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URANIUM MILL TAILINGS

Cleanup Continues, but Future Costs Are Uncertain





United States
General Accounting Office
Washington, D.C. 20548

**Resources, Community, and
Economic Development Division**

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Congressional Recipients

As part of our basic legislative responsibilities, we reviewed the costs and current status of the Department of Energy's (DOE) program for cleaning up uranium mill tailings, conducted under the authority of the Uranium Mill Tailings Radiation Control Act of 1978 (P.L. 95-604). Although the act directed that the cleanup be completed by March 1990, the Congress subsequently extended this deadline twice. Because the current legislative authority expires on September 30, 1996, we are providing this report in anticipation of congressional deliberations on reauthorizing this program. The act made DOE the primary federal agency for managing the program and assigned regulatory responsibilities to the Environmental Protection Agency and Nuclear Regulatory Commission.

This report contains matters for consideration by the Congress concerning DOE's authority under the program. It also contains a recommendation to the Nuclear Regulatory Commission aimed at improving the accuracy of the one-time charge made to owner/operators to ensure that this charge fully covers future costs at their sites.

Please call me on (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix I.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'Victor S. Rezendes'.

Victor S. Rezendes
Director, Energy and
Science Issues

B-261528

List of Recipients

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B-261528

The Honorable David M. McIntosh
Chairman

The Honorable Collin C. Peterson
Ranking Minority Member

Subcommittee on National Economic Growth,
Natural Resources, and Regulatory Affairs

Committee on Government Reform and Oversight
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Executive Summary

Purpose

Decades of processing uranium ore for use in the government's nuclear weapons and energy programs resulted in the accumulation of radioactive wastes at about 50 ore processing sites and about 5,000 nearby properties in various states and on some Indian tribal lands. When the government's need for uranium for defense purposes dwindled in the late 1960s, many of the processing operations ceased, and huge piles of contaminated mill tailings (a sand-like by-product of ore processing) were left in place and spread to nearby properties, posing potential health risks. Accordingly, the Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978, which authorized the Department of Energy (DOE) to clean up contamination at the processing sites. In 1979, DOE developed its Uranium Mill Tailings Remedial Action project. This project has two key components: cleanup of the surface and cleanup of the groundwater.

Because DOE's authority for the surface cleanup will expire at the end of fiscal year 1996, GAO is providing the Congress with information on (1) the status and cost of DOE's surface and groundwater cleanups and (2) factors that could affect the federal government's costs and liabilities in the future.

Background

The Uranium Mill Tailings Radiation Control Act of 1978 authorized the cleanup of the nation's uranium ore processing sites. Title I of the act governs the cleanup of sites that were already inactive at the time the legislation was enacted (referred to in this report as Title I sites); title II covers the cleanup of sites that were still active at that time (referred to as Title II sites). Under the act, DOE is to clean up the Title I sites and nearby properties affected by the contamination, mostly at its expense, but the affected states are to contribute 10 percent of the actual cost of the remedial actions. The Title II sites are to be cleaned up mostly at the expense of the private companies that own and operate them and then turn them over to the federal government or states for long-term custody. Before a Title II site is turned over to federal or state custody, the Nuclear Regulatory Commission (NRC) is responsible for entering into financial arrangements with the owners/operators that provide sufficient funds to cover the costs of necessary long-term monitoring and maintenance at the sites.

After studying the 24 Title I sites that required cleanup, DOE established priorities—high, medium, and low—for cleaning up the sites, based on the severity of their potential risk to public health. DOE used these priorities to help determine the order in which cleanup would begin at the sites.

Results in Brief

DOE anticipates completing the cleanup of both surface and groundwater contamination from uranium mill tailings by about 2014 at a cost of over \$2.4 billion.¹ At DOE's 24 Title I sites, surface cleanup is complete at 15 sites, is under way at another 7, and has not yet started at the remaining 2. Approximately 5,000 nearby properties, including homes, schools, and businesses, have also been cleaned up. The cost of the surface cleanup to date totals about \$2 billion. The Department anticipates that, if provided a 2-year extension of its authority for the surface cleanup, it can complete its responsibilities in 1998 at an additional cost of about \$300 million. DOE is currently seeking reauthorization of its surface cleanup program through fiscal year 1998. Because the Department initially focused on the surface cleanup and because of a delay in the issuance of EPA's final groundwater standards, DOE postponed the start of its groundwater cleanup until 1991. Since then, the Department has primarily studied the sites and developed groundwater cleanup strategies. It has not reached agreement with the affected states and tribes on the cleanup strategies to be used or reaffirmed the states' financial support for the project. However, on the basis of its proposed "least-cost" strategies, DOE estimates that its efforts to clean up the groundwater will cost at least another \$147 million.

Various factors could affect the future federal costs and ultimate completion dates of both the surface and groundwater cleanups. Among these factors are whether (1) DOE will keep open a portion of one disposal site to dispose of tailings unearthed during future work on roads and utilities and (2) the affected states will provide their 10-percent share of the groundwater cleanup expenses. Depending on their outcome, these factors could add millions of dollars and years of work to the cleanup effort. Furthermore, the assumptions that underlie NRC's minimum charge to the owners/operators of the Title II sites for long-term surveillance has not been reviewed and updated to reflect the current cost of basic surveillance and does not include the cost of the routine, ongoing maintenance that may be needed at each site.

¹All dollars are present-value 1995 dollars, unless otherwise noted.

GAO's Analysis

Status and Cost of Surface and Groundwater Cleanups

After several schedule extensions and increases in the project's costs, DOE currently plans to complete its surface cleanup responsibilities in 1998, at a total cost of about \$2.3 billion. For the most part, DOE has completed the surface cleanup at those sites that posed the greatest potential health risk to the public (e.g., sites located near major population centers). At most of the other sites, DOE's cleanup efforts are well under way.

In January 1995, DOE estimated that the total cost of the surface cleanup at the Title I sites will be about \$2.3 billion, or \$621 million more than it estimated for cleanup in 1982. The increase in the cost of the surface cleanup was caused by unexpected growth in the project's size and complexity. According to DOE officials, this growth came through several avenues. For example, changes in federal requirements resulted in additional work and costs for DOE. To comply with new groundwater standards, in particular, DOE had to change the location and design of many waste disposal cells (containment areas where the tailings are enclosed and stored). Furthermore, as its cleanup work progressed, DOE identified more contamination than its original surveys had projected—more in terms of both the quantity of tailings and the number of nearby properties that needed to be cleaned up.

DOE's groundwater cleanup work began in 1991, and by June 1995 the Department had spent about \$16.7 million on planning and developing its strategies for the cleanup. DOE's next step is to consider the views of the affected states and Indian tribes and select the final methods that will be used to clean up the groundwater at each site. If the least-cost strategies that DOE has proposed are adopted, the Department anticipates completing its groundwater cleanup in about 2014, at a minimum cost of about \$147 million.

Factors That May Affect Project's Future Costs

Various factors may affect the project's future costs. For example, one factor that could affect these costs is how the project resolves the issue of what to do with the mill tailings in Grand Junction, Colorado, which are now buried under streets and utility corridors, but which may be unearthed during future excavations for repairs. One possible solution is to keep a portion of the Grand Junction site's disposal cell open to deposit any tailings that are unearthed during such repairs. However, according to

DOE, it would need legislative authority to keep a portion of the cell open after its authority for the surface cleanup has expired. Furthermore, keeping a portion of the cell open could result in additional costs of several hundred thousand dollars annually over the next 20 years.

Regarding groundwater cleanup, DOE does not know whether the states will be willing and able to provide their 10-percent share of the cost of the remedial actions. One state has already voiced concern that its legislators may not provide funding for the groundwater cleanup. If the states do not provide their share of these costs, DOE believes it does not have the congressional authority to proceed with the cleanup.

Finally, NRC's minimum charge for long-term surveillance is based on the assumption that the annual cost of surveillance will be \$5,300 per site (in 1995 dollars). NRC's charge has not been revised and updated since the basis for the charge was developed in 1980. DOE estimates that the current cost of annual surveillance is \$16,000 per site (in 1995 dollars). In addition, DOE estimates that the cost of annual maintenance at each site will be about \$5,000 (in 1995 dollars), but NRC's minimum charge was based on the assumption that ongoing maintenance would not be required.

Matters for Congressional Consideration

GAO is raising matters for the Congress's consideration concerning (1) the Department of Energy's lack of authority to keep open a portion of the Colorado disposal cell and (2) whether and under what circumstances the Department can complete the cleanups when the states do not contribute their share of the cleanup costs. The complete text of these matters for congressional consideration is found in chapter 3.

Recommendation

To provide a realistic indication of the future costs of long-term monitoring and maintenance, GAO recommends that the Commissioners of the Nuclear Regulatory Commission direct its staff to consult with the Department of Energy to develop an accurate estimate of these costs and what they entail, and use that information to (1) update the minimum one-time charge for basic surveillance and (2) determine whether routine maintenance will be required at each site, and, if so, incorporate the cost for such maintenance into the minimum charge.

Agency Comments

GAO provided copies of a draft of this report to the Department of Energy, Environmental Protection Agency, and Nuclear Regulatory Commission

for their review and comment. Officials from all three agencies expressed general agreement with the report's findings.

GAO met with officials of the Department of Energy, including the Office Director, Office of Southwestern Area Programs, who generally agreed with the report's findings and provided technical clarifications that have been incorporated into the report where appropriate. The Environmental Protection Agency's Deputy Director, Federal Guidance, from the Office of Radiation and Indoor Air, also generally agreed with the report's findings and provided technical clarifications that have been incorporated where appropriate.

GAO met with officials of the Nuclear Regulatory Commission, including the Chief of the High-Level Waste and Uranium Recovery Projects Branch, who generally agreed with the report's findings. However, in commenting on the report's recommendations, these officials said that they are not certain that the assumptions NRC used to estimate the one-time charge for basic surveillance are invalid; however, they are reexamining the issue. These officials fully agreed with the report's recommendation to determine if routine maintenance will be required at each site and incorporate any resulting costs into the one-time charge. According to these officials, they have taken a number of steps, described in chapter 3, to ensure that this recommendation will be successfully implemented. Technical clarifications provided by these officials have also been incorporated into the report where appropriate.

