, NRC, states, environmental organizations, and waste generators and their associations. We reviewed law review articles and various articles and books from academic sources and professional associations. And, we hosted a meeting of representatives of low-level waste generator organizations from six states and compacts.

We visited several facilities to obtain information about waste generation, storage, treatment, and disposal. We visited waste storage and processing facilities at the National Institutes of Health in Bethesda, Maryland; a research hospital in Pennsylvania; a research hospital, pharmaceutical manufacturer, and a nuclear power plant in Illinois; and a biotechnology research firm in California. We also visited the operating disposal facility at Barnwell, South Carolina, and a waste treatment facility in Tennessee.

Finally, to assess pertinent economic issues, we examined reports prepared by DOE contractors, NRC, and members of academia on the economics of disposing of low-level waste. Although these reports did not address economic issues related to states' specific plans for developing disposal facilities, they did provide general information on topics such as the economic effects of developing varying numbers and sizes of disposal facilities. We did not independently verify the cost data in these reports, and comparable economic studies were not available from states.

To ensure that our report is accurate, complete, and objective, we provided copies of the draft report or portions of the draft report to knowledgeable federal officials, including the program manager for DOE's National Low-Level Waste Management Office and NRC staff in the Office of State Programs, Division of Waste Management, Office of Nuclear Materials Safety and Safeguards, and Office of the General Counsel. These officials generally agreed with the facts as presented in our report, and NRC officials noted that our report accurately characterized the current situation in developing low-level waste disposal facilities. NRC and DOE officials also provided several technical and editorial comments which we incorporated as appropriate to clarify and update the report.

Our work was performed from January 1993 through April 1995 in accordance with generally accepted government auditing standards.

States Are Making Slow Progress on Developing New Disposal Facilities

As of January 1995, 11 states had plans to develop disposal facilities for commercially generated low-level waste, and the state of Washington planned to continue operating its existing disposal facility. Altogether, these 12 facilities would serve waste generators in 47 states. Five other states had no plans to meet the needs of their waste generators.[1] Only 4 of the 11 states have selected candidate sites for disposal facilities; and none of these proposed facilities is under construction. States' estimated dates for opening the planned facilities range from 1997 to 2002, but these dates may be optimistic.

The length of time states are taking to establish new disposal facilities is largely attributable to the controversial nature of nuclear waste disposal. Because existing facilities had closed to most states and new facilities will not be built for some time, waste generators in 33 states, which generate about 42 percent of the waste, have not had access to disposal facilities since July 1, 1994. These waste generators will have to store their own wastes until new disposal facilities are built.

New Disposal Facilities Are Years Away

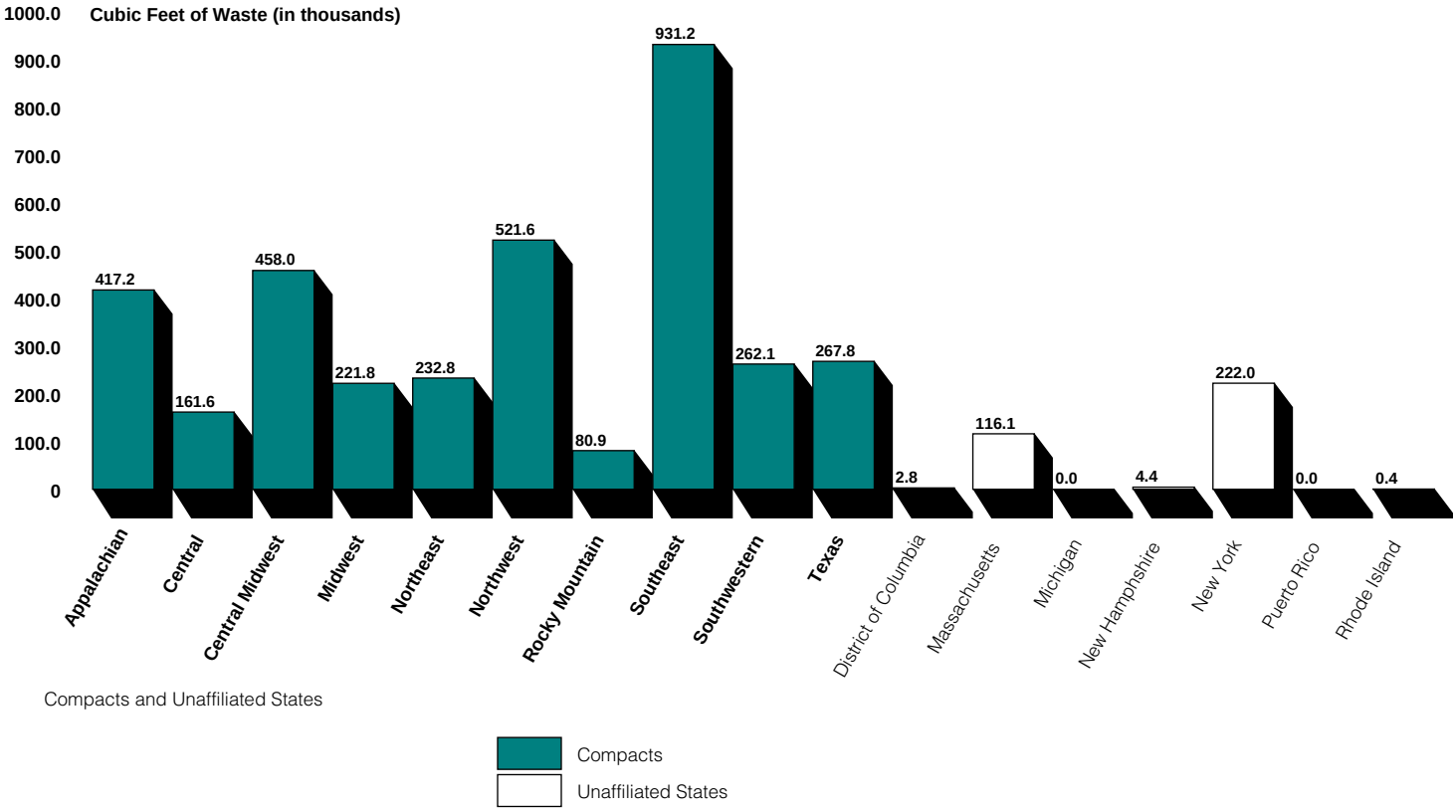
Forty-two states have established nine compacts. The Northwest and Rocky Mountain Compacts, comprising 11 states, intend to use Washington's existing disposal facility. The Southeast Compact of eight states plans to develop a disposal facility in North Carolina and to close the Barnwell, South Carolina, disposal facility, which is currently available for only those eight states.[2] And, six other compacts plan to develop seven new disposal facilities. (The two states that comprise the Northeast Compact—Connecticut and New Jersey—each plan to develop its own facility). Three other states have formed a tenth compact, the Texas Compact, that has not yet been approved by the Congress. This proposed compact also plans to develop a disposal facility in Texas. Finally, two states, Massachusetts and New York, are not members of compacts, and they intend to develop their own disposal facilities. Thus, 11 new disposal facilities are planned, and 1 existing facility would remain open for a total of 12 disposal facilities. Only four compacts, however, have selected candidate sites for their respective facilities, and no new disposal facility is

[1]The law defined "state" to include the District of Columbia and Puerto Rico.

[2]On April 13, 1995, the governor of South Carolina called on the state's General Assembly to extend the life of the Barnwell facility for 10 years or until North Carolina has opened its planned disposal facility. The governor did not explicitly state whether he proposed to once again open the facility to waste generators in all states or to limit access to the facility to generators within the Southeast Compact. Under the current arrangement, the Barnwell facility could not be reopened to waste generators outside the Southeast Compact without the approval of the state legislature and the compact. On May 2 the compact commission considered but did not pass a motion to extend access to the facility.

yet under construction.[3] Figure 2.1 shows the volume of waste disposed of by waste generators in each compact and unaffiliated state from 1991 through 1993 and the membership of each compact.

Figure 2.1: Waste Volume Among Compacts and Unaffiliated States From 1991 Through 1993



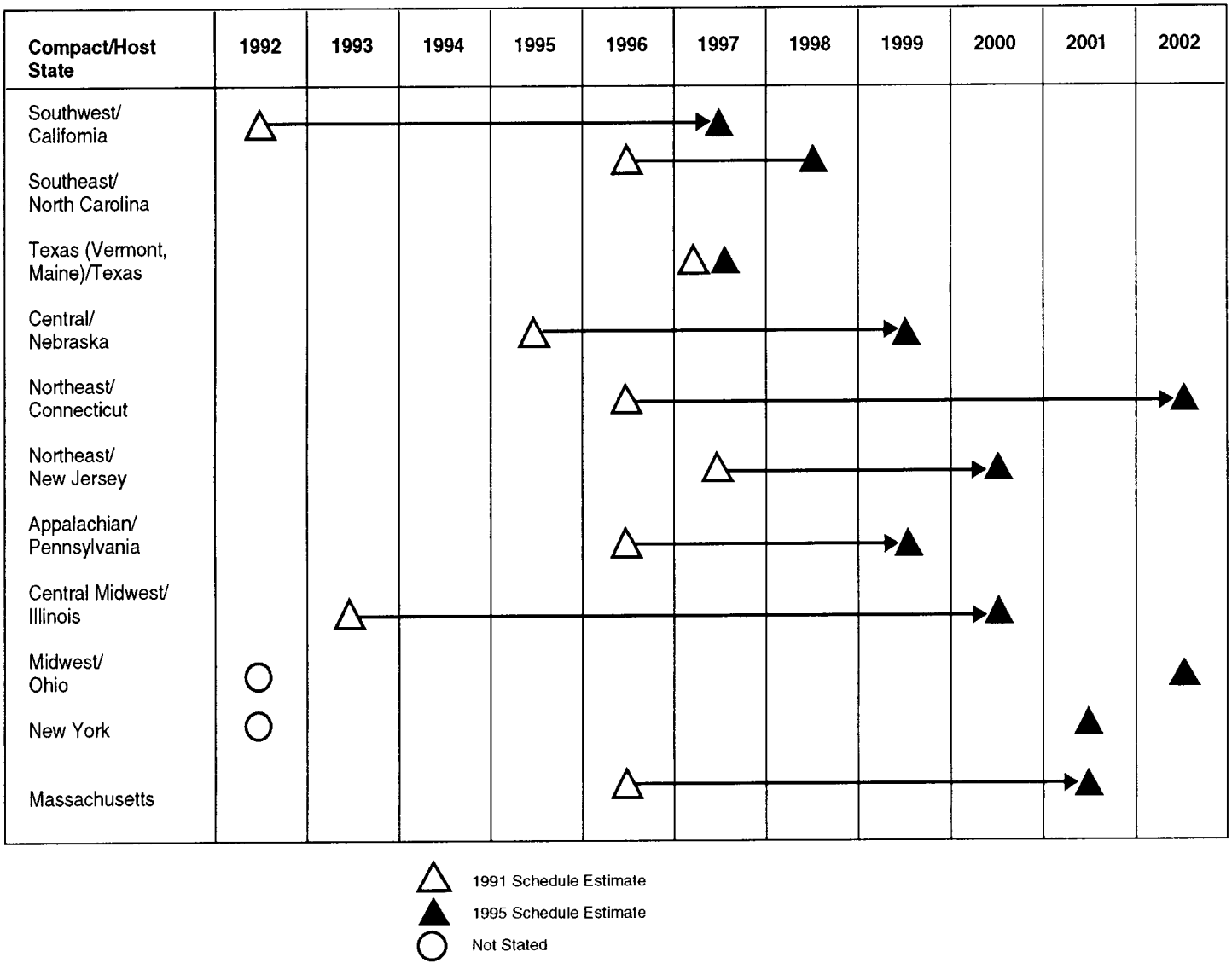
Note:The figures are based on the amounts of waste sent to existing disposal facilities. Michigan generators have not been allowed access since 1990. In that year, the state had about 36,000 cubic feet of waste, or 3 percent of the nation's total.

