United States General Accounting Office

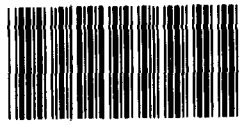
GAO

Report to the Chairman, Subcommittee on Superfund, Recycling, and Solid Waste Management, Committee on Environment and Public Works, U.S. Senate

September 1993

SUPERFUND

Cleanups Nearing Completion Indicate Future Challenges



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GAO

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

Resources, Community, and
Economic Development Division

B-247753

September 1, 1993

The Honorable Frank R. Lautenberg
Chairman, Subcommittee on Superfund,
Recycling, and Solid Waste Management
Committee on Environment and
Public Works
United States Senate

Dear Mr. Chairman:

As requested, this report discusses the Environmental Protection Agency's (EPA) efforts to conduct cleanups of hazardous waste sites. It focuses on the type and extent of actions taken at those sites where remedy construction is complete and at sites deleted from the Superfund priority list. It also evaluates the challenges EPA will face in managing and monitoring these sites.

As agreed with your office, unless you publicly announce its contents earlier, we will make no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Administrator, EPA; and the Director, Office of Management and Budget. We will make copies available to others on request.

This work was performed under the direction of Richard L. Hembra, Director, Environmental Protection Issues, who can be reached on (202) 512-6112 if you or any staff have any questions. Other major contributors to this report are listed in appendix II.

Sincerely yours,

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

After 12 years of the Superfund program and $15.2 billion in government authorizations, questions remain as to whether the Environmental Protection Agency (EPA) has made significant progress in cleaning up hazardous waste sites. Under Superfund, EPA placed the 1,275 sites with the most serious problems on a cleanup priority list. EPA has evaluated the potential risks of many of these sites and is now conducting cleanup work at 374 of them. After criticism of its apparently slow progress, evidenced by the deletion of only 40 sites from the priority list, EPA took steps to expedite its cleanup accomplishments and reporting.

The Chairman, Subcommittee on Superfund, Recycling, and Solid Waste Management, Senate Committee on Environment and Public Works, requested that GAO review completed Superfund cleanups. Specifically, GAO was asked to (1) summarize EPA's efforts to conduct cleanups, including the type and extent of cleanup work at sites deleted from the priority list or where construction of cleanup remedies is complete, and (2) evaluate the challenges EPA will face in managing and monitoring these sites.

Background

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) allows EPA to evaluate hazardous waste sites and place the worst on a National Priorities List (NPL). Superfund also established a fund for cleaning up these priority sites and required that parties responsible for the sites help conduct or pay for the cleanup. Under Superfund, EPA oversees cleanups and deletes sites from the NPL when human health and the environment are protected. EPA expects about 100 sites to be added annually to the 1,275 sites it has included on the NPL to date. States are responsible for cleaning up hazardous sites that are not on the NPL.

Once a site is included on the NPL, EPA conducts or oversees a study to identify wastes and evaluate possible remedies. Next, EPA develops a plan outlining cleanup activities and goals for reducing contaminants. EPA or the responsible parties then construct the remedy. When all work is complete and cleanup standards are reached, EPA can delete the site from the NPL. If contamination remains at the site after deletion, EPA must conduct at least one review 5 years after the cleanup began to ensure that the remedy still protects human health and the environment. States and responsible parties operate, maintain, and monitor the site.

In response to criticism that the cleanup process proceeds too slowly, in 1991 EPA began to emphasize completing cleanup at NPL sites. EPA created a

new "construction-complete" category to more accurately report those sites where all construction of cleanup remedies is completed. Sites in this category cannot yet be deleted from the NPL because they may require long-term efforts, like groundwater treatment, to reach cleanup standards. Or they may need to meet other requirements, like state concurrence. EPA set a goal of achieving 130 construction-complete and deleted sites by the end of fiscal year 1992. By the end of fiscal year 1992, EPA had deleted 40 sites from the NPL and completed remedy construction at 109 sites, for a total of 149 sites.

Results in Brief

Significant amounts of hazardous wastes have been removed or controlled at the 149 sites EPA deleted from the NPL or reported as construction-complete. GAO found that this cleanup work addressed surface and groundwater contamination, such as contaminated soil that released hazardous waste into underlying groundwater, threatening drinking water supplies. Through a combination of cleanup activities and removal actions, EPA or responsible parties addressed immediate contamination risks and controlled long-term threats to human health and the environment. At 60 percent of the 149 sites, EPA or responsible parties constructed a cleanup remedy to control a long-term threat, while at 19 percent of the sites a removal action was sufficient. At the remaining sites, studies revealed that no cleanup was necessary. However, in reporting cleanup completions, EPA has not differentiated between sites that already protect human health and the environment and those that require ongoing treatment to reach their cleanup objectives.

Despite EPA's progress, significant federal, state, and responsible party resources will still be needed to address contamination problems at Superfund sites and to achieve and sustain cleanup goals at construction-complete and deleted sites. Sites that have not yet reached the construction-complete stage will likely be more costly to clean up because they are more complex and because waste treatment rather than containment remedies will be used more frequently. At almost half the construction-complete and deleted sites, EPA, states, and responsible parties are also incurring significant costs for oversight, operation, and maintenance to ensure that cleanup remedies, such as on-site waste containment, remain effective. The ability of states and responsible parties to maintain and operate these sites will determine the continued protectiveness of these remedies. Although financial concerns led some states to challenge EPA's view that they are responsible for maintaining these sites, a recent court ruling held that they must pay for all operation

and maintenance costs. While EPA has conducted a study forecasting the costs to states of operating and maintaining construction-complete and deleted sites, ongoing studies will be needed to help states and EPA plan for these increasing costs.