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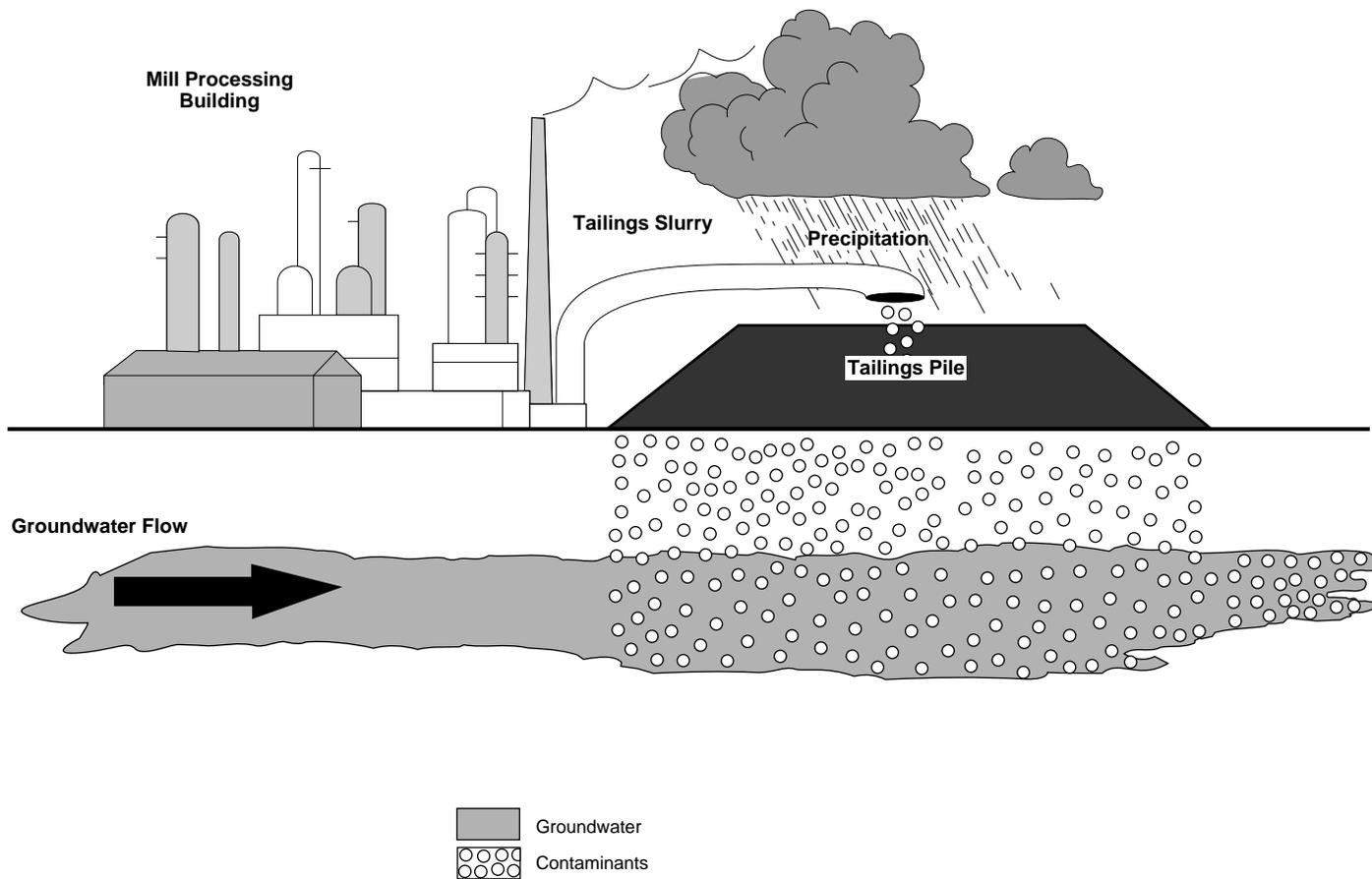
DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
UMTRA	Uranium Mill Tailings Remedial Action project

Introduction

At over 50 sites, mostly in the southwestern United States, widespread contamination of both land and groundwater resulted from uranium ore processing operations that took place from the early 1940s throughout the 1960s. During that period, most of the nation's uranium mining and milling (ore processing) activities were conducted by private companies for the Atomic Energy Commission (the Department of Energy's predecessor). Uranium ore was crushed and processed for use in developing weapons and in the emerging nuclear energy industry. But for every ounce of uranium that was extracted from ore, 99 ounces of waste were produced in the form of mill tailings—a finely ground, sand-like material. By the time the government's need for uranium peaked, tons of mill tailings had been produced at the processing sites. After fulfilling their government contracts, many companies closed down their uranium mills and left large piles of tailings at the mill sites.

The abandoned piles of uranium mill tailings contain radioactive wastes and other hazardous materials that had been used in the uranium extraction process. Despite the potential health risks, some mill operators left the piles of tailings uncovered and exposed to the elements. As a result, the tailings were spread—by wind, water, and human intervention—thus contaminating properties beyond the mill. In some communities, citizens used the tailings as building materials for homes, schools, office buildings, and roads because the health risks were not commonly known. Disposal of the tailings and the contaminated liquids from uranium processing resulted in contamination of the groundwater. In addition, because the piles of tailings were exposed to weather, in some cases the leaching effects of rain and snowmelt also contaminated the groundwater. Figure 1.1 shows how groundwater becomes contaminated.

Figure 1.1: Uranium Processing Cycle Showing Impact on Groundwater



Source: Department of Energy and Nuclear Regulatory Commission.

By the late 1960s, radiological research had determined that the abandoned mill sites posed a potential hazard to public health. Exposure to radioactive substances may cause cancer and other diseases, as well as genetic damage. The most hazardous constituent of uranium mill tailings is radium, which is radioactive. Radium produces radon, a radioactive gas whose decay products can cause lung cancer. In effect, the amount of radon released from a pile of tailings remains constant for about 80,000 years. Tailings also emit gamma radiation, which can increase the

incidence of cancer and genetic risks. Other potentially hazardous substances in tailings include arsenic, molybdenum, and selenium. The concentrations of these materials found in the tailings vary by site, ranging from 2 to more than 100 times the amounts naturally existing in soil. Concerns about the potential long-term adverse health effects of exposure to uranium mill tailings led to engineering and radiological studies that identified many abandoned uranium mill sites and nearby properties in need of cleanup.

Uranium Mill Tailings Radiation Control Act of 1978 Required Cleanup of Tailings

In November 1978, to provide a comprehensive regulatory scheme for the safe disposal of uranium mill tailings, the Congress passed the Uranium Mill Tailings Radiation Control Act of 1978 (P. L. 95-604). Title I of the act governed the cleanup of mill sites that were already inactive when the legislation was passed, referred to in this report as Title I sites; Title II governed the control and cleanup of milling operations that were still active at that time, referred to in this report as Title II sites. The act made DOE primarily responsible for the cleanup of the Title I sites and the operators/owners of the Title II sites responsible for cleaning up their own sites.

The act assigned responsibilities to three agencies: the Environmental Protection Agency (EPA), the Department of Energy (DOE), and the Nuclear Regulatory Commission (NRC). EPA was directed to establish standards for the cleanup and disposal of contaminated material from both inactive and active uranium processing sites. Under the act, as amended, EPA was to consider factors such as the risk to public health, safety, and the environment, and the environmental and economic costs of applying its standards. In January 1983, EPA issued standards for remedial actions at the Title I sites. Later that same year, EPA issued standards governing the Title II sites. These standards, except those concerning groundwater, were essentially identical to those adopted for the Title I sites.¹ In part, these standards limit the release of radon gas into the environment and require that the disposal method be designed to control radiological hazards “for up to one thousand years, to the extent reasonably achievable, and in any case, for at least two hundred years.”

Under the act, DOE was required to clean up all the Title I sites to EPA’s standards. The act created a plan of federal and state cooperation in which

¹Both sets of standards were challenged by several parties in the U.S. Circuit Court of Appeals for the Tenth Circuit. The Court upheld all aspects of the standards except the groundwater standards for the Title I sites. In 1987, EPA proposed new groundwater standards for these sites. Final groundwater standards were not issued until January 1995.

the federal government, in conjunction with those states where the Title I sites were located, would enter into cooperative agreements for cleaning up the sites. The act directed DOE and the participating state, with the concurrence of NRC, to jointly select the method and perform the cleanup. The states are responsible for 10 percent of the actual cost of remedial actions.

NRC, working with EPA, was required to establish regulations governing the control and cleanup of the mill tailings and land at the Title II sites. These sites, generally owned and operated by private companies, are licensed by NRC or by the state in which they are located. NRC was to ensure that its regulations conformed to EPA's general standards and to implement and enforce those standards. Generally, once these sites are cleaned up, they will be turned over to DOE for long-term monitoring and maintenance.

NRC is also responsible for ensuring that before the federal government takes custody of a Title II site,² it makes financial arrangements with the owners/operators that are adequate to cover the costs for any necessary long-term monitoring and maintenance. Such arrangements are to ensure that the owners/operators, not the federal government, bear these costs.

DOE Is Managing Cleanup of Title I Sites

Under title I of the act, in 1979 DOE established its Uranium Mill Tailings Remedial Action project (UMTRA) to manage the cleanup and disposal of the tailings at the 22 inactive mill sites designated in the act and at 2 additional sites located in North Dakota that DOE designated.³ In managing the cleanup of these 24 sites, DOE is responsible for all decisions about the project, for reviewing and supervising work done by its contractors, and for coordinating the cleanup with the affected states, Indian tribes, and local governments.