[a]Texas, Maine, and Vermont formed a compact in 1992; however, the Congress has not yet approved the compact.

[3]In 1988, Utah licensed a disposal facility for large shipments of specific low concentrations of a limited number of radionuclides of relatively less hazardous low-level waste. However, the privately developed facility is privately owned and operated. The Northwest Interstate Compact provided a resolution allowing the acceptance and disposal of these wastes, and the facility operators have received the necessary licenses and permits.

No state has developed a new facility for disposal of commercially generated low-level radioactive waste since the 1980 act was passed. Current estimated dates for opening the 11 planned facilities range from 1997 to 2002. These dates, however, may be optimistic because earlier dates have slipped over the years. Also, some states that once appeared to be making the most progress, such as Illinois, are now further behind other states because of setbacks in their efforts to select a site for a disposal facility. Figure 2.2 shows how state and compact estimates of completion dates changed between 1991 and 1995.

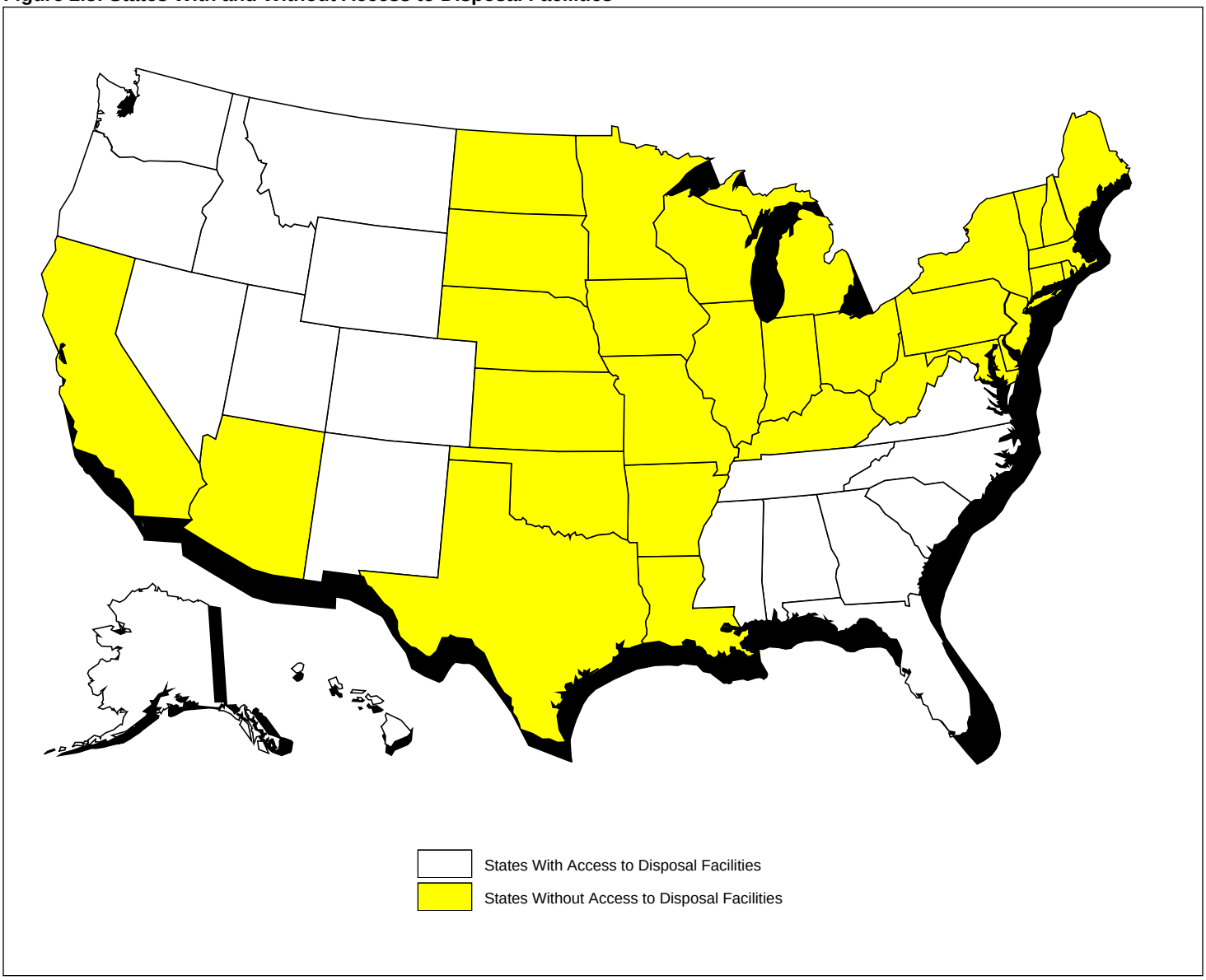
Figure 2.2: Difference Between 1991 and 1995 Estimates for Opening New Disposal Facilities



Three compacts totaling 19 states continue to be served by the existing disposal facilities in South Carolina and Washington. (See fig. 2.2.) Since

July 1, 1994, when the South Carolina facility closed to waste generators outside the Southeast Compact, generators in the remaining 33 states have not had access to disposal facilities. (See fig. 2.3.) In fact, the states and compacts with jurisdiction for the South Carolina and Washington facilities began denying waste generators in some states, such as Michigan, New Hampshire, Puerto Rico, and Rhode Island, access to the existing disposal facilities prior to 1994. The denials were made on the basis that those states had not demonstrated sufficient progress in either joining other compacts of states or developing their own disposal facilities. Waste generators that do not have access to disposal facilities accounted for about 42 percent of all commercially generated low-level waste in 1993, the last full year that waste generators in most states had access to a disposal facility. The waste generators will have to treat and/or store their low-level wastes until their respective states develop new disposal facilities or obtain access to other facilities.

Figure 2.3: States With and Without Access to Disposal Facilities



California, Nebraska, North Carolina, and Texas are the host states for new disposal facilities for three compacts and a proposed compact made up of a total of 20 states. Waste generators in these 20 states account for about 43 percent of all commercially generated low-level waste. Developers of potential disposal facilities in the four host states have

submitted applications to state regulatory authorities to construct and operate their facilities.

The developer for a potential facility in California submitted a license application in 1989, and the state has licensed the facility pending sale of the land to the state by the U.S. Department of the Interior. In 1990, the developer for the Nebraska facility submitted a license application and then revised the application in 1993. The developers in North Carolina and Texas submitted final license applications for state reviews in 1993. None of the host states for other compacts or Massachusetts and New York have identified candidate sites for disposal facilities.

Slow Progress Is Due to Controversy Over Disposal Facilities

The limited progress states have made in developing new facilities for disposing of commercially generated low-level waste appears to be fundamentally due to the controversial nature of such facilities. Put another way, the length of time required to form compacts, select states to host new facilities, develop necessary legislation and regulations, and select candidate sites for facilities appears to reflect the widespread concern about such facilities among the affected public and various state and local government entities.

Early in 1993, NRC's staff reviewed the experiences of 13 states in addressing the needs of their waste generators for access to disposal facilities. NRC's staff identified seven factors that, in its judgment, had affected the progress of these states, including

- criteria and procedures for selecting sites,
- funding and legislation,
- litigation,
- perceptions that federal and state regulations were inadequate,
- perceptions that long-term storage of waste is more desirable than disposal, and
- liability protection for citizens and property from potential releases of radioactivity from a disposal facility.

The staff said that the seventh factor—public and political concern over the development of new disposal facilities—appeared to be one of the major factors linked to many of the other factors. Public concern and an absence of broad-based public and political acceptance has had a significant effect on the development of new disposal facilities. Public

concern, according to the staff, has been demonstrated in a variety of ways, including

- lack of volunteer sites for disposal facilities,
- delays in enacting necessary legislation,
- changes in states' legislation affecting site-selection processes,
- strict site-selection regulations, and
- litigation.

Moreover, according to the staff, public concern tends to increase and change as the site-selection process advances.

The process of developing compacts and selecting a state within a compact to develop a disposal facility illustrates the difficulty at the political level of moving forward with a program for developing a disposal facility. In the early 1980s, 11 northeastern states were considering forming a regional compact. However, the compact never materialized because, according to observers, no state would agree to host a disposal facility for the large amount of waste that would be coming from the other states. Subsequently, the states splintered into smaller compacts, and several states decided to independently pursue their own waste disposal solutions, but none has selected a site for licensing.

In an earlier report, we also pointed out that choosing sites for disposal facilities could be controversial and time-consuming.[9] The process of selecting sites became longer than states had originally anticipated, in part, because of the extent of public involvement in these proceedings.

The following discussion of the experiences of several states illustrates how the public and political concern over disposal facilities has affected the states' abilities to develop new facilities.

Illinois

Because of questions about the process for selecting a new site for a disposal facility and concerns about the suitability of a proposed site, the governor of Illinois and the state's legislature created an independent commission to examine the safety of the proposed site in 1989. In 1992, the commission found the site unacceptable, rejecting the conclusions of the state agency that had spent 8 years and about $85 million finding and studying the site. Since then, Illinois has abandoned the site and has

[9]Nuclear Waste: Slow Progress In Developing Low-Level Radioactive Waste Disposal Facilities (GAO/RCED-92-61, Jan. 10, 1992).

embarked on a new approach which involves determining scientific requirements for the siting process followed by statewide screening to find a site.

Connecticut

In 1991, citizen groups in Connecticut challenged the results of a statewide screening and selection process. Afterwards, the state enacted legislation that voided the site screening and selection results and directed the state's siting authority to restart the site-selection process.[10] The authority is now using a volunteer process to find a site that has been approved by the local electorate in a referendum.