Principal Findings

Superfund Cleanup Accomplishments

The Superfund program's achievements are substantial in controlling hazardous waste at the 149 construction-complete or deleted sites and in responding to releases of toxic substances. Through removals and remedial actions, EPA and responsible parties have addressed surface and groundwater contamination, such as waste released into the soil that contaminates the underlying groundwater. Most activities at the 149 sites involved cleaning up surface wastes: disposing of untreated waste in hazardous waste landfills, containing waste with an impermeable cap to prevent it from spreading, and treating waste with technologies like waste solidification or vacuum extraction of contaminants from soil. At some sites, contaminated groundwater is being treated; as a result, long-term efforts are often needed before cleanup goals are achieved. Finally, more than a third of the 149 sites required no remedial action because EPA's removal program had already addressed site risks or, after more study, the sites were found to need no cleanup at all.

EPA's removal program for immediate action at sites was instrumental in cleaning up wastes. In all, EPA took 125 separate removal actions at over half of the 149 sites. Although subsequent remedial actions were needed at many of these sites, EPA averted further site and environmental contamination by such actions as removing waste from the sites or constructing fences that prevented access to the waste.

Despite these accomplishments, EPA could do a better job of reporting the extent of cleanup work performed at NPL sites. In recent testimony, EPA failed to distinguish significant differences in the extent of work performed and the level of cleanup achieved at these sites. For example, 15 percent of the 149 sites needed no cleanup actions of any kind but were still included on a recent completion list.

Future Superfund Resource Demands

The types of cleanups required at sites in the NPL pipeline suggest that EPA, states, and responsible parties should plan for significant future demands

on their limited resources. To date, EPA alone has incurred costs of $374 million to clean up contamination at construction-complete and deleted sites. EPA incurred a median cost of $2.1 million at sites where it funded all the site work. Future costs to clean up Superfund sites still in the pipeline may be significantly higher, since collectively these sites are more complex and can be expected to demand more resources to finance cleanup activities.

Furthermore, EPA estimates that states' operations and maintenance costs will run about $1 billion at construction-complete and deleted sites in the next 7 years. EPA, states, and responsible parties will be required to operate, maintain, and monitor sites where untreated waste remains. Otherwise, the continued protectiveness of cleanup remedies could be jeopardized. For example, cleanup at about 40 percent of construction-complete and deleted sites involved groundwater treatment or containment technologies that require continuing vigilance.

GAO found that some states are concerned about their ability to operate and maintain completed sites and to monitor the sites' continued level of protection. At one site, the state did not have the resources and staff to take required yearly samples from the site wells in accordance with the monitoring plan. This problem may become more severe as states are called upon to operate and maintain an increasing number of Superfund sites. Such financial concerns led nine states to legally challenge EPA's interpretation of CERCLA that the states are responsible for all costs of operating and maintaining these sites. The court recently upheld EPA's interpretation.

Recommendations

To improve the information EPA provides to the Congress and the public, GAO recommends that the EPA Administrator modify the classification of construction-complete and deleted sites to identify sites according to whether they have achieved the objectives of protecting human health and the environment and have been deleted or are awaiting deletion from the NPL, required no removal or remedial action, or will require long-term effort to achieve cleanup objectives. GAO also recommends that the EPA Administrator, to plan for potential resource requirements at deleted and construction-complete sites, conduct additional studies to estimate EPA's long-term costs to monitor and inspect these sites and the states' costs to operate and maintain them.

Agency Comments

GAO discussed the report's findings and recommendations with EPA officials, including the State and Local Coordination Branch Chief in EPA headquarters and branch and section chiefs in EPA's regions. These officials generally agreed with the findings and recommendations, and their comments were incorporated where appropriate. As requested, GAO did not obtain written EPA comments on a draft of this report.

Contents

Figures

Abbreviations

ASTSWMO	Association of State and Territorial Solid Waste Management Officials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	Environmental Protection Agency
GAO	General Accounting Office
HRS	Hazard Ranking System
NAPL	nonaqueous phase liquid
NPL	National Priorities List
OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RCRA	Resources Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
TCE	trichloroethylene

Introduction

Twelve years after the Congress created the Superfund program as a short-term project to clean up the nation's most hazardous waste sites, concerns exist about the slow rate of site cleanups. With the law scheduled for reauthorization in 1994, discussion centers on Superfund's accomplishments to date and the challenges the Environmental Protection Agency (EPA) faces in cleaning up the remaining Superfund sites and managing and monitoring sites where contamination has been left in place. In response to these concerns, in 1991 EPA set new goals for significantly increasing the number of sites where substantial cleanup work would be completed.

While cleanup work is now under way or completed at hundreds of hazardous waste sites, thousands more await study and potential cleanup. The EPA's National Priorities List (NPL) included more than 1,200 contaminated sites as of September 30, 1992. Although EPA may delete sites from the NPL when it is certain they are cleaned to a level protective of human health and the environment, the rate that new sites will be added to the list is expected to exceed the rate at which they will be deleted. Consequently, EPA projects that the NPL will grow to about 2,100 sites by the year 2000. Since cleanup takes, on average, approximately 10 years, the nation can expect a long-term effort to resolve its hazardous waste problem.