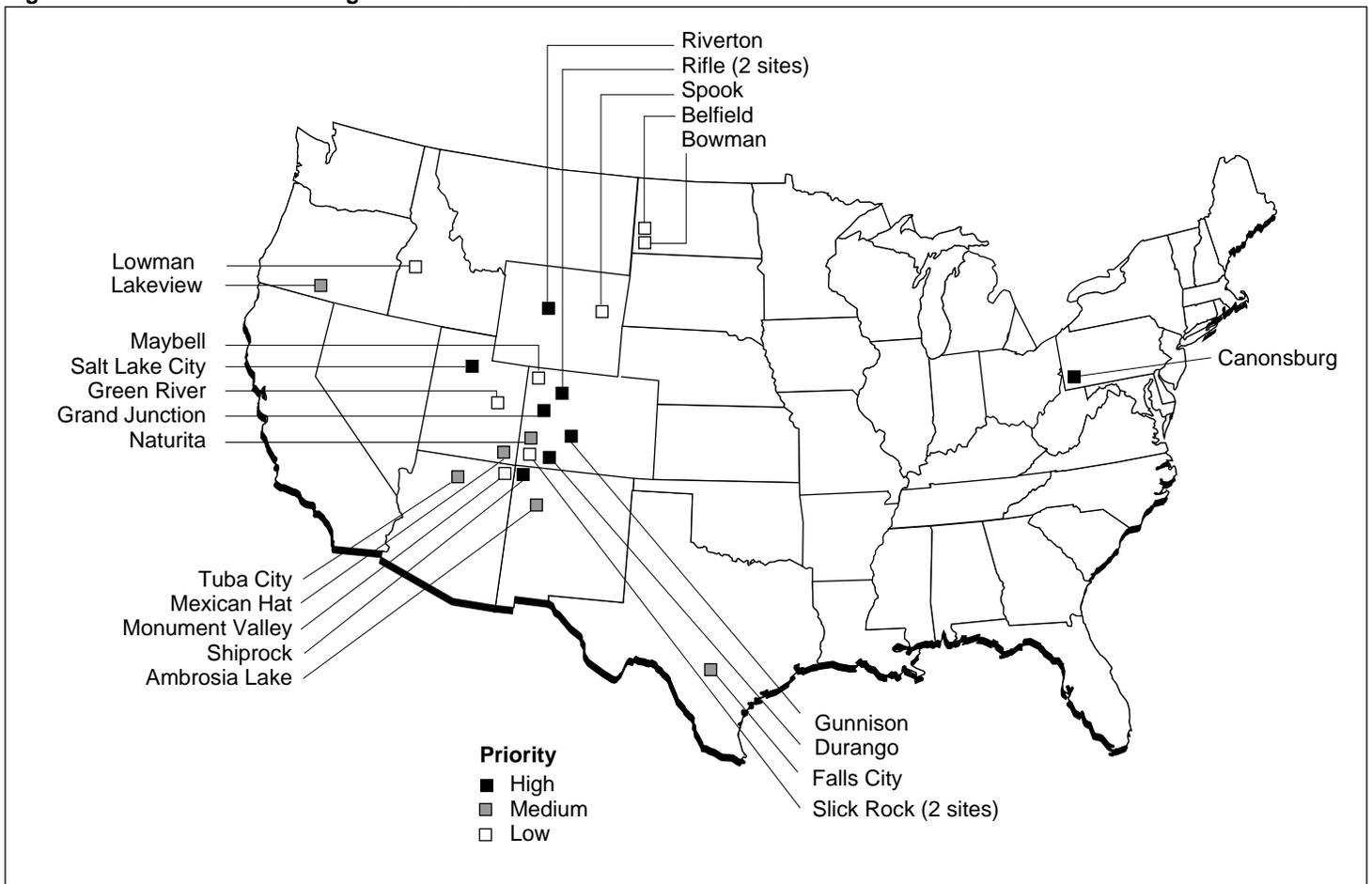
For each of the sites, DOE assessed the potential health hazard to the public from the tailings and, on the basis of this assessment, established a cleanup priority for the site of either high, medium, or low. DOE used these priorities to help determine the order in which the cleanup would begin at the various sites. However, the priority ranking was not intended to

²State governments may elect to assume custody of the Title II sites. However, DOE does not expect any states to assume this responsibility.

³Unlike most of the other Title I sites, the two North Dakota sites were not uranium mill processing sites. Rather, both were sites at which uraniumiferous lignite (brown coal containing uranium) was burned in the 1960s. Uranium-rich ash from the kiln process was loaded into rail cars at the sites and transported to uranium mills in Colorado and New Mexico. Ash-contaminated soil remained at the sites.

prevent work from being initiated at the lower-priority sites before all the work was completed at the higher-priority sites. Although the cleanup priority was based on the risk to the public, all sites, regardless of this risk, must be cleaned up to the same standards. Figure 1.2 shows the 24 Title I sites, by priority.

Figure 1.2: Location and Ranking of Title I Sites



Source: Department of Energy.

DOE estimated that over 91 percent of the potential radiological health risks occurred at the nine sites that it had designated as high priority. In

turn, the six medium-priority sites represented about 8 percent of the radiological health risks, and the nine low-priority sites posed less than 1 percent of the risks. DOE believed that the greatest health risks were at the 5,000-plus properties in the vicinity of the sites—homes, schools, and other buildings contaminated by tailings and referred to by DOE as “vicinity properties”—because the likelihood of exposure to radon is greatest when radon gas is concentrated in enclosed structures.

Two years after passing the Uranium Mill Tailings Radiation Control Act, the Congress established a different method of setting the cleanup priorities. Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, or Superfund, potentially hazardous waste sites are screened to determine those whose contamination and risk are serious enough to warrant their inclusion on the National Priorities List. This list is composed of sites considered to present the most serious threats to public health and the environment. Once a site has been included on the list, however, its relative risk does not routinely play a part in determining the site’s priority for cleanup. Other factors, such as how long a site has been on the list, have influenced the cleanup priority.⁴

Under UMTRA, DOE pays most of the costs of cleaning up the Title I sites, and the owners/operators of the Title II sites generally pay completely for the cleanup of their sites.⁵ Under Superfund, hazardous waste generators and transporters, as well as a site’s owners/operators, are potentially responsible for either cleaning the site up or reimbursing the government for its cleanup efforts.

Extent of Surface and Groundwater Contamination at Title I Sites

The extent of surface and groundwater contamination varied greatly among the 24 Title I sites. In the aggregate, about 3,900 acres of ground were contaminated with uranium mill tailings and other contaminants, ranging from 21 acres at the Spook, Wyoming, site to 612 acres at the Ambrosia Lake, New Mexico, site (including areas contaminated by windblown material). Furthermore, these 24 Title I sites contained about 39 million cubic yards of surface contaminants, ranging from 58,000 cubic yards at the Belfield, North Dakota, site to over 5.7 million cubic yards at the Falls City, Texas, site.

⁴Uranium mill tailings sites that are being cleaned up by DOE under Title I are exempt from Superfund.

⁵P.L. 102-486 requires DOE to reimburse these owners/operators for the cost of the remedial actions attributable to mill tailings generated as in conjunction with sales to the United States. However, the total reimbursement for all owners/operators has a maximum limit.

The groundwater at many Title I sites is also contaminated with radioactive and other elements, such as metals and nitrates. These contaminants can pose risks to human health if the contaminated groundwater is used for drinking water. Although the groundwater is not currently serving as drinking water at any of the Title I sites, groundwater constitutes an important source of drinking water in much of the arid Southwest, where most of these sites are located. For example, according to EPA, nearly half of the drinking water consumed in Arizona and New Mexico and 20-30 percent of the water consumed in Utah, Colorado, Idaho, and Texas is groundwater.

DOE estimates that approximately 4.7 billion gallons of groundwater at the Title I sites is contaminated, but this estimate does not include all sites.⁶ Milling operations at the Mexican Hat, Utah, and Ambrosia Lake, New Mexico, sites introduced contaminated water into geological formations that did not previously contain water, but contamination of naturally occurring groundwater has not been observed at these two sites. At 21 of the other sites, however, seepage of contaminated water has affected naturally occurring groundwater. At the site with the highest level of groundwater contamination—Monument Valley, Arizona—an estimated 750 million gallons of groundwater were contaminated. The Lowman, Idaho, site is the only UMTRA site where groundwater contamination is not related to the mill processing operations. Furthermore, the groundwater contamination at that site does not exceed EPA's standards.

What Surface Cleanup Entails

The cleanup of surface contamination consists of four key steps: (1) identifying, or characterizing, the type and extent of contamination; (2) selecting and acquiring a disposal site; (3) developing a remedial action plan, which describes the proposed cleanup method and specifies the requirements for the conceptual design and construction of the disposal cell (a containment area where the tailings are enclosed and stored); and (4) carrying out the selected remedial action. DOE and the affected states work together to select the disposal sites, taking into consideration factors such as the size and density of nearby populations and the existence of flood plains. Thus, the uranium mill site and the disposal site are not always the same. According to DOE, most of the off-site disposal sites are on federally owned land. However, if the selected disposal site is privately owned, the state in which the site is located acquires title to the land (except for sites on Indian lands, which remain with the tribe).

⁶This estimate is not complete because DOE has found that the level of contamination at some sites is difficult to quantify.

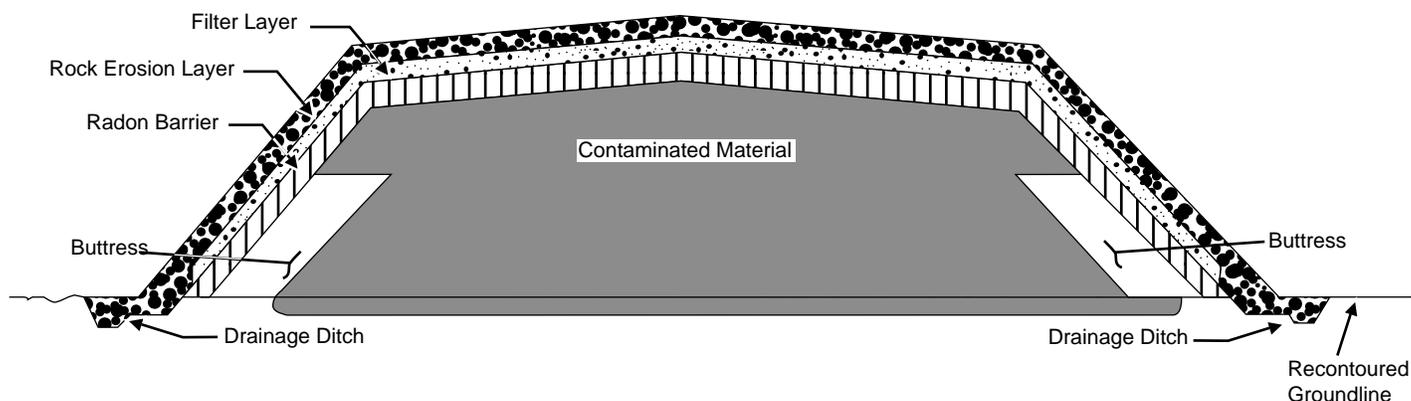
Before acquiring a disposal site, DOE generally completes a site characterization study. If disposal is to be on-site, this study identifies the type and extent of contamination at the site, as well as the geological structure and other features of the disposal site that may affect the placement or design of the disposal cell.⁷

While the site characterization study proceeds, DOE concurrently conducts the environmental assessments required by the National Environmental Policy Act and prepares the remedial action plan. This plan describes the proposed remedial action and lists the requirements for the design and construction of the disposal cell. NRC must concur with the final remedial action plan and with any subsequent changes to it.