Nebraska

In 1988, during the screening process to find a suitable site in Nebraska, the developer received a formal expression of interest from several counties. The developer submitted a license application to the state agencies in July 1990, and the state declared the application complete and ready for technical review in December 1991. In January 1993, however, the state filed a lawsuit in the U.S. District Court for the District of Nebraska seeking a permanent injunction to prevent the licensing or construction of a facility in the state until community consent is demonstrated. In October 1993, the court granted summary judgment in favor of the defendants on procedural grounds. The court held that action on the community consent issue was barred by the statute of limitations provision in the compact. In June 1994, the U.S. Court of Appeals for the Eighth Circuit affirmed the lower court's decision. The state's petition to the Supreme Court to hear an appeal was denied in November 1994.

Also in January 1993, Nebraska's regulatory agency announced its intent to deny a license for the proposed disposal facility on the basis that the site contained wetlands. In October 1993, after the developer redesignated the boundaries of the site and eliminated the disputed wetlands area, the regulatory agency notified the developer that the agency would withdraw its intent to deny the license. The developer's license application is currently under state review.

North Carolina

In 1990, two candidate sites were selected in the host state of North Carolina. Subsequently, officials in the affected counties opposed the selection of the two candidate sites and filed two suits against the state's

[10]Nuclear Waste: Connecticut's First Site Selection Process for a Disposal Facility (GAO/RCED-93-81, Apr. 5, 1993).

siting authority. One suit claimed that an environmental impact statement was required before investigation of a site could begin. The other suit alleged that improper procedures were used in the site-selection process. In February 1993, the state court of appeals ruled in favor of the siting authority. The counties appealed to the state supreme court in March 1993 and, in November 1993, that court agreed to let stand the decision of the appeals court.

Because of the pending lawsuits, the siting authority's contractor, which was responsible for studying the sites, could do only preliminary, off-site testing. As a result, the siting authority did not select one of the two sites for use as a disposal facility until December 1993, or 3 years later than the siting authority had planned. Because the state called for further study of site features in 1994, the siting authority's estimated date for licensing construction of the planned disposal facility has slipped from March 1995 until August 1997.

California

In 1993, California officials had expected that their proposed disposal facility in the Mojave Desert for the Southwest Compact would be operating by 1994, but the controversy surrounding the siting effort has led to a later estimated opening. Besides lawsuits filed by opposition groups, a group of U.S. Geological Survey geologists, acting independently of their organization, prepared a report raising technical concerns about the site and the siting process. On the basis of the geologists' report, a California Senator asked the President for a full hearing and an examination of alternatives for the site before the sale of federal land to the state. In 1994, the Secretary of the Interior asked the National Academy of Sciences to review the concerns of the Geological Survey geologists and to report back in May 1995. Depending upon the Academy's findings, the Secretary may also want an adjudicatory hearing to examine opponents' concerns. After the Academy has issued its report and, perhaps, an adjudicatory hearing has been held, the Secretary will determine whether the land will be transferred to the state.

Michigan

By October 1989, Michigan, the original host state for the Midwest Compact, had identified three candidate sites for a disposal facility but had then eliminated the three sites from further consideration because the sites did not meet its siting criteria. At a July 1991 meeting, Michigan presented several conditions for the compact to meet if it expected the state to continue its siting efforts. One condition, for example, was that the

state would be released from its role as host state if, under Michigan law, the state could not find a suitable site for a disposal facility.

The compact decided that Michigan had unreasonable criteria that essentially precluded the state from finding a suitable site. The compact then voted to expel Michigan for not acting in good faith to honor a binding contractual obligation to find a waste disposal site in Michigan. Ohio has assumed the host-state responsibility and has begun to develop a process for selecting a site for a disposal facility.

New York

In 1989, a New York state commission selected five potential sites for low-level waste in Cortland and Allegany counties. The commission had intended to conduct initial on-site technical investigations of the five sites by late spring of 1990 and then select at least two of the sites for a more intensive, 1-year investigation. However, public protests—including civil disobedience during the commission's attempts to gain access to the sites—and other objections from citizens and local governments caused the governor to request the commission to defer on-site work until a new approach could be developed. The commission suspended its field work in April 1990, and later in 1990, the state amended its waste disposal act.

In the meantime, Cortland County, where two of the five proposed sites are located, had questioned the commission's credibility, in part, because the county contended that the commission did not follow its site-selection plan in selecting a volunteer site. In February 1990, the state joined the two potential host counties in filing suit against the federal government questioning the constitutionality of the Low-Level Waste Policy Act, as amended. These lawsuits led to the Supreme Court's decision that the act's take-title provision was unconstitutional. The state is currently trying to determine the best method for disposing of waste before deciding on a location for a disposal facility.

Economic Efficiencies in Fewer Disposal Facilities May Depend in Part on Future Waste Volume

There are no reliable estimates of the cost to dispose of the nation's commercially generated low-level radioactive waste. In 1980, there were three operating disposal facilities serving almost four times the current volume of commercially generated low-level radioactive waste. Currently, 11 new facilities are planned in addition to the state of Washington's existing facility. Most states have not estimated the total costs of their planned facilities or the unit disposal costs. Studies by DOE and others that examine economic aspects of low-level radioactive waste facilities have concluded that fewer larger new facilities could accommodate current waste volumes at less cost than a larger number of small facilities. The studies, however, have limited usefulness in determining the optimal number of sites. For example, no studies had up-to-date cost data, and the models that were used had limited scope and were not capable of estimating costs for the potential range of required disposal facility sizes.

In addition, there are uncertainties related to the volume of commercially generated low-level waste that may be produced over the lifetime of the planned disposal facilities that were not accounted for in available studies of the economics of waste disposal. Two interrelated uncertainties are when utilities will retire their nuclear power plants and, once plants have been shut down, when they will be dismantled. Also, waste generators might, depending on the availability of disposal capacity and disposal fees, intensify past efforts to minimize the volume of waste that they must manage and eventually dispose of.

States Have Not Estimated Total Disposal Costs

Most states and compacts have not estimated what the total costs will be for their proposed facilities. State officials said that they are reluctant to provide such estimates because the different methods of calculating cost estimates that the states would use would lead to inaccurate comparisons of facility costs. For example, in determining the life-cycle cost—the full cost of the facility, including siting, development, construction, operating, closing, and post-closure monitoring—volume, and type of facility would play an important part. The unit cost of disposal at a small facility with above-ground concrete vaults to hold the waste would be higher than at a large facility that relied on shallow burial in earthen trenches. Also, each state and compact has different institutional and regulatory requirements, including liability funds.

In 1993, NRC surveyed states and compacts to obtain cost information. Of the 11 potential host states, 5 provided life- cycle cost

estimates—California, Massachusetts, Pennsylvania, Texas, and Vermont.[1] The estimates ranged from $260 million in Texas to $920 million in Pennsylvania. In an April 1993 letter to NRC, the Low-Level Waste Radioactive Forum questioned the timing, methodology, accuracy, and usefulness of NRC's study. The Forum was concerned that NRC's presentation of the data could erroneously imply that data for the states were comparable and complete. Forum officials told us that the reasons for the wide variance in estimates may be based on factors such as the type of facility, accounting methods, definition of terms, and varying talents at estimating costs among the states.

Studies Show That Fewer and Larger Facilities Are More Cost-Efficient

We identified and reviewed seven conceptual studies that examined the costs of disposing of commercially generated low-level radioactive waste.[2] (See app. I for information on these seven studies.) All of these studies concluded that fewer, larger facilities would be more economically efficient than several smaller ones. The optimal number of facilities was between two and five. This finding was consistent even though the studies were produced at different times, employed different methodologies and cost estimates, and varied in their estimates of the optimum number of facilities. Moreover, the studies were limited to assumptions that the volume of waste would continue at the same rate for the life of the facilities.[3] The volume may increase or decrease, depending, for example, on how and when nuclear power plants are dismantled. We were not able to develop a comparative cost analysis to demonstrate the relative efficiency of a wide range of plant sizes because we found no model with up-to-date cost data that was capable of estimating costs for the entire range of facility sizes required.

Three of the studies prepared for DOE clearly demonstrate the economic benefits of consolidating small-volume facilities. The 1987 Conceptual Design Report, which examined large-scale facilities, found that increasing annual disposal capacity from an annual rate of 235,000 cubic feet to 350,000 cubic feet would reduce unit disposal costs by 25 to 50 percent. A

[1]Massachusetts did not initiate a search for a disposal facility site until about a year after providing the estimate to NRC. Also, Vermont subsequently decided to join a compact with Texas rather than develop its own facility.

[2]Four of the studies were prepared for DOE. A fifth study was prepared for the Electric Power Research Institute. Also, two studies were prepared by university researchers. None of the studies relied on state information regarding all the specifically proposed disposal facilities.

[3]While the price of disposal has traditionally been based on volume, several state officials and industry representatives said that future pricing may be based more on the radioactivity of the waste, which has shown an erratic trend in the last 15 years.

1991 report on small volume facilities concluded that unit costs rise radically as facility size decreases. The report estimated that costs were 143 percent higher for a disposal facility capable of annually accepting 10,000 cubic feet of waste than for a facility with three times this waste acceptance capacity. A 1993 study concluded that efforts to develop a cost-effective waste disposal facility should seek to match facility size as closely as possible to disposal waste demand and concentrate waste disposal activities at a small number of large sites.

Disposal facilities that can handle high volumes of commercially generated low-level waste enjoy economies of scale because a significant portion of facility costs are fixed and do not vary with volume of disposal. These fixed costs can be spread over the high number of waste units received, thus lowering the per-unit cost of disposal. Because fixed costs are very significant in low-level waste disposal, a facility's average costs decline markedly as facility size increases. (See table 3.1.) Also, a few large sites can reduce the fixed costs of identifying and licensing many small sites.

Table 3.1: Costs Compared to Facility Size

Facility size (cubic feet)	Annual disposal rate (cubic feet per year)	Unit disposal cost
300,000	10,000	$643.27
900,000	30,000	$223.99
1,500,000	50,000	$140.14

Source: Economics of a Small Volume Low-Level Radioactive Waste Disposal Facility, (Dames and Moore, Jan. 14, 1993).

Although there is agreement among the studies on the efficiency of fewer, larger facilities, only three of the seven studies we reviewed estimated the optimal number of sites. The estimates for the optimum number of sites ranged from two to five. In 1990, Bullard and Weger found that facilities designed to handle annual volumes between 200,000 and 500,000 cubic feet were most economically efficient. Using DOE's projection of 933,000 cubic feet on average annually for the period 2000 to 2030, the number of economically efficient sites would be from two to five. In 1992, Coates, Heid, and Munger estimated the maximum number of economically viable sites to be five, while stating that a more realistic estimate would be two or three facilities.