The Superfund Cleanup Program

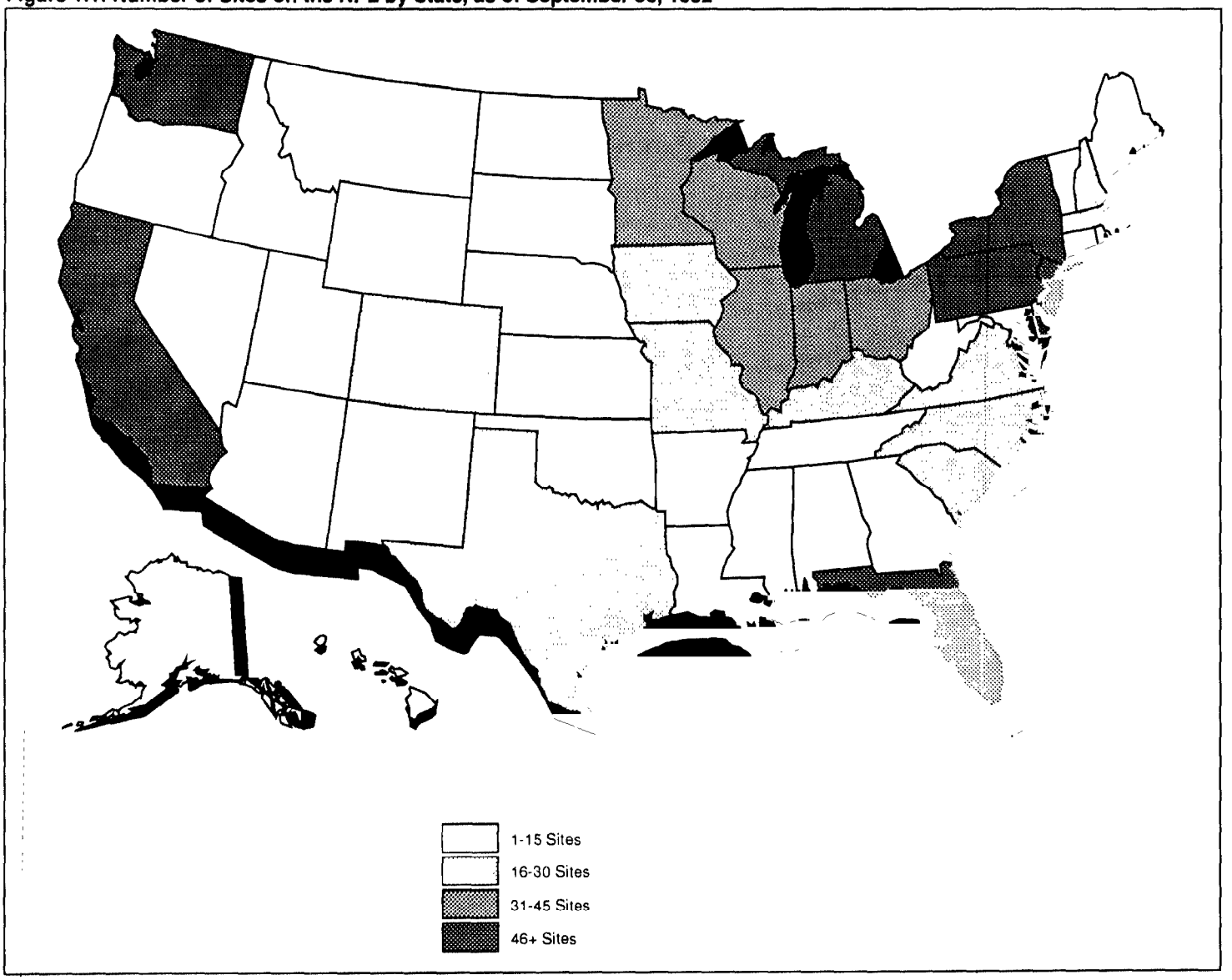
The Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) in 1980 to facilitate cleanup of highly contaminated hazardous waste sites. The act gave EPA authority to respond to problems at these sites or to compel the parties responsible for the hazardous wastes to assist in the cleanup.[1] CERCLA established a $1.6 billion trust fund, financed primarily by taxes on crude oil and certain chemicals, for EPA to implement this program. In 1986, the Superfund Amendments and Reauthorization Act (SARA) set new requirements and ambitious targets for initiating cleanups and added $8.5 billion to the trust fund. In 1990, the Congress reauthorized CERCLA through 1994 and added $5.1 billion to the trust fund without making any substantive changes to the program.

As part of its Superfund responsibilities, EPA investigates potential hazardous waste sites and places the most severely contaminated on the NPL. EPA uses a Hazard Ranking System to assign potentially hazardous sites a numerical score on the basis of their characteristics and risks.

[1]Responsible parties include waste generators, waste haulers, and site owners and operators.

Placement on the NPL makes sites eligible for in-depth study and subsequent cleanup, if necessary. The first NPL, published in 1983, included 406 sites; CERCLA had specified that a minimum of 400 sites should be identified. EPA updates the NPL every year; as of September 30, 1992, it included 1,275 sites nationwide. (See fig. 1.1.)

Figure 1.1: Number of Sites on the NPL by State, as of September 30, 1992



Source: GAO's analysis of EPA's data.

At Superfund sites, the site is first studied and then the cleanup remedy is selected, designed and constructed. When EPA determines that a site no longer poses a significant risk to human health and the environment, EPA

may delete it from the NPL. To date, the growth rate of the NPL—nearly 100 sites per year—significantly exceeds the deletion rate. Only 40 sites have been deleted from the NPL, although cleanup work and investigation continue at hundreds of other sites.

To clean up sites on the NPL, EPA uses either Superfund dollars or its enforcement powers to require that responsible parties perform the cleanup.[2] If responsible parties are unwilling to perform the cleanup, EPA has the authority to clean up the sites itself and seek recovery of its costs from the parties. EPA also cleans up "orphan sites," for which responsible parties cannot be located to perform or to pay for cleanup. The states are required to pay 10 percent of cleanup costs at sites where EPA funds the cleanup, or at least half the cleanup costs at publicly operated sites.

The Site Cleanup Process

Once a hazardous waste site has been identified, EPA investigates the site to determine the extent and nature of contamination and to identify potential cleanup remedies. Hazardous waste at Superfund sites may be present in different forms, including leaking barrels and tanks, contaminated surface and subsurface soil, and contaminated surface water and groundwater.[3] Following the site study, EPA selects a cleanup remedy appropriate for the site's waste. Remedies for different waste problems may include

- treating or destroying contaminated waste material,
- disposing of contaminated waste at an off-site landfill,
- treating contaminated groundwater, or
- containing waste at the site by covering it with an impermeable cap.

In reauthorizing the Superfund program in 1986, the Congress encouraged EPA to select remedies that treat waste to reduce its toxicity, mobility, or volume whenever practicable.