Finally, the surface remedial action is performed according to requirements set forth in 40 C.F.R. 192 and DOE's approved remedial action plan. A contractor manages the day-to-day remedial action. Generally, the primary remedial action consists of containing the tailings in a disposal cell. First, the tailings are placed in the containment area, covered with compacted clay to prevent the release of radon, and then topped with rocks or a vegetative covering. When the surface cleanup is completed, DOE prepares a report to certify that the cleanup was completed in accordance with all applicable requirements. NRC reviews and, if it agrees, concurs with the certification of the remedial action. DOE then prepares a long-term surveillance plan. NRC reviews the plan, and if it approves the plan, issues an acceptance letter to DOE, thus bringing the site under a general license for long-term care. Once NRC has licensed a site, the site is transferred into DOE's custody for long-term surveillance and maintenance. Figure 1.3 is a diagram of a disposal cell.

⁷According to DOE, there should be no contamination to characterize at the relocated sites.

Figure 1.3: Diagram of a Disposal Cell



Source: Department of Energy

States and Indian Tribes Also Participate in Cleanup Process

The Uranium Mill Tailings Radiation Control Act requires that the affected states participate fully in the cleanup of the Title I sites and that affected Indian tribes be consulted, as appropriate, in the performance of the remedial action on their lands. The involvement of each affected state and tribe is defined through a cooperative agreement with DOE. This agreement establishes the funding, actions involving real estate, and requirements for the technical reviews necessary to perform the remedial action.

Each affected state is responsible for providing 10 percent of the cost of the remedial action for each of its sites and, if necessary, for acquiring title to the processing or disposal site. When the remedial action is complete, the state is required to transfer ownership of the disposal site (if it owns the site) to the federal government. Indian tribes are not responsible for paying any of the costs but participate in selecting disposal sites and proposing remedial actions.

DOE's Responsibilities Do Not End When Cleanup Is Finished

DOE's responsibilities do not end with the disposal of the tailings; the Uranium Mill Tailings Radiation Control Act requires DOE⁸ to monitor and maintain the sites to ensure their integrity over the long term. After each Title I site has been cleaned up and NRC has licensed it, the site is transferred to DOE's Long-Term Surveillance and Maintenance Program.

⁸Or another federal agency designated by the President.

DOE will be responsible for long-term surveillance and maintenance not only at the Title I sites but also at most, if not all, of the Title II sites.

Objectives, Scope, and Methodology

The objectives of our review were to provide the Congress with information on (1) the status and cost of DOE's surface and groundwater cleanups and (2) factors that could affect the federal government's costs and liabilities in the future.

To determine the status and cost of the surface cleanup program, we interviewed officials and reviewed documents on budget and status from several DOE offices: the Office of Southwestern Area Programs (in Germantown, Maryland), the Office of Environment/Project Management (in Albuquerque, New Mexico), the Uranium Mill Tailings Remedial Action Project Office (in Albuquerque, New Mexico), and the Grand Junction Projects Office (in Grand Junction, Colorado). We also interviewed several DOE project managers responsible for the sites. In addition, we interviewed numerous DOE contract specialists and reviewed the documents they maintained.

In addition to DOE officials, we also interviewed officials of and reviewed documents from NRC's High-Level Waste and Uranium Recovery Projects Branch and Office of State Programs (in Rockville, Maryland). We also interviewed an official and reviewed documents from EPA's Office of Radiation and Indoor Air. To obtain a state and local perspective, we also interviewed officials from Colorado, New Mexico, and Pennsylvania. We visited sites located in Canonsburg, Pennsylvania; Rifle, Colorado; and Grand Junction, Colorado. We also visited several vicinity properties located near the site in Grand Junction.

To determine the status and cost of the groundwater cleanup activities at the Title I sites, we interviewed officials and reviewed planning and budgetary documents for groundwater cleanup at DOE's Uranium Mill Tailings Remedial Action Project Office. In addition, we interviewed NRC officials from the High Level Waste and Uranium Recovery Projects Branch who have regulatory authority for the groundwater program. We also interviewed officials from EPA's Office of Radiation and Indoor Air.

To identify factors that could affect the federal government's costs and liabilities in the future, we interviewed officials and reviewed documents at DOE's Office of Southwestern Area Programs, Office of Environment/Project Management, Uranium Mill Tailings Remedial Action

Project Office, and Grand Junction Projects Office. (The Grand Junction Projects Office will be responsible for DOE's long-term surveillance and maintenance program as well as for DOE's groundwater program.) We also requested and received letters from DOE's Deputy General Counsel and NRC's General Counsel. In addition, we interviewed officials of NRC's High Level Waste and Uranium Recovery Projects Branch who are responsible for regulating both the Title I and II sites. We also interviewed Colorado state officials about long-term concerns they have about the tailings in Grand Junction, Colorado. Finally, we interviewed representatives of the National Mining Association (formerly the American Mining Congress), a major trade association that represents many owners/operators of the Title II sites.

We conducted our review between January 1995 and November 1995 in accordance with generally accepted government auditing standards. We provided copies of a draft of this report to DOE, NRC, and EPA and discussed the information in the draft report with officials from each agency. Officials from all three agencies generally agreed with the report's findings and provided technical clarifications that we have incorporated as appropriate. Additional details on the agencies' comments are contained in chapter 3.

UMTRA Project Has Grown in Size and Cost

Since its inception in 1979, the UMTRA project has grown in both size and cost. The surface cleanup at the Title I sites is almost complete, but it took DOE nearly 8 years longer than expected and cost 37 percent more than the agency anticipated. The schedule changes and cost increases resulted from several factors, including unexpected quantities and locations of tailings, changes in federal regulatory requirements, and state and local concerns. As for the cleanup of the groundwater at the Title I sites, efforts have only recently begun. DOE initiated groundwater cleanup at the Title I sites in 1991 and currently estimates completion in about 2014, at a cost of at least \$147 million.¹

Surface Cleanup Is Nearly Complete but Has Taken Longer and Cost More Than Anticipated

DOE is currently seeking reauthorization of the surface cleanup program through fiscal year 1998, or 8 years past the act's original deadline. When it was enacted in 1978, the Uranium Mill Tailings Radiation Control Act directed DOE to complete the cleanup of the Title I sites by March 1990 (7 years after EPA's standards became effective). The deadline for the surface cleanup was later extended through fiscal year 1994, and then still later, through 1996.² According to DOE, these extensions were necessary because of growth in the program's size and complexity. The Department currently expects that its surface cleanup will be completed by the beginning of 1997. DOE is working with NRC to expedite the licensing process so that all of the work is completed by the end of 1998.

As of October 1995, the surface cleanup was complete at 15 of the 24 Title I sites, was under way at 7 additional sites, and was being planned at another 2 sites. Of the 15 sites where DOE has completed cleanup, 3 have been licensed by NRC as meeting EPA's standards. Ten of the other 12 sites are working on obtaining an NRC license (e.g., preparing paperwork for submission to NRC or undergoing NRC's review or inspection).³ Additionally, DOE has completed the surface cleanup at about 97 percent of the 5,276 nearby properties—which DOE terms vicinity properties—included in the program as of October 1995.

¹These amounts, as well as all others in this chapter, have been converted to present-value 1995 dollars.

²Although DOE, through its 1992 planning process, requested that the program be authorized through fiscal year 1998, the Energy Policy Act of 1992 provided authorization only through 1996.

³According to DOE officials, unlike the other sites, the sites at Monument Valley, Arizona, and Riverton, Wyoming, will not be licensed because the tailings were relocated to either a Title I or a Title II site.

In January 1995, DOE estimated that the total cost of the surface cleanup at the Title I sites will be about \$2.3 billion,⁴ or \$621 million (37 percent) more than it estimated in 1982. Through fiscal year 1994, expenditures for the surface cleanup already totaled about \$2 billion, and DOE expects to spend another \$300 million in completing this cleanup. Of the total projected cost of \$2.3 billion, DOE expects to spend about 22 percent cleaning up the vicinity properties and the rest on cleaning up the 24 Title I sites.⁵ Through fiscal year 1995, the states will have contributed \$99.9 million, and they are expected to spend another \$29.6 million through the completion of the program as their share of the cleanup costs.

Table 2.1 summarizes the status and cost of the surface cleanup at the Title I sites and vicinity properties.

⁴In DOE's accounting system, this amount is reported as \$1.47 billion in what DOE terms "escalated" dollars.

⁵While DOE's budget system accounts for the two largest cost components of the cleanup at vicinity properties, it cannot fully itemize all these costs. As a result, according to DOE, the 22 percent of the total project cost that DOE expects to spend for cleaning up these properties is understated to a small extent.

Chapter 2
UMTRA Project Has Grown in Size and Cost

Table 2.1: Status and Cost of Surface Cleanup at Title I Sites, by Location

Site/Location	Actual/ estimated date of completing remedial action	Volume of contaminated materials (in thousands of cubic yards)	Acres of contaminated land	Disposal on site?	Number of vicinity properties	Cleanup costs (in millions of dollars) ^a		
						Expenses through fiscal year 1994	Estimated costs remaining	Total projected costs
High priority								
Durango, Colorado	5/91	2,534	127	No	130	\$ 119.11	\$ 1.25	\$ 120.36
Grand Junction, Colorado	8/94 ^b	4,655	114	No	4,381 ^c	654.03	92.05	746.07
Gunnison, Colorado	11/95 ^d	719	68	No	12	82.38	12.31	94.69
Rifle, Colorado (2 sites)	5/96 ^d	4,135	326	No	112	117.62	46.18	163.80
Shiprock, New Mexico	11/86	1,600	130	Yes	15	51.65	0.47	52.12
Canonsburg, Pennsylvania ^e	12/85	226	79	Yes	163	136.79	0.17	136.96
Salt Lake City, Utah	6/89	2,710	128	No	118	204.34	1.15	205.48
Riverton, Wyoming	9/90	1,793	140	No	42	92.07	0.06	92.14
Medium priority								
Tuba City, Arizona	5/90	785	327	Yes	1	53.52	0.77	54.29
Naturita, Colorado	9/97 ^d	547	247	No	37	31.40	39.50	70.90
Ambrosia Lake, New Mexico	7/95	3,759	612	Yes	5	54.35	9.03	63.37
Lakeview, Oregon	11/89	926	116	No	8	62.03	0.11	62.14
Falls City, Texas	7/94	5,764	593	Yes	13	68.63	1.91	70.54
Mexican Hat, Utah	2/95	2,810	250	Yes	11	79.99	6.54	86.53
Low priority								
Monument Valley, Arizona	3/94	942	83	No	4	38.30	1.05	39.35
Maybell, Colorado	1/97 ^d	3,500	214	Yes	11	23.03	32.93	55.96
Slick Rock, Colorado (2 sites)	12/96 ^d	573	139	No	13	23.09	30.95	54.04
Lowman, Idaho	6/92	128	30	Yes	38	28.84	0.02	28.86
Belfield, North Dakota ^f	12/96 ^d	58	31	No	7	20.64	20.94	41.58
Bowman, North Dakota ^f	12/96 ^d	128	71	Yes	1	1.09	1.56	2.65
Green River, Utah	12/89	382	48	Yes	17	39.25	0.34	39.58
Spook, Wyoming	9/89	315	21	Yes	2	20.33	0.05	20.39

(continued)

Chapter 2
UMTRA Project Has Grown in Size and Cost

Site/Location	Actual/ estimated date of completing remedial action	Volume of contaminated materials (in thousands of cubic yards)	Acres of contaminated land	Disposal on site?	Number of vicinity properties	Cleanup costs (in millions of dollars) ^a		
						Expenses through fiscal year 1994	Estimated costs remaining	Total projected costs
Other								
Edgemont, South Dakota ^g	Not available	Not available	Not available	Not applicable	135	13.43	0	13.43
Total		38,989	3,894		5,276	2,015.91	299.34	2,315.23

^aAll dollars are adjusted to present-value 1995 dollars.