We were not able to develop a comparative cost analysis to demonstrate the relative efficiency of a wide range of facility sizes because all available

cost studies contained either outdated data, which do not reflect current marketplace conditions, or limited scope for considering a narrow range of disposal facility sizes. However, all available cost information we collected point to a rapidly rising trend in major cost categories and most notably in pre-operating and siting costs.

Cost information from North Carolina and Nebraska confirm that states are facing escalating costs. In 1989, North Carolina projected that pre-licensing costs would be $17.7 million; by 1991 the estimate had tripled to $51.1 million.[4] Nebraska's total cost estimates rose 231 percent from 1987 to 1992, from $36.9 million to $122.3 million. Also, NRC reported in its study that California's cost estimate had increased by a factor of six. Although we did not attempt to verify specific cost data reported, we believe that the sources that were used are the best available on the economic trends faced by states and compacts under the program.

Uncertainties That Could Affect Waste Volume and Economics of Disposal Facilities

There are uncertainties related to the volume of commercially generated low-level waste that may be produced over the lifetime of the planned disposal facilities that were not accounted for in available studies of the economics of waste disposal. Two uncertainties are when utilities will retire their nuclear power plants and when they will decontaminate and dismantle retired plants. In addition, waste generators might, depending on factors such as the availability of disposal capacity and fees charged for disposal services, continue past efforts to minimize the volume of waste that they must manage and eventually dispose of.

Timing of Nuclear Power Plant Retirements Will Affect Waste Volume

Today, there are more than 100 civilian nuclear power plants in operation in about 30 states. In 1993, the operating plants collectively produced about 50 percent of the volume (and 95 percent of the radioactivity) of commercially generated low-level waste. Typically, NRC licenses these nuclear power plants to operate for 40 years, but many utilities are interested in extending the authorized operating lives of their plants by up to 20 years. Although NRC's regulations permit such life extensions, no civilian nuclear power plant has yet operated for 40 years. Sixteen plants have been permanently shut down before operating that long.

In the next 20 years, about 50 nuclear power plants will have to be retired unless their licenses are extended. No utility has yet submitted an application to extend its operating license, and since 1979 utilities have

[4]Unless otherwise noted, all costs have been adjusted to 1992 dollars.

retired seven nuclear plants earlier than had originally been anticipated.[5] For example, owners of the Yankee Rowe and the Monticello plants originally planned to submit applications to NRC for license extensions as part of a cooperative program between DOE and the nuclear power industry. However, in 1992, the utility that owns the Monticello plant indefinitely deferred its application for a number of reasons, such as increases in estimated costs of upgrading to new equipment standards, and DOE's inability to accept spent fuel from the plant for storage or disposal. Then, in 1992, the owner of the Yankee Rowe plant decided to retire that plant for economic reasons.

Thus, future decisions on when to retire civilian nuclear power plants from service, including the possibility of extending the operating lives of these plants, will affect the volumes of commercially generated low-level waste that must be disposed of over the next several decades. The state of Pennsylvania, for example, has estimated that extending, by 20 years, the operating lives of the 12 nuclear power plants located in states that make up the Appalachian Compact could produce an additional 3.3 million cubic feet of low-level waste through the first quarter of the next century.

Timing of Decontaminating and Dismantling Nuclear Power Plants Will Affect Waste Volume

In addition to the low-level waste that civilian nuclear power plants produce during their operating periods, many components of the plants become contaminated with radioactivity as a result of years of plant operations. For this reason, plants that have been retired from service must be decommissioned. Decommissioning refers to safely removing a nuclear plant from service, reducing residual radioactivity to a level that permits release of the plant property for unrestricted use, and terminating the utility's license for the plant.

NRC requires a utility to submit a plan for decommissioning a nuclear power plant within 2 years of the time that the utility retires the plant from service. Although specific decommissioning plans may vary from plant to plant, NRC generally requires that a utility complete decommissioning within 60 years of the plant's retirement. To meet the 60-year requirement, utilities may either dismantle and/or decontaminate portions of a plant that contain radioactive contaminants shortly after retirement or allow the radioactive contaminants to decay over a period of years prior to decontamination and/or dismantlement.

[5]Two of the seven plants are unusual cases. First, one of two plants at Three Mile Island experienced an accident after less than 2 years of operations. Second, the Shoreham plant was tested intermittently for 2 years but then permanently shut down. The average life of the remaining five plants was about 20 years, or half the typical 40-year period of an operating license.

Thus, decisions on when to decontaminate and dismantle retired plants will affect the waste volume just as decisions on when to retire nuclear power plants will affect the volume. DOE estimates that decommissioning and decontaminating the nuclear power plants that utilities will shut down over the next 30 years will generate about 55 million cubic feet of low-level waste. DOE assumed a 2-year planning period after a plant has been permanently shut down followed by a 4-year decontamination period. Either more or less waste than estimated, however, could be generated and disposed of at new disposal facilities, depending on the timing of decommissioning and decontamination of these plants. If utilities decontaminate and dismantle more nuclear plants over the next 30 years than projected, they could generate even more low-level waste.

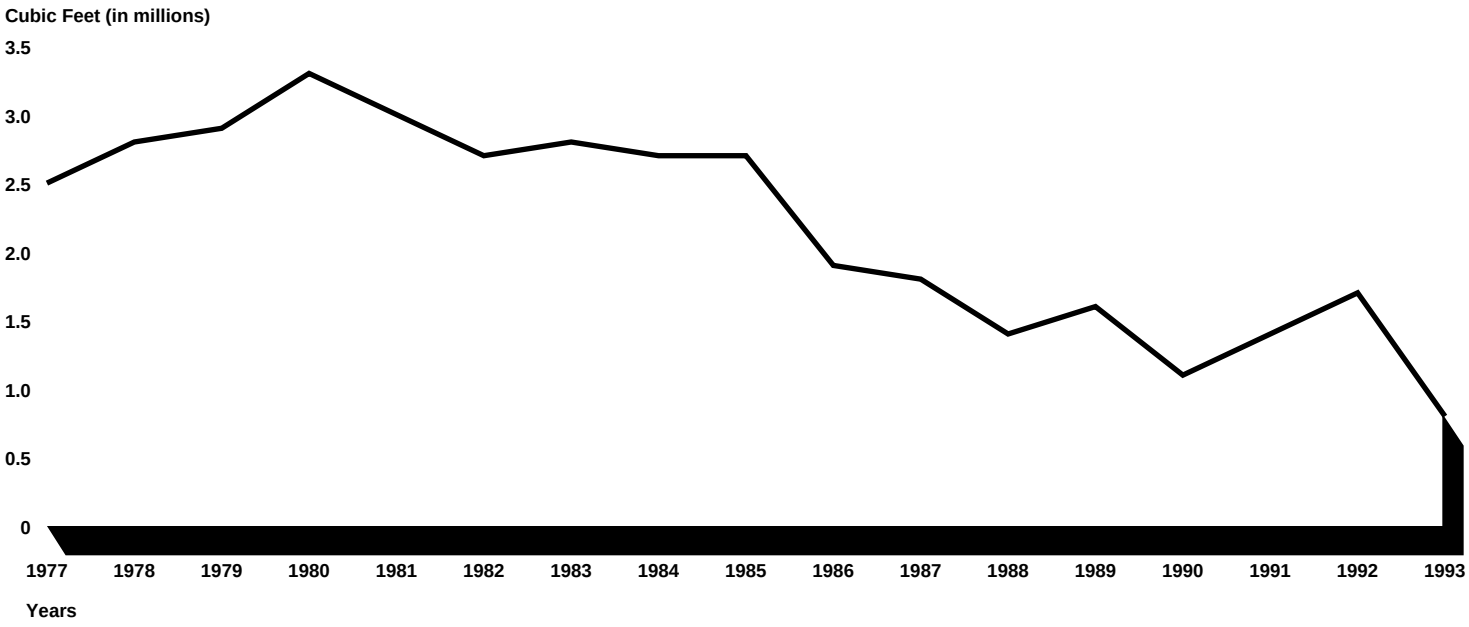
Even if nuclear power plants are not decommissioned and decontaminated immediately, there may be a sizable amount of waste generated to keep them operating. If all nuclear plants in the Appalachian Compact received 20-year license renewals, for example, Pennsylvania officials estimated that 3.3 million cubic feet of waste would be generated for the same period.

Trends in Waste Volume

The future trend of waste volume depends on several uncertainties. Among other things, the trend may depend on the economics of storage and disposal and waste minimization techniques.

In the initial years (1963 to 1971) of commercially generated low-level waste disposal, the volume of waste and the number of sites increased. As the number of disposal facilities declined, the volume of disposed waste continued to increase, until the Low-Level Waste Policy Act of 1980 was enacted. (See fig. 3.1.) Since 1980, the volume has decreased. This reversal has been attributed, in large part, to the 1980 act, as amended; decisions by states with existing disposal facilities to charge higher disposal fees; and limits on the volume of waste that could be disposed of in their facilities.

Figure 3.1: Volume of Low-Level Waste Disposal



Note: There were five disposal facilities in 1977, four facilities until April 1978, and three facilities from April 1978 through 1992. In 1993, two facilities were available to most states. Also, the Utah facility was available since 1988 for large shipments of specific low concentrations of a limited number of radionuclides.

Source: DOE.

Industry representatives and state and federal officials that we talked with differed on whether further significant reductions will occur in the volume of commercially generated low-level radioactive waste that must be disposed of. Some of the officials said that uncertainties in the costs of storage and disposal could eventually lead to reduced volume through new or additional treatment that would not necessarily reduce radioactivity. Others said that the uncertainties could lead to reduced usage of radioactive materials, particularly among smaller generators. For larger generators, such as utilities, storage and disposal costs are not expected to be as important.[6] According to the Office of Technology Assessment, even

[6]A representative of a disposal facility developer estimated that an increase in disposal cost from $50 to $250 would mean a $1 annual increase for the average electricity user.

with higher anticipated disposal costs, low-level waste costs would average about 1 percent of the utility's operational costs.

Specific Environmental Effects of the Current Program Are Unknown

No studies have been conducted on the combined environmental effects of the number of planned disposal facilities. Also, because no new disposal facilities have been built, little is known about the specific environmental effects at most of the planned facilities. With waste generators in most states now storing their own wastes and no new disposal facilities available, the environmental risks of long-term storage may increase as the amount of waste increases and reaches generators' current capacities.

Little Known About the Environmental Effects of the Planned Disposal Facilities

Currently, no studies have been conducted of the overall environmental effects of the 1 existing and 11 planned disposal facilities for commercially generated low-level waste. Furthermore, there are opposing views on whether having more disposal facilities than in the past will increase the environmental risks.