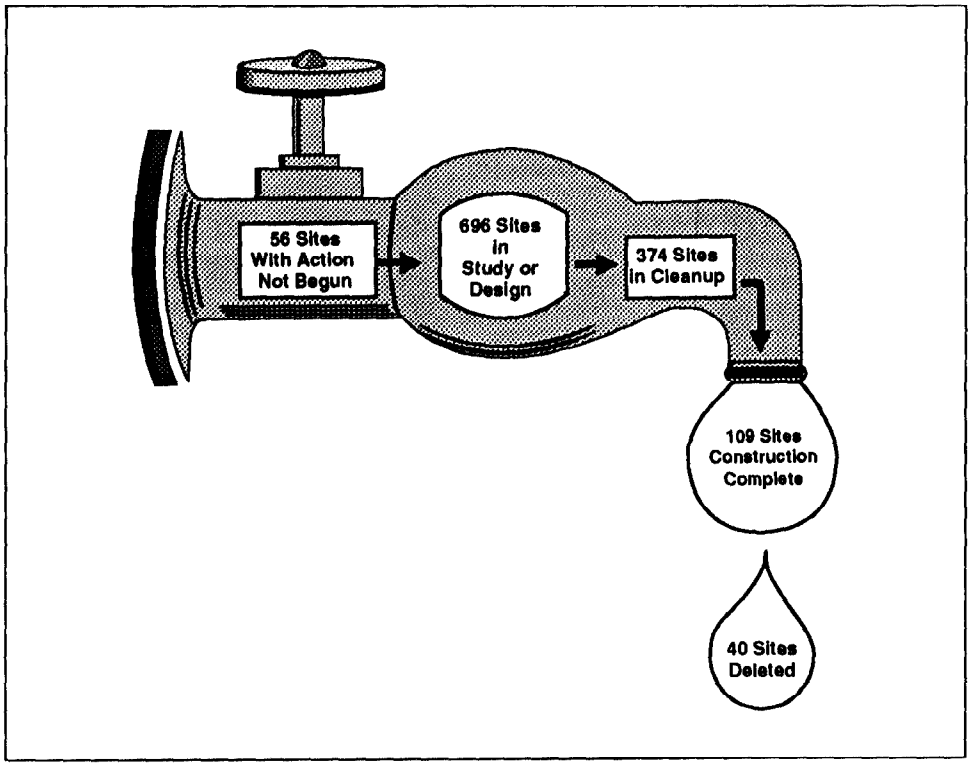
Once the remedy has been selected, EPA oversees the remedial action taken at the site. Following the completion of a detailed cleanup design, the chosen remedy is constructed—for example, a treatment plant may be built to pump and treat contaminated groundwater. When the selected

[2]While CERCLA regulates the cleanup of existing hazardous waste sites, the Resource Conservation and Recovery Act (RCRA) seeks to prevent the emergence of new sites. RCRA establishes technical and safety standards for the handling, treatment, and disposal of hazardous wastes.

[3]Groundwater refers to underground water contained in aquifers. Aquifers may become contaminated when chemicals present in soil migrate into the underlying groundwater.

remedy has been built, EPA places the site into its "construction-complete" category, indicating the completion of construction necessary to implement the remedy. In some cases, the cleanup remedy will need to operate for a number of years to reduce contaminants to a level EPA has determined will protect human health and the environment. EPA can delete the site from the NPL when EPA and the state where the site is located agree that no further action is necessary since site risks have been reduced to a level that protects human health and the environment. (See fig. 1.2.)

Figure 1.2: Status of 1,275 Superfund Sites, as of September 30, 1992



Source: GAO's analysis of EPA's data.

EPA may use its emergency removal program at any time during this process if it determines that immediate action is needed to protect human health and the environment. Emergency removals are actions taken to clean up or stabilize acute contamination problems, such as leaking drums that could contaminate a nearby stream. These actions should cost less than $2 million and be completed within 12 months. Such actions may

include removing waste from the site, constructing a fence around the site, or providing an alternate water supply, if necessary.

EPA's Office of Solid Waste and Emergency Response (OSWER) administers the Superfund program, setting its policy and direction through the Office of Emergency and Remedial Response. EPA's 10 regional offices manage site cleanup, including determining when sites can be classified as construction-complete and when they should be deleted from the NPL.

Deletion From the NPL

Before EPA deletes a Superfund site from the NPL, all work at the site must be completed and all threats to human health and the environment must be controlled. The state must also concur with the decision to delete the site from the NPL. When EPA determines that all appropriate work is completed, including implementing any restrictions on future land use at the site and a plan for site maintenance, the agency may place a notice of intent to delete the site from the NPL in the Federal Register. The public has 30 days to comment on the proposed deletion, and EPA must respond to any comments. The site may not be deleted unless state agencies concur that the site protects human health and the environment, and the state or responsible parties agree to maintain the site. At sites where EPA funded the cleanup, the states are required to fund all of the ongoing site operations and maintenance.

EPA is required to periodically review construction-complete or deleted sites where waste remains on site to ensure that the remedies remain protective of human health and the environment. For example, if EPA contains the risk of further contamination by capping waste with impermeable materials, the agency will be required to review the site 5 years after construction began to determine if the cap continues to contain the contamination. These reviews will continue as long as waste remains on site. Deleted sites may be returned to the NPL if contamination problems recur.