^bProcessing site only.

^cIncludes 115 vicinity properties that were cleaned up under Grand Junction's remedial action program.

^dAnticipated completion date.

^eIncludes contaminated materials from the vicinity property in the Burrell, Pennsylvania, area.

^fThe collection of costs at the Belfield and Bowman sites was not consistent during fiscal years 1980-94; sometimes the costs for both sites were included in the totals for one site, and sometimes the costs were split. However, the combined costs are correct.

^gThe UMTRA project is responsible for cleaning up the vicinity properties only—the former uranium mill site in Edgemont is owned and was cleaned up by the Tennessee Valley Authority in the late 1980s.

As the table shows, among all of DOE's cleanup sites, the Grand Junction, Colorado, location stands out in several respects. Its projected cleanup costs are by far the highest, as would be expected since it had the second greatest volume of contaminated material and the greatest number of vicinity properties that needed cleanup.

The table also shows that the cost of cleaning up the high-priority locations was generally higher than the cost of cleaning up the medium-priority locations, which in turn was higher than the cost of cleaning up the low-priority locations. About 70 percent of the total projected costs will be incurred at the high-priority locations, about 18 percent at the medium-priority locations, and about 12 percent at the low-priority locations. On average, the projected cleanup cost is \$179.1 million for a high-priority location, \$68 million for a medium-priority location, and \$31.4 million for a low-priority location.

In general, at those locations where the tailings were taken off-site for disposal, the costs were greater than they were at the sites where the

tailings were kept on-site. Averaged over all locations, the estimated cost of off-site disposal is about \$130 million per location, compared with about \$55.6 million per location for on-site disposal.

With work completed at 15 of the 24 Title I sites, the bulk of the expenditures for surface cleanup have already been made, as shown in table 2.1. The estimated remaining costs make up only 13 percent of the projected total cost. For the most part, DOE has completed the surface cleanup at those sites that posed the greatest potential health risk to the public (e.g., sites located near major population centers). At most of the other sites, DOE's cleanup efforts are well under way.

Several Factors Increased Cost of DOE's Surface Cleanup

As DOE's surface cleanup at the Title I sites grew in size and complexity, its costs increased. In 1982, DOE estimated that the entire cleanup effort would cost about \$1.7 billion, but by 1992, its estimate had risen to \$2.3 billion.⁶ On the basis of studies it conducted in 1990 and 1992, DOE identified several factors that contributed to the cost increases. Among these factors were the (1) development of EPA's new standards to protect groundwater; (2) establishment or revision of other federal standards addressing such things as the transport of the tailings and the safety of workers; (3) unexpected discovery of additional tailings, both at processing sites and at newly discovered vicinity properties; and (4) changes made in cleanup strategies in response to state and local concerns. DOE has concluded that to varying degrees, each of these factors caused additional work, thus increasing costs.

Compliance With EPA's Groundwater Standards Required Changes in Surface Cleanup Strategies

One of the major factors that DOE identified as driving up the cost of its surface cleanups was EPA's establishment of groundwater standards, which were proposed in 1987 and finalized in January 1995. EPA developed these standards specifically for the UMTRA project.⁷ The standards addressed the likely types and levels of contamination associated with all

⁶The 1982 estimate assumed that the cleanups would be completed in 7 years and that only one pile of tailings would need to be relocated. However, the 1992 estimate assumed that the surface cleanup would be completed in 1998 and that 13 piles of tailings would need to be relocated. The two estimates, while different in some respects, are the best cost estimates that DOE had available.

⁷According to DOE, until the standards were finalized, it treated the proposed standards as final after 1987, as directed by section 275 of the Atomic Energy Act.

of the sites.⁸ The groundwater standards, which were applicable to all the Title I sites, set the maximum levels of contaminants allowed in the groundwater.

To comply with EPA's new standards, DOE had to ensure that each of its surface cleanup strategies would prevent the uranium and other contaminants in the tailings from entering and contaminating the groundwater underlying the site.⁹ DOE had to demonstrate compliance with the revised groundwater standards on the basis of numerical limits. Thus, at six sites, DOE either (1) removed the tailings to an off-site location rather than disposing of them on-site as planned or (2) changed the location of a planned disposal cell. For example, for the site at Naturita, Colorado, DOE plans to relocate the contaminated materials off-site because of their close proximity to the groundwater. DOE estimates that relocating the tailings from that site increased the cleanup cost by about \$12 million (in the years of the expenditure). In addition, at five other sites, DOE had to redesign a disposal cell and/or the cell's cover to comply with the new standards. At the Grand Junction, Colorado, site for example, DOE changed the location of the site and redesigned the disposal cell and its cover, resulting in a cost increase of about \$48 million between fiscal years 1983 and 1992 (in the years of the expenditure).

Compliance With Other Federal Requirements Also Increased Costs

Changes in other federal agencies' regulations required DOE to undertake additional cleanup activities and also resulted in cost increases. According to DOE, the Department had to comply with federal transportation requirements and health and safety requirements for workers. For example, because the tailings are residual radioactive material (which is classified as a hazardous material), DOE had to comply with the Department of Transportation's regulations governing the transport of hazardous waste. According to DOE, complying with the regulations added approximately \$11 million (in the years of the expenditure), or \$1.75 per cubic yard of tailings, to the cleanup cost at the Grand Junction, Colorado site.¹⁰ To comply with transportation requirements that mandated various

⁸The law required that the standards established under title I of the act provide protection that is consistent, to the maximum extent practicable, with the requirements of the Resource Conservation and Recovery Act of 1976, as amended. However, EPA's groundwater standards provided some flexibility; for example, allowing the groundwater to cleanse itself through natural flushing until the contaminants gradually decreased.

⁹Also, as discussed later, to comply with the new groundwater regulations, DOE had to clean up groundwater that had already been contaminated.

¹⁰DOE notes that because of the experience it gained at the Grand Junction site, the cost increases at other sites should be less than \$1 per cubic yard of tailings.

inspections, DOE, among other things, hired a full-time transportation compliance officer, provided additional training for truck drivers on handling hazardous material, and purchased additional insurance.

Furthermore, under the requirements for hazardous materials, DOE also had to follow the requirements of the Occupational Safety and Health Administration, among others. For example, DOE had to provide full-time employees with a 40-hour training course on operations involving hazardous materials. DOE estimates that providing such training added about \$600,000 (in the years of the expenditure) to the cost of cleaning up four Title I sites.

Discovery of Additional Tailings and Vicinity Properties Led to Additional Work and Increased Costs

The cleanup costs also increased because of the unexpected discovery of additional tailings at the sites. DOE's 1982 cost estimate was based on the assumption that about 19.3 million cubic yards of tailings would need to be cleaned up at the sites. By April 1995, this amount had doubled to 39 million cubic yards. According to DOE, the amount increased because the initial site characterization studies were limited. In addition, DOE had not anticipated the requirements it would need to meet when heavy metals and thorium were found at the sites. At some sites, these requirements increased the total amount of material to be cleaned up, which in turn increased the size of the needed disposal cell and the associated costs.

The vicinity properties also contributed to increased costs. As at many of the processing sites, DOE found more tailings than anticipated at some of the vicinity properties. For example, in Grand Junction, Colorado, the amount of tailings at the vicinity properties increased from an estimate of 747,000 cubic yards to almost 2 million cubic yards. Furthermore, additional vicinity properties were discovered, requiring cleanup work not included in the original estimate. In the early 1980s, DOE estimated that a total of 4,875 vicinity properties would need to be cleaned up. By October 1995, remedial actions were planned for 5,276 vicinity properties—an increase of about 8 percent.

State and Local Concerns Resulted in Changes in Cleanup Strategies, Thus Increasing Costs

State and local entities' concerns also affected the cleanup strategies selected and the attendant costs. For example, at the Grand Junction site, the local county's concern about safety led to the use of a train-and-truck method of transporting contaminated materials, rather than a cheaper truck-only method. Local officials wanted a transport system that avoided routing extensive truck traffic through heavily populated areas. The

train-and-truck method required the construction of railroad transfer facilities and the manufacture of specially equipped containers. According to a DOE estimate, changing to the train-and-truck method cost an additional \$28 million (in 1995 dollars) at the Grand Junction site.

The change to the train-and-truck method at the Grand Junction site also caused DOE to delay remedial action at three other Title I sites. According to a DOE program official, the additional unanticipated costs at the Grand Junction site required DOE to temporarily stop work at the Mexican Hat and Monument Valley sites and postpone planned work at the Ambrosia Lake site. DOE suspended work at the Mexican Hat and Monument Valley sites from February 1990 through December 1990, at an estimated cost of about \$5 million (in 1995 dollars). According to DOE, at the Ambrosia Lake site, the remedial action was delayed by over a year, from April 1990 until July 1991, costing about \$1.6 million (in 1995 dollars). In total, the change to the train-and-truck method at Grand Junction resulted in additional expenditures of about \$34 million (in 1995 dollars).

In addition, according to an analysis by DOE, concerns expressed by the state and by local communities influenced DOE to change from on-site disposal to more costly off-site disposal at several locations, including Grand Junction and Gunnison, Colorado; Salt Lake City, Utah; and Riverton, Wyoming. These changes resulted in cost increases because they required additional site characterization and engineering, as well as additional construction activity.