Because of past problems at disposal facilities, representatives of national groups opposed to nuclear activities and some local opponents of states' efforts to find sites for disposal facilities question whether the waste can be safely disposed of. Several former disposal facilities experienced environmental problems, such as radionuclides leaking into groundwater. However, several state officials and generators said that new disposal facilities would not encounter such problems because the land disposal regulations developed by NRC in 1982 include, among other things, stricter requirements for investigating sites and building and operating facilities. In addition, NRC officials pointed out that each new disposal facility would have to comply with these regulations, including limits on the dose of radiation that a member of the public could receive each year from operation of the facility. (App. II provides a brief description of NRC's standard for allowable radioactive risk to the public and EPA's current concern about NRC's standard.) NRC officials also said that the environmental impact statement that NRC prepared for the purpose of developing its disposal regulations assessed, in general terms, potential environmental effects, such as air quality, energy use, and social impacts.

Because of regulatory requirements for a buffer zone of land surrounding a disposal facility for commercially generated low-level waste, developing the 11 planned facilities may require more land dedicated to disposal than would fewer larger facilities. The acreage dedicated to such facilities, including buffer zones, will require monitoring and limited land-use applications for at least a century. Furthermore, unless the currently planned facilities can expand their operating lives, there may be a need to establish more sites in 20 to 30 years. For example, the Southwest

Compact Agreement states that, if California decides to close its facility after an operating life of 30 years, another state in the compact will become the host of another disposal facility for another 30 years.

According to some state officials and waste generators, however, having several disposal sites could have positive effects on public health and safety by reducing distances from generators to processors and to disposal facilities and, therefore, reducing the chances of transportation accidents. Estimating potential transportation benefits may be difficult, because of the many factors, such as road conditions, weather, driver error, and type of vehicle, that contribute to accidents. In addition, many generators use various waste brokers and processors in different parts of the nation for temporary storage, packaging, and treatment of waste before sending it to disposal facilities, which could also affect transportation distances. Proponents of new disposal facilities also point out that the transportation of waste has never created a grave environmental or safety risk. According to DOE, 53 transportation accidents involving low-level waste were reported in the 20-year period from 1971 to 1991. Four involved the release of radioactive waste, but no radiologically related death or injury occurred. (See fig. 4.1 for an example of how some types of low-level waste are transported.)

Figure 4.1: How Some Waste Is Transported

Source: Chem Nuclear Systems, Inc.

Too Early to Estimate Environmental Effects of Specific Sites

Very little information exists on the potential environmental effects at most of the 11 planned disposal sites. California has licensed a facility, but environmental concerns remain unresolved. Nebraska, North Carolina, and Texas are currently reviewing license applications, including environmental impact statements. If the states find significant environmental concerns based on their reviews, the sites can be rejected.

After 7 years of investigating the suitability of a site in Ward Valley, in the Mojave Desert, California found that the site and proposed facility met its regulatory requirements. The state's findings, however, have been challenged on the basis that the developer's investigation of the site was not thorough and independent. Opponents of the site point out that three geologists with the U.S. Geological Survey have challenged the assumptions and theoretical models used to analyze the safety of the proposed facility. For example, the geologists believe the potential exists for the contamination of groundwater underlying the Ward Valley site and

subsequent transmittal of radioactive materials to the Colorado River—a major source of water for Southern California, Arizona, and part of Mexico. A scientific consultant for the Metropolitan Water District of Southern California said that the long-term potential for contamination of the river is uncertain. Because the Ward Valley site is on federal land, the Secretary of the Interior has decided to postpone further action on transferring the land to the state until the National Academy of Sciences examines these issues and, if necessary, the issues have been examined in an adjudicatory hearing.[1]

North Carolina has not completed its examination of the environmental suitability of a proposed site for a disposal facility. The North Carolina developer submitted a report indicating that both of the sites it had studied were suitable for disposal facilities. In October 1993, the developer submitted licensing documents for a site in Wake County, noting that the site meets all applicable laws, regulations, and requirements. According to the developer, even using very conservative estimates of the release of radioactive particles to the environment, the public and the environment are protected and estimated radiation doses are far below the regulatory limits. On December 8, 1993, North Carolina approved the 746-acre Wake County site for further consideration, and the state regulatory authority is reviewing the license application.

There Are Potential Adverse Environmental Effects of Long-Term Storage

Waste generators have stored waste temporarily to permit the waste to decay or to consolidate waste for shipment for processing or disposal. With the recent closing of the Barnwell facility to waste generators outside the Southeast Compact, however, waste generators in the 33 states that are not members of the Northwest, Rocky Mountain, and Southeast Compacts have no disposal facilities to accept their wastes until their respective compacts or states have developed new disposal facilities. These generators, who accounted for about 42 percent of all commercially generated low-level waste in 1993, will have to arrange storage for their waste until their respective compacts or states develop new disposal facilities or obtain access to other facilities.

In the meantime, waste storage is increasing in numerous locations around the nation, including in heavily populated areas and in industrial parks. For example, in 1993, after Washington, D.C., lost access to a disposal facility, the radiation safety officer at a university's medical research

[1]The land would be transferred to the state because it is the policy of Interior not to permit waste disposal sites on public lands.

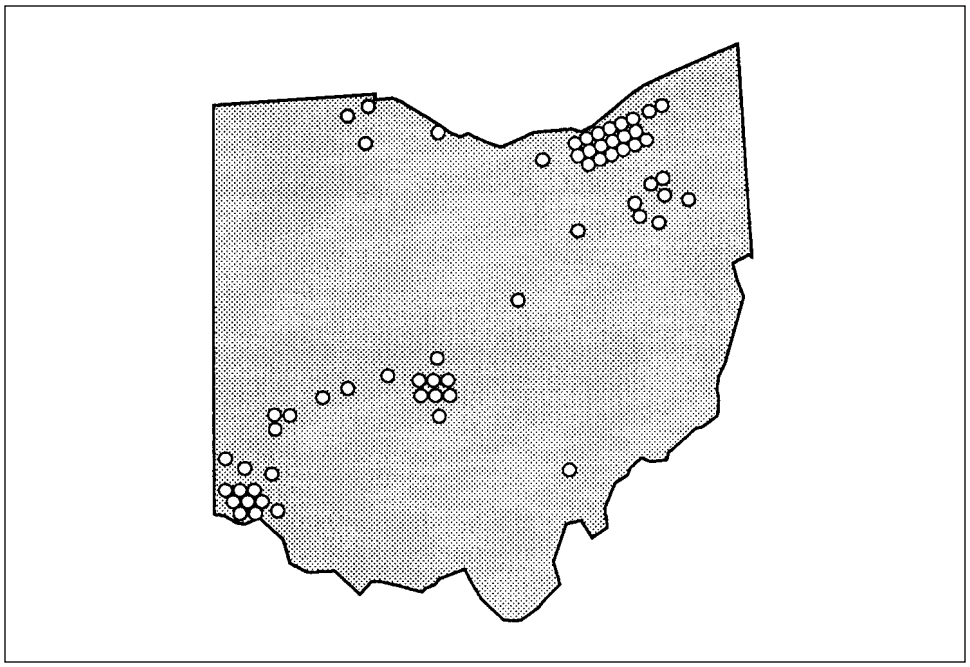
center in the District said that he converted a portion of the institution's parking area to a storage area. Some biotechnology firms in an industrial park in San Diego, California, store their waste drums and liquid waste containers in cargo containers, as approved by the California Department of Health. Figures 4.2 and 4.3 show two other examples of storage areas. Figure 4.4 shows the number of on-site storage areas in Ohio.

Figure 4.2: Low-Level Waste Storage Area on a University Campus in Washington, D.C.

Figure 4.3: Low-Level Waste Stored at an Industrial Park Near Chicago

Note: The photograph shows the amount of disposable waste accumulated during 1 year.

Figure 4.4: Storage Areas for Low-Level Waste in Ohio



Note: Some waste generators may ship wastes to brokers or processors for short-term storage.

Source: The map is based on information from the Ohio Department of Health.

The prospects of long-term storage of increasing quantities of commercially generated low-level waste has raised several environmental and health concerns, particularly for small waste generators. Generally, large generators, such as utilities that operate nuclear power plants, have adequate storage space and technical expertise. Although some alternatives to supplement long-term storage, such as legal disposal into sewage systems or incineration, may be available to some waste generators, little is known about the extent to which these alternatives might relieve the storage burden on generators. In this regard, there is limited information currently available throughout the nation on quantities of waste now in storage, waste generators' storage capabilities, and the extent to which generators are using alternative waste management techniques. And, neither NRC nor DOE currently have plans to collect such information.

Long-Term Storage Raises Environmental and Health Concerns

NRC has several primary concerns about the potential effects on public health and the environment from waste generators significantly increasing their storage of commercially generated low-level waste. One concern is the potential for releases of radioactive materials in the event of an accident caused by an event such as a fire, hurricane, or tornado. According to an NRC official, no serious accidents related to storage have occurred in the past. Although NRC has not conducted any analyses of the potential consequences of such an event, it believes the risk of potential releases as a result of an event or accident at one of numerous storage sites around the country is higher than the risk of a release from a limited number of disposal sites.

Another NRC concern relates to potential degradation of the packages that contain stored waste. Depending on the waste storage environment, degradation of waste packages could occur in several ways, such as temperature fluctuations, corrosion, generation of gases and corrosive substances, and radiation-induced embrittlement of certain containers. (Fig. 4.5 shows an example of corrosion of low-level waste drums at a DOE facility.) Therefore, waste generators need to maintain sufficient integrity of their stored waste packages to prevent dispersal of the waste during storage, transport, and handling. According to NRC, if gone undetected, degradation of packages could lead to spills or releases during handling for disposal, which would create the potential for increased worker exposures during handling, repackaging, and cleanup. NRC officials did not have any examples of such degradation, they said, because extended on-site storage is a relatively new phenomenon.

Figure 4.5: Degradation of Low-Level Waste Containers

Source: DOE.

Another of NRC's concerns is the possibility of increased radiation exposure to workers from storage-related activities. For example, conducting routine radiation surveys and inspecting waste in storage could add to workers' occupational doses of radiation. Nuclear utilities in Michigan, for example, indicated that technicians may experience greater exposure levels due to the need to store larger quantities of waste.