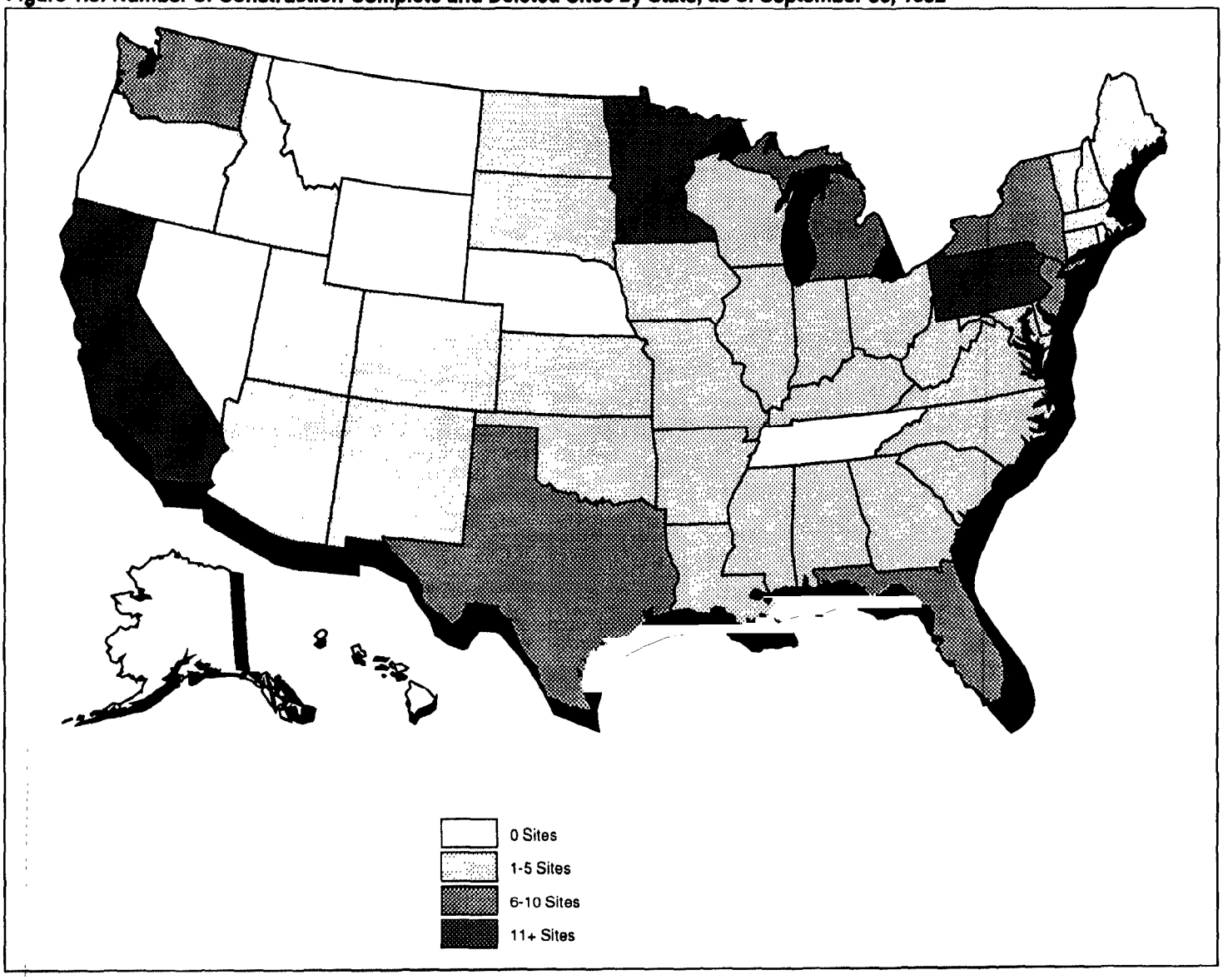
Before December 1991, EPA would not delete a site with remaining waste from the list until it had performed a 5-year review. Current policy allows EPA to delete a site before a 5-year review is completed if the site has met all cleanup standards established in the cleanup plan. This new policy should speed up the deletion process.

EPA's New Goals for Remedy Completion

In response to criticism that Superfund cleanups proceed too slowly and to reflect the program's progress, in 1991 the EPA Administrator proposed new goals for completing cleanups. The Administrator proposed a goal of 130 sites placed in the construction-complete category or deleted from the NPL by the end of fiscal year 1992. EPA believed that it had previously underreported the program's progress. Consequently, in 1992 an EPA work group proposed new guidelines for categorizing NPL sites, allowing sites to be classified as construction-complete earlier in the cleanup process. By September 30, 1992, EPA reported that it had met the Administrator's goal, deleting 40 sites from the NPL and completing construction of the selected remedy at an additional 109 sites. (See figs. 1.3 and 1.4.) Thus, EPA considers that 149 sites are in the construction-complete and deleted categories it uses to measure cleanup progress. EPA was able to achieve its goal partly because it began to define sites with remedial actions in progress as construction-complete sites.[4] Under current policy, such sites can be classified as construction-complete if the cleanup technology has been installed or constructed.

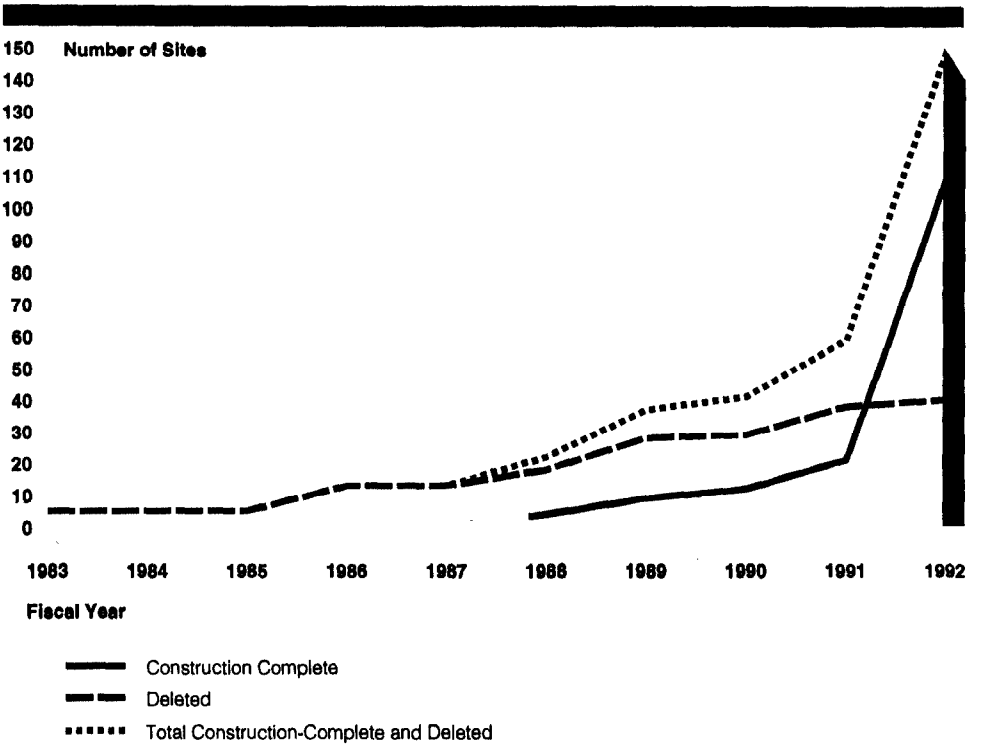
[4]EPA established a "site complete" category in April 1989 to describe sites awaiting deletion from the NPL after all cleanup work was complete, but it did not include sites with operating treatment systems or set specific "site completion" goals. EPA began specifically documenting completion of remedy construction in February 1992.