DOE has construed the states' role as that of a full partner in selecting and performing the remedial action for each site. Although DOE believed that it was necessary to make the changes discussed above in response to the states' concerns, DOE program officials acknowledge that the changes did result in some additional expenditures.

Groundwater Cleanup Is in Planning Stages

DOE began work on its groundwater cleanup in 1991. Currently, DOE expects to complete its groundwater cleanup by 2014, at an estimated cost of at least \$147 million, if the cleanup methods DOE has proposed are used. DOE's stated goal is to protect human health and the environment at the Title I sites by cleaning up the groundwater to EPA's standards. Although DOE has targeted potential groundwater cleanup strategies for the sites, it has yet to reach a final agreement with the affected tribes and states on what strategies will ultimately be used.

According to DOE officials, the Department will pursue those strategies that will enable it to comply with regulatory requirements at the least cost. Thus, wherever possible, DOE will either take no remedial action (leave the groundwater as it is) or allow the groundwater to cleanse itself through passive remediation (natural flushing) over time. Where necessary, DOE will use active remediation, such as pumping the groundwater out of the ground and treating it. DOE's proposed groundwater strategies call for taking no action at 13 sites, employing passive remediation at 9 sites, and using active remediation at 2 sites.

Status and Cost of DOE's Groundwater Cleanup Activities

DOE's groundwater cleanup effort is just beginning. Although EPA issued groundwater standards in 1983, the U.S. Court of Appeals for the Tenth Circuit remanded the standards to EPA. In 1987, EPA proposed new standards to replace those remanded. In 1988, Public Law 100-616 authorized DOE to clean up the groundwater at the Title I sites without any time limitation. DOE planned its groundwater program while the proposed rules were in effect. DOE began its groundwater cleanup effort in 1991. In January 1995, EPA published its final groundwater standards. Because the law established no deadline for completing the groundwater cleanup and because EPA had not issued its final standards, DOE delayed its efforts so it could concentrate instead on completing the surface cleanup, which had a fixed completion deadline. According to a Department official, DOE believed at the time that the groundwater cleanup would be expensive and lengthy. In addition, DOE believed it would have been inappropriate to begin the groundwater cleanup before the groundwater standards were finalized.

As of June 1995, DOE had spent about \$16.7 million on activities related to the groundwater cleanup. Most of these expenditures were for (1) technical and management support, such as planning activities, and (2) site characterization, such as studying the extent and type of contamination and assessing the associated health risk. Although the groundwater cleanup had not been completed at any of the Title I sites as of November 1995, DOE is forecasting that its sites will meet EPA's groundwater standards by 2014. On the basis of the cleanup strategies it will propose to the affected states and Indian tribes, DOE estimates that the groundwater cleanup will cost at least \$147 million.

As a major step in implementing its proposed cleanup strategies, DOE intends to modify its existing cooperative agreements with the affected states and Indian tribes to more explicitly address groundwater issues. DOE

intends to modify these agreements to reflect the needed funding, actions concerning real estate, and technical reviews necessary to perform the chosen remedial action. As of October 1995, DOE had not completed any modifications to the agreements with the affected parties.

In addition to modifying the cooperative agreements, DOE plans to obtain comments from the affected states and Indian tribes on a major planning document¹¹ that provides the framework for the groundwater cleanup program, as well as on other technical documents.¹² Once DOE has received comments from the affected states, tribes, and citizens on these documents, it plans to draft a remedial action plan for each site.

DOE's Proposed Cleanup Strategies Are Based on Risk Assessment and Applicable EPA Standards

DOE is currently formulating groundwater cleanup strategies that will comply with EPA's standards, on the basis of health and environmental risk assessments and the potential use of the water. According to EPA's groundwater standards, DOE should apply the most cost-effective cleanup remedies available to meet these standards at each site. The standards establish concentration limits for those contaminants expected to be found in the groundwater as a result of uranium processing at the sites. According to DOE, EPA set the following four standards for DOE's use:

- Maximum concentration limits. This standard is intended to protect human health and the environment from the many contaminants that can occur at a site. For each contaminant, the standard establishes a maximum concentration limit. For a site to meet this standard, these limits cannot be exceeded.
- Alternate concentration limits. Under this standard, contamination levels can be higher than those allowed under the standard for maximum concentration limits. DOE may apply to NRC to use the alternate standard if it can demonstrate that human health and the environment are still protected, even though the contamination levels exceed the maximum concentration levels.
- Background level. This standard may apply at sites where nearby water, while not contaminated by contaminants resulting from uranium processing, is of naturally poor quality (e.g., because of high levels of mineral concentration). If the contaminants have not reached the maximum concentration levels or if the quality of the background water

¹¹Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Groundwater Project, draft, DOE.

¹²These documents include the site work plans, which provide detailed characterization of the sites and environmental assessments.

exceeds the maximum concentration levels, DOE may choose to clean up the groundwater only to the background level standard.

- Supplemental standards. This standard may apply at sites under special circumstances, such as the following: (1) the groundwater is not a current or potential source of drinking water because of its poor quality or limited quantity, (2) the groundwater cleanup would cause more harm than good to the environment, or (3) the cleanup is not technically feasible. In such cases, DOE may apply to NRC to use the supplemental standards and leave the groundwater as it is.

DOE's Proposed Cleanup Strategies Vary Considerably

After assessing the applicability of EPA's various groundwater standards at each site, DOE developed proposed cleanup strategies for 24 sites. These proposed strategies are (1) no further action at 13 sites, (2) passive remediation at 9 sites, and (3) active measures to clean up the contamination at the 2 remaining sites.¹³ When no health risk is demonstrated, DOE may decide that no cleanup action is necessary. Or, depending on its assessment of risk, DOE may decide to use a passive cleanup, such as a natural flushing approach. At sites where DOE believes that it is necessary to protect health and the environment, the Department may initiate a more active cleanup strategy, such as pumping and treating the groundwater. Regardless of the strategy it chooses, DOE must obtain NRC's concurrence.

At 13 sites, DOE believes that no groundwater cleanup activities are warranted and so has proposed no further action at these sites. If DOE's proposal is accepted, the cost of the groundwater activities at these 13 sites will be primarily for activities such as studying the sites (e.g., to identify the type and level of contamination), holding public meetings, and working with NRC. DOE believes that its proposal to take no further action at these 13 sites will comply with EPA's groundwater standards as long as the groundwater contamination does not exceed the background levels or maximum concentration limits, or as long as supplemental standards are applicable on the basis of limited use of the groundwater.¹⁴

¹³Because the proposals shown are DOE's projections and are for planning purposes only, they are subject to agreements reached with the affected states and tribes and the completion of the final site-specific documents.

¹⁴Groundwater may be classified as "limited use" if the total dissolved solids exceed 10,000 milligrams per liter, if there is widespread ambient contamination that cannot be cleaned up using treatment methods reasonably employed in public water supply systems, or if the quantity of water available is less than 150 gallons per day.

“No further action” can mean one of three things, which DOE breaks down as follows:

- The site’s groundwater is not contaminated. DOE characterizes this condition, which has occurred at one of the Title I sites, as “no further action.”
- The groundwater is contaminated, but conditions at the site warrant the use of the supplemental standards or alternate concentration limits. DOE characterizes this condition, which has occurred at six sites, as “no further action, compliance demonstration.”
- Insufficient data on groundwater were collected at the site during the surface cleanup, so that additional data must be collected to demonstrate that the supplemental standards should be used. DOE characterizes this condition, which has occurred at six sites, as “demonstrate compliance through additional characterization.”

DOE believes that nine sites are candidates for passive remediation, or natural flushing. Although the cleanup of the groundwater contamination at these nine sites may take up to 100 years to complete, DOE estimates that, except for long-term monitoring, its work will be completed by 2014. By that time, DOE will need to show that the cleanup of the groundwater is occurring at such a rate that the cleanup will be completed within 100 years.

As noted above, passive remediation means performing no cleanup and instead relying on natural flushing. Natural flushing cleans groundwater through the process of dilution. Over time, as the groundwater flows through the aquifer, the concentration of contaminants gradually decreases. EPA’s regulations require monitoring to verify the movement of contaminants in the groundwater and the related reduction in contamination. DOE plans to continue monitoring the sites for 30 years and then demonstrate through its groundwater models that the process will result, within 100 years, in a level of cleanliness that meets the applicable EPA standard.

DOE believes that natural flushing is a viable cleanup strategy when (1) it will protect human health and the environment, (2) it will reduce the concentration of contaminants to a level below that prescribed by the standards in less than 100 years, and (3) the groundwater is not used for and is not expected to be used for drinking water. If natural flushing is chosen, access to the contaminated groundwater must be restricted

through means such as monitoring and controlling the site's boundaries and developing and enforcing land-use policies.

According to a DOE official, the federal government has never used natural flushing as a cleanup strategy. However, EPA believes that natural flushing is a viable alternative when (1) water use and ecological considerations are not affected and (2) the cleanup will occur in less than 100 years. Furthermore, EPA believes that institutional controls, if enforced by governmental entities or installed with a high degree of permanence, can be relied upon for up to 100 years.

Finally, at some sites a passive compliance strategy may not comply with the applicable EPA standards, may not adequately protect human health or the environment, or may not be accepted by the public or the affected community. Under these circumstances, DOE will propose an active strategy for the groundwater cleanup. For example, DOE may propose (1) pumping out the contaminated groundwater, treating it, and discharging it on the surface or (2) adding nutrients to the groundwater to promote bacterial growth that will break down the contaminants into nonhazardous elements (known as bioremediation).

DOE believes that two sites—Monument Valley and Tuba City, Arizona—are candidates for active remediation because natural flushing at these sites would not clean the groundwater within 100 years. These two sites are located on lands belonging to the Navajo and Hopi Indian tribes. According to DOE officials, tribal officials are supporting active remediation of the groundwater. In addition, although the groundwater is not currently being consumed by people, the contaminants associated with the groundwater at both sites could cause death if ingested by infants.

DOE's Future Costs Are Uncertain

The ultimate extent and cost of DOE's surface and groundwater cleanups depends on the resolution of a number of issues. First, while the surface cleanup of the Title I sites is completed or progressing at the majority of the sites, it will not be completed by the end of fiscal year 1996, when DOE's legislative cleanup authority expires. Second, because the groundwater cleanup is in its early planning stages, as discussed in chapter 2, its final scope and cost depend largely on the methods chosen to conduct the cleanup and the financial participation of the affected states. If DOE's proposed least-cost approaches are not chosen, the project's costs will increase accordingly. In the event that any state is unwilling or unable to share the cost of the groundwater cleanup, DOE will notify the Congress that it cannot complete the cleanup in those locations. Third, if the Congress provides for disposal of additional tailings in Grand Junction, Colorado that are unearthed in the future, DOE will incur added costs. Finally, NRC's regulations specify that it make a one-time minimum charge to the owners/operators of Title II sites of \$250,000 in 1978 dollars (\$530,000 in 1995) to pay for the basic surveillance costs at each site. This amount has not been reviewed and updated since 1980 and excludes any amount for ongoing maintenance. DOE's estimates of the annual costs of surveillance and maintenance at the sites indicate that NRC's expected minimum charge may be understated.