In addition to NRC's concerns, some generators and state officials said that there could be a greater risk of illegal dumping as the amounts of waste in storage increase and storage capacity becomes saturated. For example, the officials said, NRC's regulations permit, under certain conditions, users

of radioactive materials to dispose of wastes in sewage systems. In the absence of access to disposal facilities, these generators and officials said, waste generators might dispose of waste in sewage systems in excess of the limits that NRC permits. In a 1980 report, we reported that the abrupt closure of disposal facilities in 1979 might have led to some illegal dumping.[2]

Another concern among some generators is a possible reduction in nuclear health care and medical research because of a lack of access to disposal sites and storage capabilities. For example, Organizations United for Responsible Low-Level Radioactive Waste Solutions[3] said that hospitals and clinics could be forced to stop nuclear medicine procedures to diagnose heart disease, detect cancer, or cure thyroid disease. In some cases, the organization said that physicians will choose other, less desirable, alternatives, such as ultra-sound, rather than referring a patient to another hospital for a nuclear medicine procedure. The organization also said that medical research on cancer, AIDS, Parkinson's disease, diabetes, and other illnesses could suffer. In 1993, the organization's chairman expressed concern that small hospitals where research is conducted could give up their nuclear departments and some therapy and research suppliers could go out of business.[4]

Alternatives Might Alleviate Some of the Storage Burden

NRC's regulations permit alternatives to alleviate storage or disposal for some commercially generated low-level waste. Small amounts of certain radioactive materials that are readily soluble or dispersible in water, for example, can legally be disposed of in sewer systems. Some generators that had not been using this alternative are now beginning to use it. The radiation safety officer at a hospital in California told us that the hospital began the legal disposal of radionuclides in the sewage system for the first time in 1993. The radiation safety officer for a hospital in Washington, D.C., told us that, when the District lost access to a disposal facility in 1993, he encouraged a variety of efforts for researchers at his institution, including legal sewage disposal. Furthermore, researchers at a medical college in New York have designed a method to dissolve radioactive animal carcasses used in medical research. According to the researchers, using this chemical process results in a solution that can then be disposed of into the sewer within permissible levels of radiation.

[2]The Problem of Disposing of Nuclear Low-Level Waste: Where Do We Go From Here? (EMD-80-68, Mar. 31, 1980).

[3]A coalition of national organizations formed to achieve progress in building new disposal facilities.

[4]The chairman was also president of the American College of Nuclear Physicians.

Others, however, have concerns about the increased disposal in sewage systems. Medical experts at some hospitals told us that they did not believe that disposing of radioactive wastes in sewage systems within legal limits is the best method of disposal. They said that this disposal method provides additional exposure to the public and, although the amounts disposed of are within permissible levels, the resulting exposure to the public is not as low as is reasonably achievable by disposing of wastes in a land disposal facility. Furthermore, we recently reported that nine sewage treatment plants were contaminated by radioactive materials appearing in the sewage sludge, ash, and related by-products that are sometimes used for agricultural and residential purposes, such as lawn and garden fertilizer.[5] Officials at the affected plants said that they had been unaware of the problem and had not tested for it. The full extent of the radioactive contamination at sewage treatment plants across the country is unknown, in part, because NRC has inspected only 15 of the approximately 1,110 NRC licensees that may discharge radioactive material to treatment plants to determine if a concentration problem exists. Furthermore, NRC did not have information on another approximately 2,000 licensees that discharge radioactive materials into sewers because inspections of these licensees are the responsibility of agreement states.

Another alternative, treatment by on-site incineration, might be attractive to waste generators for some waste if local opposition were not an issue. Local communities, however, may not always accept incineration facilities, and some generators may be concerned about taking possession of ash that contains radioactive elements from other waste generators. Some generators have used on-site incinerators to reduce their waste, particularly biodegradable waste, such as radioactive animal carcasses. However, because of local opposition, it may be difficult to build new incinerators or continue using existing ones. In 1984, for example, an engineering firm canceled its plan to build a low-level waste incinerator in Pennsylvania because of public opposition, and in 1994 the National Institutes of Health closed an incinerator in Bethesda, Maryland, because of public concern about emissions. Officials of the institutes said that the facility, which was used to burn medical waste, including some radioactive waste, met all permitting requirements, but they considered it more important to address the public's concerns.

The acting radiation safety officer for the institutes said that they are considering using a waste processor's incinerator in Tennessee.

[5]Nuclear Regulation: Action Needed to Control Radioactive Contamination at Sewage Treatment Plants (GAO/RCED-94-133, May 18, 1994).

Meanwhile radioactive animal carcasses are stored on-site in freezers. Although the Tennessee incinerator has been used by many waste generators, few have used it for low-level biomedical waste. Some generators of biomedical waste have said that they are concerned that their ash would be commingled inadvertently with that of others and they would receive radionuclides not allowed in their licenses when ash remaining from the burn is returned to them.

Another alternative, decay in storage, is available to medical licensees and others under certain conditions, including that candidate radioactive wastes must have radioactive half-lives of less than 65 days and that the waste generators must store the waste for a period of time equal to 10 times the material's half-life.[6] Several generators told us that this is a common practice; therefore, the extent to which its use could increase is undetermined.

Several waste processors said that new technologies for treating waste may be developed if waste processors can find not only technological solutions but also economic incentives to do so.

Limited Information on Generator Storage Capacity

With disposal unavailable to most waste generators, storage of wastes at generators' facilities is now increasing. However, no information is being collected on on-site storage of low-level waste on a nationwide basis. Although some individual state surveys have been conducted on the storage capacity of the generators, the data are inconsistent and therefore difficult to compare. We identified and reviewed surveys by five states on the storage of low-level radioactive waste. Because most of these surveys were completed between 1992 and 1993, the information in them is somewhat dated. Overall, storage capacity varies significantly. NRC and state officials, as well as generators, agree that nuclear utilities would generally have the most capability to store their waste and small medical research facilities in urban areas would have the least capability.

Moreover, neither NRC nor DOE—the two federal agencies that could provide a national perspective on low-level waste issues—currently have plans to collect such data. DOE officials said that the agency lacks the necessary authority. According to NRC officials, that agency has considered both the cost to collect this data and the potential usefulness of the data in its regulatory programs. NRC has concluded, the officials added, that

[6]Half-life is the time required for a radioactive substance to lose 50 percent of its activity by decay. In 10 half-lives, the waste has lost enough radioactivity that it is no longer regulated.

collecting the data would be costly and that the data would be of marginal value. Without some nationwide perspective on the status of on-site storage capacity and the trends, it may be difficult to determine whether federal agencies, like NRC and DOE which have some responsibilities in this area, need to improve measures to protect the public health and environment.

Caution Warranted in Considering Changes to the Existing State-Compact Approach

For reasons such as limited progress in developing new disposal facilities and related economic and environmental concerns, questions have been raised about the relative effectiveness of the current approach and alternative approaches to managing commercially generated low-level waste. Alternatives include, among other things, providing federal incentives or penalties to states, or making the federal government or the private sector responsible for commercial low-level waste disposal. Alternative approaches, however, should be viewed with caution. Supporters of the current program believe that exploring other approaches could undermine support for the state-compact approach and the progress that many compacts and states have made. Furthermore, other approaches also appear to have similar difficulties that states have encountered such as obtaining political and public acceptance of disposal facilities.

Strong Support for the State-Compact Approach

States were instrumental in shifting responsibility for disposal of commercially generated low-level waste from private industry to compacts of states, because the states wanted control over the selection of sites for disposal facilities. After 14 years of experience with the state-compact approach, states support continuing the program and believe that they can be successful. Other affected parties, including some waste generators and developers/operators of disposal facilities, agree and offer reasons to continue with this approach.

As discussed earlier, by 1978, three of the six disposal facilities operated by private companies had been shut down. That year, President Carter established an interagency group to review the entire U.S. nuclear waste management program. In its March 1979 report, the group recommended, among other things, that either individual states or the federal government identify sites for disposing of commercially generated low-level waste within the framework of a national plan developed by, and agreeable to, federal and state governments.[1] According to the group, states commenting on a draft of its report generally supported development of a national plan; however, some states took a strong position against the federal government selecting sites for disposal facilities within their jurisdictions. Also, other states said that states should retain the right, within the concept of a national plan, to veto the selection of sites for disposal facilities within their jurisdictions.

[1]Report to the President by the Interagency Review Group on Nuclear Waste Management, DOE (Mar. 1979.)

At about the time of the report, selecting sites for new disposal facilities began to be seen as a state, rather than federal, responsibility. The governors of the three states with operating disposal facilities—Nevada, South Carolina, and Washington—testified to this effect before congressional committees. Also, officials in several states said that the political climate in their states might prevent them from acting to solve the problem of disposing of low-level waste; therefore, they said, developing new disposal facilities might only be possible if responsibility for selecting new sites is clearly fixed in law. Other states, however, wanted a federal solution because, in their view, public opinion would probably impede states' unilateral efforts to establish regional disposal facilities.

In 1980, task forces formed by states and other organizations agreed that a state-oriented solution was the best means of ensuring development of new disposal capacity. The task forces believed that the states would be in a better position than the federal government to protect their citizens' public health and safety. For example, the National Governors' Association task force on low-level radioactive waste disposal issued a report in November 1980 that stated, in part,

> "Since low-level waste is generated in every state, it is unfair to expect three states to shoulder the sole responsibility for the safe disposal of the entire nation's waste. Unlike high level waste, the problem is not so technologically complex that it requires the leadership of the federal government to manage it effectively. Because the states are primarily charged with protecting their citizens' health, safety, and environment, it is appropriate that they assume this responsibility. In addition, the public is more likely to accept siting and other waste management decisions made by state government than by a more remote, less accessible federal agency."

In addition, task forces formed by the National Conference of State Legislatures and the Conservation Foundation agreed with the National Governors' Association position on state control over siting disposal facilities for commercially generated low-level waste. Finally, the State Planning Council on Radioactive Waste Management, formed by the President to review nuclear waste issues, recommended that every state should be responsible for commercially generated low-level waste and that states should be authorized to enter into interstate compacts. This broad support and the unanimous endorsement of the National Governors' Association contributed significantly to enactment of the Low-Level Radioactive Waste Policy Act of 1980.

Despite what may be viewed as the slow pace of implementation of the 1980 act, as amended, state support for the disposal approach set out in that legislation appears to continue. For example, in October 1993, the Director, Natural Resources Group, National Governors' Association, said that the majority of states prefer to keep the current approach, because most states will not have to develop new disposal facilities. According to the director, alternatives to the current approach would have to come from the states themselves. The director added that staffs of the National Governors' Association and governors have raised the issue a few times in recent years; however, they concluded that it would be unwise to reopen the act because they are unsure of what would result. Currently, the National Conference of State Legislatures has a policy statement supporting the act, as amended.

Supporters of the state-compact approach maintain that most states have pursued, either in compacts or on their own, development of disposal facilities. The supporters also believe the act is designed to establish equity among states in handling the burden of waste disposal, and they do not see other alternatives that would accomplish this goal. Moreover, the supporters question whether the investments of states, developers, and waste generators would be lost—more than $320 million in the last 14 years—and point out that it would cost more time and effort to begin an alternative disposal approach. Furthermore, merely considering an alternative would, according to the supporters, give reluctant states an opportunity for further delay.