Figure 1.3: Number of Construction-Complete and Deleted Sites by State, as of September 30, 1992



Source: GAO's analysis of EPA's data.

Figure 1.4: Cumulative Number of Construction-Complete or Deleted Sites by Fiscal Year



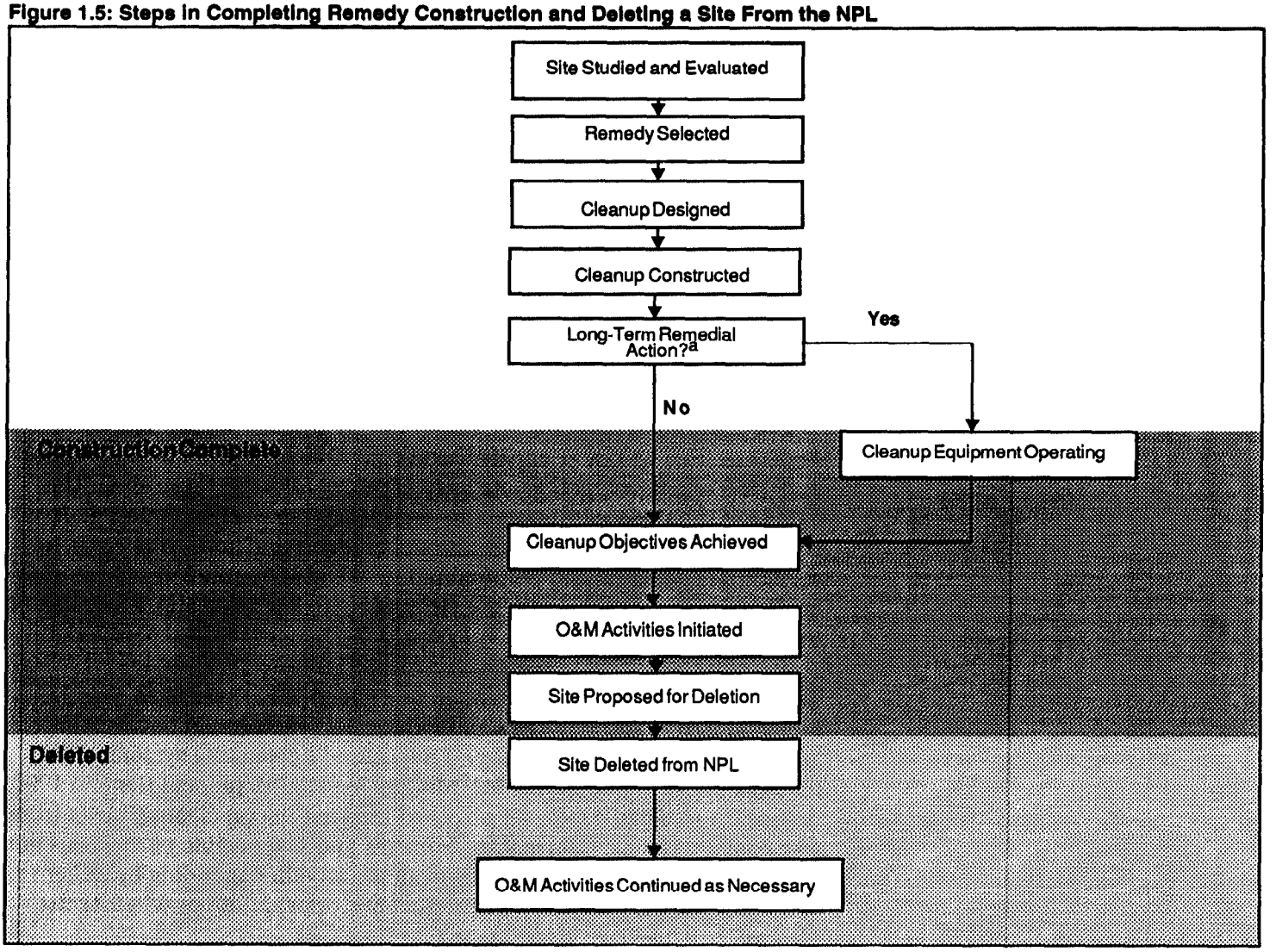
Note: Based on 149 construction-complete and deleted sites. Construction completion before 1992 was based on the approval date of the report documenting completion.

Source: GAO's analysis of EPA's data.