Various Factors May Affect Schedule and Cost of Surface Cleanup at Title I Sites

Although DOE plans to complete most of its surface cleanup by the end of fiscal year 1996—when its legislative cleanup authority expires—the Department believes it unlikely that work at some sites can be completed by then. At those sites, DOE anticipates it could complete the cleanup by early 1997. The licensing of these sites will continue into 1998 and DOE has established a goal of completing all licensing activities by the end of 1998. However, NRC officials are less optimistic that all the licensing will be completed by this date.

Completion of Surface Cleanup Depends on Resolving Problems at Five Sites

According to a DOE official, if the Department receives a 2-year extension of its cleanup authority, it can complete the surface cleanup of all the Title I sites by the beginning of 1997. Work has already been completed at 15 sites, and at another 4 sites, cleanup is progressing on schedule and completion is expected before the end of fiscal year 1996. For example, at the two Rifle, Colorado, sites, hauling of the tailings is complete, the radon barrier will be completed in October 1995, and the disposal cell's rock cover should be in place by May 1996, as scheduled. The cleanup at two other sites (Gunnison and Maybell, Colorado) is scheduled for completion

in November 1995 and January 1997, respectively. At the remaining five sites, however, progress has been hampered by outstanding issues.

At the Naturita, Colorado, site, the cleanup is scheduled for completion during fiscal year 1997, contingent on NRC's concurrence with DOE's site cleanup and disposal plan for the site, which DOE hopes to obtain in December 1995. Work at the Naturita site was delayed when DOE, in response to public pressure, changed the location of the disposal cell. Once a new location was selected, work began on the disposal cell's design, but construction of the disposal cell cannot begin until NRC concurs with the plan. Accordingly, in an attempt to speed the process, DOE skipped the first two steps of its typical three-step process for obtaining NRC's concurrence. The first two steps essentially involve obtaining NRC's early review of the preliminary plans. Because it skipped the early review steps, however, DOE is less certain than it has been in other cases that NRC will accept the plan without major modifications. Yet DOE must obtain NRC's concurrence by December 1995 in order to begin construction in the spring of 1996 and complete the cleanup of the site in 1997. According to NRC officials, the Commission received the remedial action plan for this site on November 14, 1995. As a result, although NRC is giving this review a high priority, because of the late submission of the documentation, NRC cannot guarantee completion of the review by the end of 1995.

The cleanup of the two sites located at Slick Rock, Colorado, has also been slowed by problems with a subcontractor's performance. Work at the two sites began during the spring of 1995. However, the subcontractor's poor performance resulted in slow progress, and in October 1995 a decision was made to terminate the contract. DOE estimates it will cost about \$4.6 million (in 1995 dollars) to terminate the project and rebid the work.¹ As of September 1995, the project was 6 months behind schedule. Nonetheless, DOE currently expects the cleanup at this site to be completed in fiscal year 1997, as projected.

Finally, DOE's schedule for completing the cleanup could also be affected by its decision on whether to clean up the two North Dakota sites or "de-list" them (drop them from the program). As indicated in chapter 1, DOE added these two sites to the original list of 22 Title I sites early in the

¹These costs are for the extended opening of the field office at Slick Rock, the rebidding of the contract, and attorneys' fees.

program.² However, in March 1995 the North Dakota State Department of Health and Consolidated Laboratories requested that DOE remove the two sites from the program because North Dakota's legislature was not likely to appropriate funds for the state's 10-percent share of the cleanup costs. The state also felt that there would be minimal risk to the public and environment if the sites were not cleaned up and that the benefits associated with the cleanup were not commensurate with the costs.

As of October 1995, DOE had made no decision about de-listing the sites but had initiated the process that could lead to doing so. If DOE ultimately decides to de-list the two sites, the schedule would not be affected since the sites would no longer be part of the program. However, if the sites are not de-listed and the state is willing to pay its share of the cleanup costs, the work at the sites may not be completed by the end of 1997. According to DOE officials, preparation for remedial action at the two sites would have had to begin by mid-September 1995 in order to complete the cleanup by the end of fiscal year 1997.

If North Dakota does not pay its share of the cleanup costs, DOE believes it would not have the authority to complete its cleanup. According to DOE, if a state cannot pay its 10-percent share of the costs, the Department would notify the Congress that it could not complete the remedial actions planned in that state.

DOE officials told us that the Department has a goal of completing all licensing of the Title I sites by the end of 1998 and is working closely with NRC to meet this goal. However, NRC officials are less than optimistic that the Commission will be able to license all the sites by then because of their workload at the Title II sites.

By late spring of 1996, if its authority has not been extended beyond the end of fiscal year 1996, DOE plans to start shutting down its work at those sites where the cleanup is not complete. Doing so, however, would be costly. According to a DOE official, the activities required to shut down a site (e.g., completing the paperwork required to terminate contracts and release or reassign employees, paying penalties to contractors, covering exposed tailings, and fencing work sites) would cost at least \$15 million (in 1995 dollars) at four sites: Maybell, Naturita, and the two Slick Rock sites. Furthermore, the costs would be even higher if DOE starts, and then

²According to DOE's Deputy General Counsel, by authorizing the Secretary to use discretion in adding to the list of sites designated by the Congress, the act implicitly authorizes the use of discretion in reconsidering how such sites are designated if additional information comes to light. Thus, if these two sites were not properly designated in 1979, DOE could revoke their designation.

subsequently needs to stop the cleanup work at the two North Dakota sites.

DOE May Face Added Costs at Cheney Disposal Cell

DOE is working with NRC and the state of Colorado to develop a long-term radon management plan for disposing of tailings unearthed in the Grand Junction, Colorado, area, in future years. About a million cubic yards of tailings were used in burying utility lines and constructing roads in the area and remain today under the utility corridors and road surfaces. In future years, utility and road repairs and replacements will likely cause tailings to be unearthed, resulting in a potential public health hazard if the tailings are mismanaged.

In response to this problem, DOE is working with NRC and Colorado officials to develop a plan that calls for temporarily storing the tailings as they are unearthed and periodically transporting them to the nearby disposal cell (the Cheney cell located near Grand Junction, Colorado) for permanent disposal. The city or county would be responsible for hauling the tailings to the cell, and DOE would be responsible for the cost of placing the tailings in the cell. Under the plan, a portion of the Cheney disposal cell would remain open, at an annual cost of several hundred thousand dollars. This portion of the cell would remain open until it is full or for a period of 20 to 25 years, according to a program official.

Because the law requires that all disposal cells be closed upon completion of the surface cleanup work, DOE does not have the authority to implement this plan without congressional approval to keep a portion of the Cheney cell open as far into the future as necessary.

Uncertainties May Increase Scope and Cost of Groundwater Cleanup

As discussed in chapter 2, DOE is developing a groundwater cleanup strategy that meets EPA's standards while using the least-cost approaches wherever possible. However, DOE is uncertain whether the affected states and Indian tribes will agree with its proposed approaches and, if not, to what extent their disagreement will influence DOE's choices. DOE plans to negotiate the selection of groundwater strategies with the affected states and tribes. Historically DOE has construed the states' role as that of a full partner in selecting and performing remedial actions. However, according to DOE, it has not allowed and does not plan to allow the states and tribes to exercise veto authority over the selection of the remedy.

Until DOE (1) modifies its cooperative agreements with the affected states and tribes to incorporate groundwater activities and (2) finalizes the documents pertaining to each site, such as site characterization studies and environmental assessments, the Department cannot be sure what it will cost to complete the groundwater cleanup. As of October 1995, DOE was negotiating with the state of Texas to modify its cooperative agreement and incorporate provisions for complying with the groundwater program. Texas has tentatively accepted the proposed modification to its cooperative agreement, and DOE plans to use the modified Texas cooperative agreement as a model for other states. However, DOE does not know if other states will accept such modifications. According to DOE, it is premature to speculate on how a state's refusal to modify the cooperative agreement could affect the Department's strategy for the groundwater cleanup.

DOE estimates that implementing its proposed strategies for the groundwater cleanup would cost at least \$147 million. This cost estimate, however, is based in large part on the technical assumptions underlying the selected strategies. As a result, the final cost is difficult to project because the technical assumptions may be proven invalid by the future testing and monitoring that DOE plans to conduct. According to a DOE official, examples of these assumptions are the (1) rate of speed that contaminant particles move through the aquifer and (2) volume of contaminants in the aquifer. According to EPA,³ "[t]he cleanup of groundwater is a large-scale undertaking for which there is relatively little long-term experience." EPA also noted that the condition of the groundwater at the Title I sites varies greatly and that the "engineering experience with some of the required remedial actions is limited."

While it has targeted the least-cost strategies for cleaning up the groundwater at each site, DOE has identified five sites where it believes there is a 50-percent chance that a more expensive alternative may be required. DOE may choose a more expensive alternative because (1) the affected states or Indian tribes, through negotiations, may influence the Department to select a more expensive alternative because of their disagreement over DOE's proposed cleanup strategy or (2) future studies by DOE may prove that the technical assumptions are invalid. As a result, for each of these five sites, DOE has identified an alternative strategy that, although more expensive, may address concerns raised by the affected entities or possible technical problems.

³Discussed in EPA's Jan. 11, 1995, groundwater standards.

DOE estimates that implementing the more expensive alternative approaches at these five sites would cost an additional \$72 million, thus raising the total cost of its share of the groundwater cleanup to \$219 million. According to DOE officials, however, the Department is looking for ways to reduce the cost of the groundwater cleanup.

In addition, although the states are to pay 10 percent of the cost of remedial actions, DOE has not yet specified when the states would begin to share in these costs. If DOE decides that for groundwater cleanup, as for the surface cleanup, the states will share only in the cost of the groundwater remediation plans and remedial action (and not such items as administrative costs), then the states' estimated total cost share would be about \$1 million, according to DOE.

Finally, some states may not have funds to pay their share of the groundwater cleanup cost. According to a DOE official, Pennsylvania, Oregon, and Utah may not have funding for the groundwater program. A Colorado official has also indicated that the state legislature may not provide funding unless it can be shown that the contaminated groundwater poses a serious health risk.