Those who support the current approach to disposal of low-level waste also said that more time is needed to show whether the approach can be successful. They point out that the strongest remaining incentive for states to develop disposal facilities—loss of access to existing facilities by waste generators—became effective only recently, after existing disposal facilities closed to waste outside their regions. In addition, states have flexibility for further consolidation of state-compacts, such as the Northwest Compact's arrangement to accept waste generated within the Rocky Mountain Compact and the recent formation of the proposed Texas-Maine-Vermont Compact.

Other Approaches to Managing Low-Level Waste Have Drawbacks

Representatives of some waste generators, states and state-compact organizations, environmental groups, and state and federal regulatory officials have expressed various degrees of dissatisfaction with progress on the development of new facilities for disposing of commercially generated low-level waste. Some of these officials suggested alternative approaches to managing or disposing of wastes; however, none had provided extensive analysis to show that the alternative could be more successful than the current approach. On the basis of our discussions with these parties and our collection and analysis of data related to management and disposal of low-level waste, we identified and analyzed the following general alternative approaches to management and disposal of commercially generated low-level waste:

- Modifying the state-compact approach by adding penalties and/or incentives to encourage timely development of new disposal facilities.
- Transferring responsibility for disposing of all or certain categories of low-level waste from states to the federal government.
- Returning the responsibility for disposing of low-level waste to private industry.
- Adopting alternatives to land disposal in the United States, such as storing waste; substituting shorter-lived radioactive materials or nonradioactive materials for radioactive materials, or banning the use of radioactive materials; and exporting low-level waste to other countries for disposal or disposing of waste in the oceans.

Although some of these alternatives have precedents, each appears to have drawbacks that could limit its effectiveness.

Still other representatives and officials advocate studying the management of commercially generated low-level waste and other types of nuclear waste on a comprehensive basis as a first step to determining if changes are needed in existing waste management legislation. In a bipartisan effort in 1994, 12 Senators, 27 Representatives, and numerous environmental groups separately asked the President for an independent, comprehensive review of the nation's nuclear waste programs, including commercially generated low-level waste. In their letters to the President, the proponents of an independent review asserted that nuclear waste has historically been addressed not on its hazardous nature or length of life, but by other, nonscientific delineations, such as the sources of the waste. The proponents believe that the country's nuclear waste programs deal with waste issues in a piecemeal fashion, and an integrated program would presumably be safer and more cost-effective. Such a review, they suggest,

should examine technical, managerial, and policy issues that make the nuclear waste problem so complex.

Adding Incentives or Penalties

One alternative approach to achieving the objectives in the low-level waste act is for the federal government to provide states with incentives, such as federal funding, to encourage progress, or to penalize states' lack of progress by withholding federal funds. Those proponents who suggested federal funds to assist the states, however, did not provide specifics on how such funds would improve states' programs to develop disposal facilities or how the funds would be made available.

Other proponents have suggested financial penalties, such as withholding funds to states that do not make measurable progress in developing new disposal facilities. The Low-Level Radioactive Waste Policy Act, as amended, tried this approach to a limited degree. The act required states to meet a series of milestones that would lead to the development of new disposal facilities by January 1, 1993. If a state did not meet a milestone, penalties included payment by waste generators within the state of a non-refundable surcharge and/or loss of rebates to states from an escrow account, managed by DOE and accrued from waste generators. From 1986 to 1992, DOE collected about $37 million in the escrow account. In 1993, DOE disbursed $26 million to states, including the final payment of $11 million to all but the 5 states without plans for future access to disposal facilities. The remaining $11 million will be returned to waste generators because the states and compacts did not provide any new disposal facilities by the January 1, 1993, deadline.

Assuming that states are in strict control of their siting efforts, financial incentives or penalites might have some impact. However, the process of selecting a site and developing a disposal facility is complex, controversial and, therefore, may be beyond a state's ability to strictly control in all cases. Since the surcharges have ended, the possibility has also been suggested that the federal government could withhold other federal funds, such as transportation funds, if states do not meet predetermined deadlines. Those proponents who have suggested this approach, however, have not addressed questions about equity and the effects that such an approach would have on programs for which the funds are typically provided.

Transferring Responsibility to the Federal Government

Some supporters have suggested making the federal government (probably DOE) responsible for disposing of commercially generated

low-level waste. First, there are precedents for the approach—DOE has been given responsibility for disposing of spent fuel from civilian nuclear power plants and the most radioactive class of commercially generated low-level waste. Second, this approach could permit selection nationwide of sites for new disposal facilities having superior geologic and technical qualifications rather than relying on qualified, but not necessarily outstanding, sites within many states. Third, federal sites might create less public opposition if all the waste is concentrated at remote locations. Last, the waste might be disposed of at one or more federal reservations that are already too badly contaminated to restore to unrestricted use. For example, some supporters suggested establishing regional collection and processing centers for low-level waste with disposal of the waste on federal lands that are dedicated to perpetual care, such as portions of DOE's Nevada Test Site, because of radioactive contamination. This alternative, according to its advocates, would spare uncontaminated public lands.

At first glance, federal responsibility for disposing of commercially generated low-level waste may appear attractive because of the existing precedents and the potential for disposing of this waste at already contaminated federal facilities.[2] Indeed, the Nuclear Waste Policy Act of 1982 assigned DOE responsibility for developing one or more geologic repositories for permanent disposal of spent fuel from civilian nuclear power plants and other highly radioactive waste. Moreover, amendments to that act in 1987 directed DOE to investigate one site—Yucca Mountain, Nevada—as a candidate site for a repository. If, after investigating that site, DOE determines that the site is suitable for a repository, it must recommend approval of the site to the President. Thus, in the Nuclear Waste Policy Act, as amended, the Congress directed that the site at Yucca Mountain be investigated for possible use as a site for a repository and established procedures for making a political decision on selecting the site following a technical determination on the suitability of the site.

However, establishing a similar method for federal disposal of commercially generated low-level waste may be more difficult for several reasons. First, as recognized by the task force of the National Governors' Association, disposal of commercially generated low-level waste is not so technologically complex that it requires federal management. Second, states with substantial federal lands have opposed efforts to place waste

[2]In 1992, for example, DOE disposed of its own low-level waste at its facilities in an amount about equal to 84 percent of all commercially generated low-level waste. The amount of low-level waste that DOE generates and disposes of may increase in the future as a result of its ongoing efforts to clean up its nuclear facilities.

disposal facilities within their borders. In 1991, 21 western governors said that the west had assumed a large part of the national waste management burden. The governors pointed out that a western state is the host to DOE's Waste Isolation Pilot Plant, which is a proposed repository for disposal of DOE's transuranic waste,[3] and the candidate repository site at Yucca Mountain. Also, at the time of the governors' statement, two of the three existing facilities for disposing of commercially generated low-level waste were located in the west. According to the governors, the west has been asked to shoulder a large part of the national waste burden, because of the region's geology, rainfall, and settlement patterns, while its environment and natural resources have been the lifeblood of the region. The governors said that the west should not sacrifice its environment to subsidize inadequate waste management practices in other parts of the country.

Third, it is unclear that the federal government could be more successful than states in obtaining public acceptance of new waste disposal sites. When states sought responsibility for developing facilities for disposing of low-level waste, they argued that they could meet the needs and concerns of their citizens better than the federal government. States said that federal control over the selection of sites for disposal facilities would be more difficult because of longstanding public distrust of federal nuclear waste activities. More recently, the Task Force on Radioactive Waste Management established by the Secretary of Energy Advisory Board concluded that, despite some progress, there continues to be widespread lack of trust in DOE's radioactive waste management activities.[4] On a pragmatic level, the task force said that public trust and confidence is generally essential for agencies to effectively carry out their missions.

The 1985 amendments to the low-level waste act made DOE responsible for disposing of the most hazardous class of commercially generated low-level waste. Thus, a modified method of placing disposal responsibility in the federal government is to make DOE responsible for disposing of still other, relatively hazardous, classes of low-level waste. The argument for this more modest federal assumption of disposal responsibility is that states might then find it easier to develop facilities for disposing of low-level waste that is relatively less hazardous. For example, the Illinois commission's decision in 1993 to reject a site for a disposal facility was, in

[3]Transuranic waste is discarded material (machinery, tools, filters, rubber gloves, paper, rags, sheet metal, glassware, and sludge from the reprocessing of nuclear fuels) contaminated with man-made radioactive elements having atomic numbers greater than uranium. The waste by-products of defense activities, such as plutonium, decay slowly and remain radioactive for thousands of years.

[4]Earning Public Trust and Confidence: Requisites for Managing Radioactive Wastes (Final Report of the Secretary of Energy Advisory Board Task Force on Radioactive Waste Management, Nov. 1993).

part, based on the commission's uncertainty over whether the proposed engineered facility would contain the long-lived waste that would have been disposed of in the proposed facility for the period of time—up to 500 years—that it would take for those radioactive materials to decay. On the other hand, federal assumption of responsibility for disposing of more commercially generated low-level waste would require the federal government to find a disposal solution for this waste and would not relieve the states of the need to develop facilities for disposing of the relatively large-volume classes of low-level waste with less concentrated long-lived materials.

For several years, the possibility that DOE would treat and dispose of mixed waste—low-level radioactive waste mixed with hazardous materials—has been under consideration. In November 1990, the Low-Level Radioactive Waste Forum requested that DOE explore this possibility. Although DOE has not made a decision on this request, in October 1994, DOE's Assistant Secretary for Environmental Management said that the agency, in consultation with states, would consider incorporating disposal of commercially generated mixed waste into plans that DOE is preparing for managing mixed wastes located at its nuclear facilities.[5]

Increased Private Sector Responsibility

Another alternative is increasing the private sector's responsibility for developing and operating disposal facilities similar to the role the private sector had previously. Before the Low-Level Waste Policy Act of 1980 was enacted, the private sector had developed, owned, and operated disposal facilities regulated by the states or NRC. However, environmental problems occurred at some facilities, and states in which some of these facilities were located opposed the use of these facilities by waste generators nationwide. For these and other reasons, states concluded that they could best control their own destinies by forming compacts and assuming responsibility for developing disposal facilities.

Private-sector responsibility for developing, owning, and operating disposal facilities for commercially generated low-level waste would be consistent with the role of the private sector in disposing of other waste materials, such as solid and hazardous wastes. Moreover, states' previous environmental concerns may have been addressed, to some extent, by

[5]Under the Federal Facility Compliance Act of 1992, by October 1995 DOE is required to submit plans for treating mixed waste at its facilities to EPA or authorized host states, obtain the states' or EPA's approval of the treatment plans, and enter into orders requiring its compliance with the approved plans.

NRC's issuance in 1982 of regulations governing development of disposal facilities. Finally, there is a recent precedent for private sector development of a low-level waste disposal facility. In 1988, the state of Utah, which belongs to the Northwest Compact, authorized a private company to develop and operate a disposal facility for certain kinds of high-volume, low-radioactivity low-level waste. The facility has since received licenses and permits required for the disposal of these wastes and operates under a resolution passed by the Northwest Compact. According to NRC officials, this facility does not accept routine operating waste from utilities. Moreover, the officials said that the bulk wastes that the facility does accept will not be accepted at most of the disposal facilities that states are developing.