Sites classified as construction-complete may require additional work before they can be deleted from the NPL. In some cases, they still contain some contamination, because the remedy may take a number of years to remove all contaminants. For example, sites with contaminated groundwater may be classified as construction-complete after a groundwater extraction system is operating, although contamination remains in the aquifer. To declare a site construction-complete, EPA must inspect the site to ensure that the constructed remedy meets design specifications. Classification of a site as construction-complete does not require that certain administrative parts of cleanup, such as implementation of land-use restrictions or state concurrence, be completed. To document that construction is complete, regions must also prepare a preliminary close-out report that summarizes cleanup actions

and outlines the activities remaining before the site can be considered for deletion from the NPL.

Figure 1.5: Steps in Completing Remedy Construction and Deleting a Site From the NPL



Note: O&M refers to operation and maintenance.

[a]Long-term remedial actions require construction and operation of waste treatment equipment on the site. These actions may include soil, waste, or groundwater treatment, and may take considerably longer to achieve cleanup objectives.

Source: GAO's presentation of EPA's data.

Objectives, Scope, and Methodology

The Chairman, Subcommittee on Superfund, Recycling, and Solid Waste Management, Senate Committee on Environment and Public Works, asked us to evaluate completed Superfund cleanups by reviewing construction-complete and deleted sites. We subsequently agreed to (1) summarize EPA's efforts to conduct cleanups, including the type and extent of actions taken at sites deleted from the priority list or where construction of the cleanup remedy is complete, and (2) evaluate the future challenges EPA will face in managing and monitoring these sites.

We performed our work at EPA headquarters in Washington, D.C., and at EPA Region III (Philadelphia), Region V (Chicago), and Region IX (San Francisco). We selected these regions because, in comparison with other regions, they had many construction-complete or deleted sites where a variety of cleanup techniques were being used.

To identify cleanup approaches used at Superfund sites classified as construction-complete or deleted sites, we interviewed headquarters and regional officials about policies and procedures on completion and deletion. We reviewed close-out reports and other available data on all 149 sites classified by EPA as construction-complete or deleted through fiscal year 1992 and developed a data base of information on these sites. The data base included information on emergency removal and other actions, such as implementation of institutional controls and actions to clean up surface and groundwater contamination. We also conducted case studies of 17 of these sites to review the cleanup remedies. (See app. I for a list of these sites.)

To determine the amount of resources expended at these sites, we included information on EPA's expenditures at each site in our data base. We obtained these data from EPA's Superfund accounting systems. We adjusted these expenditures for inflation in order to present them in 1992 dollars. In selected cases, we obtained information on cleanup costs from responsible parties. Information from EPA and responsible parties was not audited for reliability. Nor did we evaluate whether spending by either EPA or the responsible parties was efficient and appropriate or whether the cleanup actions were cost-effective.

We also used our case studies of 17 sites to identify the challenges EPA will face in monitoring and maintaining construction-complete and deleted sites. We identified what operations and maintenance would be required and whether the 5-year reviews had been completed. Through document review and interviews with regional project managers, we evaluated EPA's

oversight of these activities and the extent to which these sites require EPA's continued vigilance. We also used the data base of sites to determine the number that required long-term actions.

We conducted our work between July 1992 and May 1993 in accordance with generally accepted government auditing standards. We discussed our findings and recommendations with Superfund officials at EPA headquarters, including a representative of the Assistant Administrator for Solid Waste and Emergency Response and the Chief of the State and Local Coordination Branch in the Office of Emergency and Remedial Response. We also held discussions with regional officials, including a branch chief and section chiefs in the three regions we visited. These officials generally agreed with the report's findings and recommendations, and we incorporated their comments where appropriate. As requested, we did not obtain written comments from EPA on a draft of the report.

Significant Amounts of Hazardous Wastes Have Been Removed or Controlled at Construction-Complete and Deleted Superfund Sites

Significant amounts of hazardous wastes have been removed or controlled at the 149 hazardous waste sites EPA designated as construction-complete or deleted from the NPL. Through removals and remedial actions, EPA and responsible parties have addressed significant surface and groundwater contamination problems, such as toxic waste released into the soil that contaminated the groundwater and threatened the public drinking water supply. The bulk of remediation activities at the 149 sites included cleanup of surface wastes, sometimes involving more than one action. At 31 percent of these sites, untreated waste was disposed of off site in a hazardous waste landfill; at 26 percent, waste was contained through means such as an impermeable cap to prevent the contamination from spreading further. At 13 percent of sites with surface contamination, a treatment technology—such as incineration, solidification, or vacuum extraction—was used to address the contamination problems on site. In addition to any other cleanup actions taken, cleanup at 30 percent of the 149 sites involved treatment of contaminated groundwater, which will often require long-term remedial action before desired cleanup goals can be achieved. More than a third of the 149 sites required no remedial action. At 28 of these sites, risks were adequately addressed through a removal, and 23 sites were found to need no cleanup at all after more in-depth study.

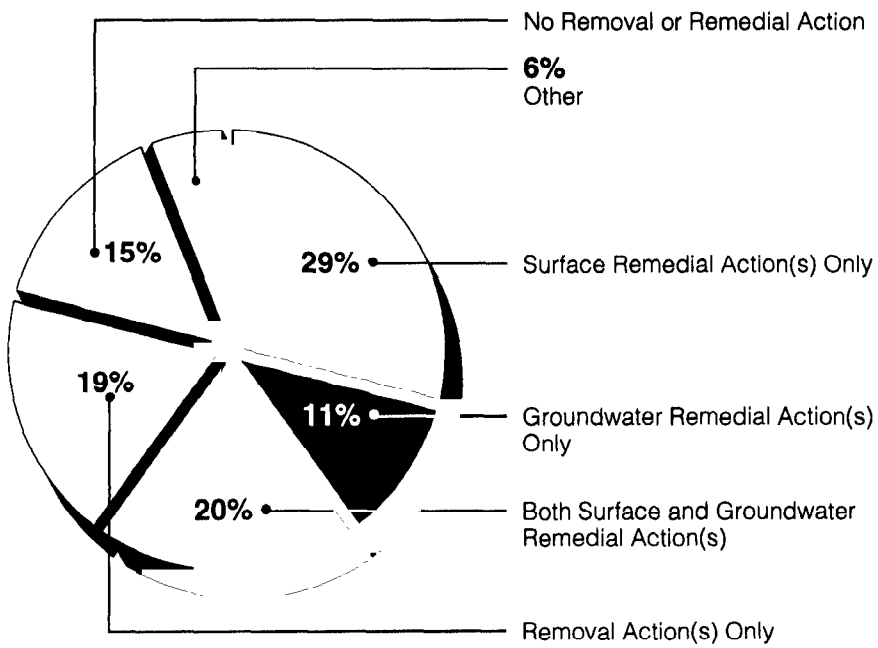
EPA's removal program was instrumental in cleaning up wastes at Superfund sites. In all, EPA took 125 separate removal actions at over half of the 149 sites. Although subsequent long-term remedial actions were needed at many of these sites, EPA averted further site and environmental contamination by removing contaminated wastes from the site or constructing fences that prevented access to the waste.