According to DOE, if the states do not provide funds for their share of the costs, it would not have the legislative authority to clean up the sites. The Department has not finalized any contingency plans in the event that the states are unable to pay their share but is considering a variety of options, including offsets and in-kind services from the states (e.g., equipment and construction services) in lieu of financial support. However, if an adequate solution is not found, DOE maintains that it will not clean up the affected sites without congressional authorization.

DOE Is Responsible for Long-Term Custody of Title I and II Sites, but Uncertainty Surrounds Costs of Long-Term Care

DOE's responsibilities for the Title I sites do not end when the surface and groundwater cleanups are complete. DOE will be responsible for the long-term custody (i.e., surveillance and routine maintenance) of both Title I and II sites.⁴ The Department estimates that its long-term custodial activities for about 45 Title I and II sites will cost about \$60 million (in 1995 dollars) between 1995 and 2030.⁵ While DOE is financially responsible for the long-term custody of the Title I sites, NRC's regulations require the owners/operators of the Title II sites to pay the long-term costs associated with routine maintenance and surveillance for their sites. The underlying assumptions on which these regulations are based have not been updated and may not reflect current cost estimates for long-term surveillance and maintenance.

DOE Will Be Responsible for Custody of Title I and II Sites

Over the coming years, DOE is expected to acquire long-term custody of its Title I sites and most or all of the Title II sites. DOE estimates that, after 2010, it will be responsible for monitoring and maintaining 19 Title I sites⁶ and 26 Title II sites. Although states have the option of assuming long-term custody of the cleaned-up Title II sites, DOE does not expect that any states will choose to do so. Accordingly, DOE expects to acquire custody of all 26 Title II sites. DOE has estimated that it will spend \$60 million (in 1995 dollars) between fiscal year 1995 and fiscal year 2030 on its responsibilities for long-term custody at the Title I and II sites. (DOE has not projected its costs past 2030.)

NRC's Minimum Charge for Long-Term Surveillance Costs Has Not Been Reviewed and Updated and Does Not Include Routine Maintenance

Under the act, NRC is responsible for ensuring that before the federal government takes custody of a Title II site, it makes financial arrangements with the owners/operators adequate to cover the costs of long-term custody so that they, not the federal government, bear these full costs. Under its regulations,⁷ NRC is to collect a one-time charge from the owner/operator of each site "such that, with an assumed 1 percent annual real interest rate, the collected funds will yield interest in an amount sufficient to cover the annual costs of site surveillance." The money is to

⁴DOE will also acquire long-term custody of about 10 other sites that were contaminated by activities conducted in support of the nation's nuclear energy programs. These sites include former government facilities for nuclear power research, development, and production.

⁵Although DOE has developed cost estimates only through 2030, its long-term custody responsibility will continue indefinitely.

⁶The total number of disposal cells is lower than the number of Title I sites because in some cases tailings from two sites were combined and disposed of in the same cell.

⁷10 C.F.R. Pt. 40, App. A (1995).

be paid to the General Treasury of the United States before the site's license is terminated.⁸

NRC's regulations specify a minimum one-time charge to cover long-term surveillance costs. If it is determined that the sites' surveillance or control requirements are significantly greater than general surveillance requirements, a larger charge could be made. In 1980, NRC estimated that the minimum annual surveillance charge per site would be \$2,500 in 1978 dollars (or \$5,300 in 1995 dollars). Using a real interest rate of 1 percent, a fund of \$250,000 per site in 1978 dollars—\$530,000 in 1995 dollars—would provide continuous interest income to cover the estimated annual costs. At that time, NRC expected that the only cost for long-term surveillance would be the cost of the time and effort involved in government inspectors' visits to sites (i.e., travel time, inspections, and preparation and follow-up for the inspections).

NRC's minimum charge for surveillance was based on the assumption that ongoing maintenance would not be necessary. However, the regulations provide that the maintenance costs could be added to the charge. According to NRC, some routine maintenance—such as repairing fences, filling in minor erosion, or eliminating rodents—is recognized in the regulations as a possibility for all sites. If NRC determines on the basis of site evaluations that maintenance will be necessary, additional funds may be required.

DOE, which will take custody of the sites, has a different view of the minimum annual surveillance cost and the need for routine maintenance. On the basis of its experience with the Title I sites, DOE estimates that minimum annual cost of surveillance at the Title II sites will consist, in 1995 dollars, of (1) \$6,000 for an annual inspection and, if necessary, a follow-up inspection and (2) \$10,000 to prepare an annual inspection report. DOE officials acknowledge that the costs for annual site inspection and report preparation have been decreasing. As the number of licensed Title I and II sites increases, inspection visits can be combined because many of the sites are located near each other.

DOE also believes that annual routine maintenance will be required at each Title II site and will cost \$5,000 (in 1995 dollars) annually. Maintenance, according to DOE's guidance,⁹ includes both "routine" (scheduled) and

⁸If the state in which the site is located chooses to assume responsibility for the site's long-term custody, then the money is paid to the state's treasury.

⁹Guidance for Implementing the UMTRA Project Long-term Surveillance Program, DOE, Sept. 1992.

“unscheduled” activities. Among the scheduled activities are mowing grass, maintaining access or perimeter roads, and removing accumulated weeds or debris. Unscheduled maintenance will be conducted as needed for purposes such as preventing animal burrows or deep-rooted vegetation from entering a disposal cell. Thus, DOE estimates that the combined annual surveillance and maintenance costs will be \$21,000 (in 1995 dollars).¹⁰ According to NRC officials, however, DOE’s \$21,000 estimate is provided without a basis and therefore cannot be verified as accurate.

If DOE’s estimate of the minimum annual surveillance costs and the need for routine maintenance is correct, the minimum charge cited in NRC’s regulations will not yield sufficient income to cover the annual costs. To update NRC’s calculation of the amount the operators will have to pay in order to cover these costs, we used the 1-percent real annual interest rate specified in NRC’s regulations and DOE’s estimates of annual costs—\$16,000 for surveillance or \$21,000 (in 1995 dollars) for surveillance and maintenance.¹¹ According to our calculations, \$1.6 million (in 1995 dollars) would be needed to cover annual costs of \$16,000, and \$2.1 million would be needed to cover annual costs of \$21,000. As noted earlier, the one-time charge based on NRC’s 1980 estimates would amount to only \$530,000 (in 1995 dollars) and yield \$5,300 annually.

Conclusions

DOE has completed much of its surface cleanup at the Title I sites but will not finish the cleanup by its legislatively mandated deadline of September 30, 1996. To complete the surface cleanup work, DOE will need at least a 2-year congressional renewal of its surface cleanup authority. DOE is currently seeking reauthorization of the surface cleanup program through fiscal year 1998. However, costs will continue after the surface cleanup has been completed.

DOE is uncertain about the ultimate cost of its groundwater cleanup program, which is now only in its infancy. It is too early to know whether the affected states or tribes will ultimately persuade DOE to implement more costly remedies than the strategies the Department has proposed. DOE is also unsure about the validity of the technical assumptions underlying its proposed strategies. As a result, DOE may ultimately choose more expensive cleanup strategies, increasing the final cost of the

¹⁰DOE expects that the annual surveillance costs will be the same for both Title I and II sites. Although DOE has projected its surveillance costs over the next 30 years, its responsibility for surveillance extends into perpetuity.

¹¹NRC used a 1-percent interest rate because that was the average rate over the period 1951-79.

groundwater cleanup by as much as \$72 million. However, until DOE, the states, and the affected Indian tribes have reached a final agreement and more is known about the accuracy of DOE's technical assumptions about the proposed methods, the final cost of the groundwater cleanup cannot be ascertained.

Furthermore, DOE has yet to determine whether the states are willing and able to pay their share of the cost of the groundwater cleanup. Because DOE believes that it is prohibited from cleaning up contamination without the states' full financial participation, if the states do not provide their 10-percent share of the cleanup cost, DOE will not move forward on the cleanup without congressional authorization.

In addition to the cost of the groundwater cleanup, DOE may incur further costs to dispose of tailings that are unearthed in the future in the Grand Junction, Colorado, area. DOE's disposal of such tailings, however, will be contingent upon obtaining congressional authority to do so.

The basis for NRC's minimum long-term surveillance charge has not been updated and does not reflect DOE's current estimates of what it will cost to provide annual surveillance and maintenance. NRC has not reviewed its estimate of basic surveillance costs since 1980, and DOE is currently estimating that basic monitoring will cost about three times more than NRC estimates. Moreover, while DOE maintains that ongoing, routine maintenance will be needed at all sites, NRC's minimum charge does not provide any amount for ongoing maintenance.

Matters for Congressional Consideration

The Congress may wish to consider authorizing DOE to keep a portion of the Cheney disposal cell open to dispose of tailings that are unearthed in the future in the Grand Junction, Colorado, area. In addition, to resolve the issue of DOE's lack of authority to complete the groundwater cleanup if the states do not contribute their 10-percent share of costs, the Congress may wish to consider whether and under what circumstances DOE can complete the cleanup of the sites when the states do not provide financial support.

Recommendation

To provide a realistic indication of the future costs for long-term surveillance and maintenance of the Title II sites, we recommend that the Commissioners of the Nuclear Regulatory Commission direct its staff to consult with the Department of Energy to develop an accurate estimate of these costs and what they entail, and use that information to (1) update

the minimum one-time charge for basic surveillance and (2) determine if routine maintenance will be required at each site, and, if so, incorporate those costs into the minimum charge.

Agency Comments and Our Evaluation

In addition to the technical corrections provided by DOE, EPA, and NRC officials, NRC commented on our recommendation that the Commission update its one-time charge for basic surveillance and determine the need for routine maintenance at each site. NRC believes that our recommendation to update the minimum one-time charge for basic surveillance presumes that the initial assumptions it used in developing its basic charge for surveillance may no longer be valid. NRC is not certain that these assumptions are invalid but is nonetheless reexamining the issue.

NRC officials fully agreed with our recommendation to determine the need for routine maintenance at each site and incorporate any resulting costs. These officials cited several steps the Commission is taking to ensure that the recommendation will be implemented. They said that the Commission and DOE are preparing a working procedure that both agencies will use in the licensing process—including how NRC will determine long-term funding for the sites and what role DOE will play. NRC is also developing a procedure to follow in granting a license, including guidance on how to determine the amount needed for long-term funding and on the information needed to justify this funding amount. Finally, NRC plans to discuss long-term funding requirements with the owners/operators of the Title II sites and with DOE.

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