For at least two reasons, however, having the private sector develop and operate disposal facilities does not appear to be a favorable alternative. First, that approach would end states' ability, provided by the compact approach of the 1980 act, as amended, to restrict access to disposal facilities located within their borders to waste generators within the compact in which the state is a member. Second, finding a site for and developing a disposal facility appears to be at least as difficult as it was before the act was passed.

Other Alternatives

Several other alternatives—from temporary storage to a ban on the commercial uses of radioactive materials—have also been offered. Critics of states' selections of candidate sites for disposal facilities, for example, have suggested that utilities store the low-level waste generated by operation of nuclear power plants at these plants and that all other low-level waste either be stored at nuclear power plants or some other central storage facility. Several states, including Connecticut, Illinois, Massachusetts, and New York, are considering such approaches, but none have adopted them.

There are, however, several potential problems with the storage approach:

- If medical and academic waste generators must pay for a centralized facility solely for their waste, they may, when possible, opt for less costly treatment or storage alternatives.
- Finding a central storage site could be as difficult as finding and developing a disposal site and facility if local residents do not perceive that a storage facility poses less risk to them than a disposal facility. Earlier experience with the concept of a central facility for storing spent

fuel illustrates this potential problem. In that case, some state, local, and environmental groups opposed DOE's plans to construct a storage facility because of concerns that the facility could become a facility for permanent storage of the spent fuel.

- A state with a centralized storage facility might not be able to prevent waste generators in other states from shipping their wastes to the central storage facility.
- Because some of the stored low-level waste would probably be hazardous for more than 100 years, disposal, rather than temporary storage, would eventually be required.

Because of the long half-lives of some radioactive materials that become low-level waste, some critics of current state efforts to develop disposal facilities have suggested that commercial firms substitute shorter-lived materials that can be stored until they decay to a harmless level and/or recycle the longer-lived materials. According to researchers in the medical and biotechnology community, however, the use of shorter-lived materials are not always an option in their research.

Representatives of some environmental groups have also recommended a moratorium on the generation of low-level waste until they are assured that the waste will be permanently managed in an environmentally sound manner. Such an approach would require a serious examination of the tradeoffs in reduced risk from nuclear waste compared to the reduced benefits from nuclear materials in society. For example, a moratorium might diminish the ability to conduct biomedical research. Adopting a moratorium would, in effect, require repealing the current policy—established in the Atomic Energy Act of 1954, as amended—of encouraging peaceful uses of atomic energy.

Finally, two alternatives that would result in the disposal of low-level waste outside the United States have been suggested. One such approach is shipping waste to another country. NRC has developed a proposed rule on licensing imports and exports of low-level waste for disposal. In commenting on the proposed rule, some state officials said that they are concerned that the rule might encourage waste exports at the expense of new domestic disposal facilities, and others did not see the need for the proposed rule in their states because waste could not move out of their compacts without their approval. Also, current international agreements discourage or prohibit this practice. All nations are required to do their best to ensure that nuclear waste is not exported unless the sending and receiving nation approves and the parties agree it is in their best interests.

A return to the earlier practice of dumping low-level waste in the Atlantic and/or Pacific Oceans is also an alternative. However, the Congress, in 1982, essentially banned ocean disposal, except for research purposes and, in November 1993, the United States was among the signatories to an international agreement banning ocean disposal of radioactive waste for at least 25 years.

Studies That Examine Economic Aspects of Low-Level Radioactive Waste Facilities

1. "Conceptual Design Report—Alternative Concepts for Low-Level Radioactive Waste Disposal," prepared for EG&G Idaho, Inc., and the Department of Energy (DOE) by Rogers and Associates Engineering Corporation, (DOE/LAW-60T, June 1987).

The report was provided by DOE's Nuclear Energy Low-Level Waste Management Program to assist states and compact regions in developing new low-level rad waste disposal facilities in accord with the Low-Level Waste Policy Amendments Act of 1985. The report provides conceptual designs and evaluation of six widely considered concepts for disposal. Among other things, costs were estimated for the preoperational, operational, closure, and institutional control periods of each facility's life cycle.

2. "Projected Costs and User Fees for Small-Volume Low-Level Radioactive Waste Disposal Facilities," by EG&G Idaho, Inc., for DOE, (DOE/LAW-91, 1991).

The report determines projected life-cycle costs and average user fees for low-level radioactive waste disposal facilities ranging in size between 10,000 and 60,000 cubic feet per year. These projected costs and fees are based on the life-cycle costs developed for a 235,000 cubic feet per-year facilities by the Conceptual Design Report—Alternative Concepts for Low-Level Radioactive Waste Disposal. Two computer models were used to project the life-cycle costs and user fees found in the report.

3. "Designs and Costs of Low-Level Waste Disposal Facilities" (EPRI, Aug. 1987, Interim Report).

The Electric Power Research Institute commissioned a project to investigate important aspects of several generic low-level radioactive waste disposal technologies. Among other things, disposal cost estimates for six generic disposal technologies are presented.

4. Automated Pricing Schedule, "National Low-Level Waste Management Program by EG&G Idaho, Inc. (DOE/LLW-97, May 1993).

The automated pricing schedule is an interactive computer model for evaluating the economics of developing, operating, and closing a low-level radioactive waste disposal site.

5. "Economics of a Small-Volume Low-Level Radioactive Waste Disposal Facility" for DOE by Dames and Moore (Jan. 14, 1993).

This report presents the results of a life-cycle cost analysis of a low-level waste disposal facility, including all support facilities, beginning in the pre-operational phase and continuing though post-closure care. The disposal technology selected for this report is earth covered, concrete vaults, which use reinforced concrete vault constructed above-grade and an earth cover constructed at the end of the operational period for permanent closure.

6. "LLRW Disposal: Economies of Scale and Waste-Type Segregation" by Clark W. Bullard and Hans T. Weger in Energy Systems and Policy, Vol. 14., pp. 227-236, (1990).

The article examines the underlying cost structure of an advanced low-level radioactive waste disposal technology that is typical of those being designed for most states and compacts. The article includes concrete canisters placed in an above-ground, earth-mounded concrete vault. Among other things, the article discusses the issue of consolidating sites by examining the relative magnitude of the fixed and variable costs.

7. "The Failure of 'Equity, Then Efficiency': U.S. Policy on Low-Level Radioactive Waste Disposal," Dennis Coates, Victoria Heid, and Michael Munger (June 1, 1992, revised Dec. 15, 1992).

The paper was prepared by an assistant professor in the Department of Economics, a graduate student in the MPA-Public Policy Analysis program, and an associate professor in the Department of Political Science at the University of North Carolina-Chapel Hill. This paper reviews the "equity" and "efficiency" issues related to low-level radioactive waste disposal policies and presents preliminary estimates of the "efficient" number of facilities for the disposal of the nation's low-level radioactive waste.

Radiation Risk Related to NRC's Standard for Low-Level Waste Disposal and EPA's Concern About the Standard

The Nuclear Regulatory Commission's (NRC) licensing requirements for land disposal of low-level waste state that concentrations of radioactive material that may be released to the general environment must not result in an annual dose exceeding an equivalent of 25 millirems[1] to the whole body of any member of the public. That dose, we estimate, could result in an estimated lifetime risk of premature cancer death of 1 in 1,000.[2] In comparing 26 federal standards or guidelines on public radiation exposure, the low-level waste standard was one of the lower ones. The estimated lifetime risk of premature cancer death ranged from 1 in 40 (the Environmental Protection Agency's (EPA) Superfund cleanup standard) for EPA's indoor radon guidance to a risk goal range of 1 in 15,000 to 1 in 1.5 million.

The radiation standards that have been developed for various purposes reflect a lack of overall interagency consensus on how much radiation risk to the public is acceptable. Because the standards have different regulatory applications and are based on different technical methodologies, the estimated risks to the public that are associated with these standards and guidelines vary considerably.[3]

Regarding low-level waste standards, NRC has established licensing requirements for land disposal of low-level waste, but EPA is responsible for establishing general criteria and numerical standards applicable to nuclear waste management activities. EPA has not completed the standards for a number of reasons.[4] The standards are being re-drafted, and EPA was seeking public comments through April 12, 1995, on a published, preproposal draft. Afterwards, EPA will follow its internal clearance process and seek review from other federal agencies before publishing proposed standards in the Federal Register for formal comment. In an October 1994 letter, EPA's Director, Office of Radiation and Indoor Air, told NRC's Director, Office of Nuclear Material Safety and Safeguards, that there is a significant gap in NRC's regulations for low-level waste disposal. The EPA official said that the issue must be addressed for EPA to conclude that NRC regulations provide a sufficient level of protection of public health and

[1]The standard also refers to annual limits of 75 millirems to the thyroid and 25 millirems to any other organ of any member of the public.

[2]The estimated risk is derived from commonly used assumptions, e.g., a cancer death risk of $5x10^{-4}$ per rem to an individual continuously exposed over a 70-year lifetime.

[3]Nuclear Health and Safety: Consensus on Acceptable Radiation Risk to the Public is Lacking (GAO/RCED-94-190, Sept. 1994).

[4]Radioactive Waste: EPA Standards Delayed by Low Priority and Coordination Problems, (GAO/RCED-93-126, June 1993)

the environment. The Director said that NRC's regulation does not specifically address groundwater protection and could allow a disposal facility to cause radioactive contamination of groundwater to levels that would require treatment before it could be used as drinking water. Thus, EPA said that NRC's regulation is inconsistent with EPA's groundwater protection policy which says that maximum contaminant limits under the Safe Drinking Water Act shall be used as reference points for water resource protection efforts when the groundwater in question is a potential source of drinking water.

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Related GAO Products

Nuclear Waste: Connecticut's First Site Selection Process for a Disposal Facility (GAO/RCED-93-81, Apr. 5, 1993).

Nuclear Waste: New York's Adherence to Site Selection Procedures Is Unclear (GAO/RCED-92-172, Aug. 11, 1992).

Nuclear Waste: Slow Progress Developing Low-Level Radioactive Waste Disposal Facilities (GAO/RCED-92-61, Jan. 10, 1992).

Nuclear Waste: Extensive Process to Site Low-Level Waste Disposal Facility in Nebraska (GAO/RCED-91-149, July 5, 1991).

Energy Reports and Testimony: 1990 (GAO/RCED-91-84, Jan. 1991).

Energy: Bibliography of GAO Products January 1986-1990 (GAO/RCED-90-179, July 1990).

Nuclear Regulation: The Military Would Benefit From a Comprehensive Waste Disposal Program (GAO/RCED-90-96, Mar. 23, 1990).

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