Despite these accomplishments, EPA could improve its reporting of cleanup work performed at sites on the NPL. In recent testimony, EPA failed to distinguish significant differences in the extent of work performed, if any, and the cleanup levels achieved at the construction-complete and deleted sites. Moreover, we found a few instances in which EPA overstated progress at the sites by categorizing some sites as awaiting deletion when these sites were still undergoing long-term remedial actions to achieve cleanup goals.

Cleanups Address Both Surface and Groundwater Contamination in a Variety of Sites

Surface and groundwater contamination, common in most of the 149 construction-complete and deleted sites, frequently required remedial action combined with short-term removal actions. (See fig 2.1.) Surface waste remedies were used at about half of the 149 sites and included actions that contained, removed, or treated waste containers, structures, or contaminated soil. Groundwater contamination was addressed at nearly one-third of the 149 sites, including some of the sites with surface contamination. EPA generally decided to address groundwater contamination by extracting the contaminated water and then treating it, or through measures to control its movement, such as installing an underground barrier.

Figure 2.1: Types of Remedies Used at Construction-Complete and Deleted Sites



Note: Based on 149 construction-complete or deleted sites. "Other" includes efforts to reduce waste exposure without physical construction. Examples include relocating residents or controlling land use.

Source: GAO's analysis of EPA's data.

Surface and groundwater contamination occurred in different types of sites. For example, industrial and municipal landfills amounted to about 20 percent of construction-complete and deleted sites. EPA classifies some sites that do not fall in specific land-use categories in terms of the type of contamination present. Approximately half of the 149 sites were contaminated with pesticides, solvents, or organic chemicals such as trichloroethylene (TCE), often in combination with metal contaminants like lead and arsenic. (See table 2.1.)

Table 2.1: Types of Contamination at Construction-Complete and Deleted Sites

Type of site or contamination	Percentage of sites
Asbestos	1%
Battery recycling	1
Industrial landfill	11
Metals	6
Metals/organic chemicals	16
Mining waste	3
Municipal landfill	9
Munitions	1
Organic chemicals	15
PCBs (polychlorinated biphenyls)[a]	6
Pesticides	7
Metal plating	5
Radioactive waste	1
Solvents	11
Wood preserving	2
Multisource groundwater	5
Total	**100%**

Note: Based on 149 construction-complete or deleted sites.

[a]According to EPA, exposure to PCBs may cause liver damage.

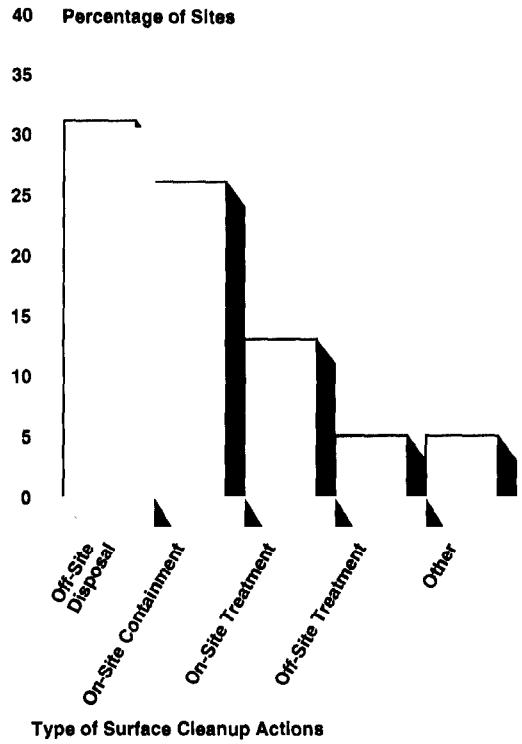
Source: GAO's analysis of EPA's data.

Combination of On- and Off-Site Techniques Used for Surface Cleanups

Surface waste cleanups were conducted at 72, or 48 percent, of the construction-complete or deleted sites. These cleanups addressed a variety of contamination problems involving contaminated site structures, hazardous waste containers buried below or lying on the surface, and soil contaminated with hazardous chemicals. Sites with surface contamination

included industrial and municipal landfills (19 sites) and sites contaminated with organic chemicals and/or metals (23 sites). EPA not only used a number of different cleanup methods, but often used combinations of methods to address contamination problems at the 72 sites where surface contamination was a problem. For example, on-site containment, such as covering waste with protective layers, was used at 38 of the 149 sites; off-site disposal in hazardous waste landfills was used at 46 sites; and on-site waste treatment was used at 20 sites. Figure 2.2 shows the percentage of sites where these different cleanup methods were used.

Figure 2.2: Percentage of Sites Where Various Types of Surface Cleanup Remedies Were Used



Note: Percentages do not add to 100 because not all 149 sites required surface cleanup remedies, and sites may use multiple remedies. "Other" includes miscellaneous activities, such as demolishing a home or diverting a creek bed.

Source: GAO's analysis of EPA's data.

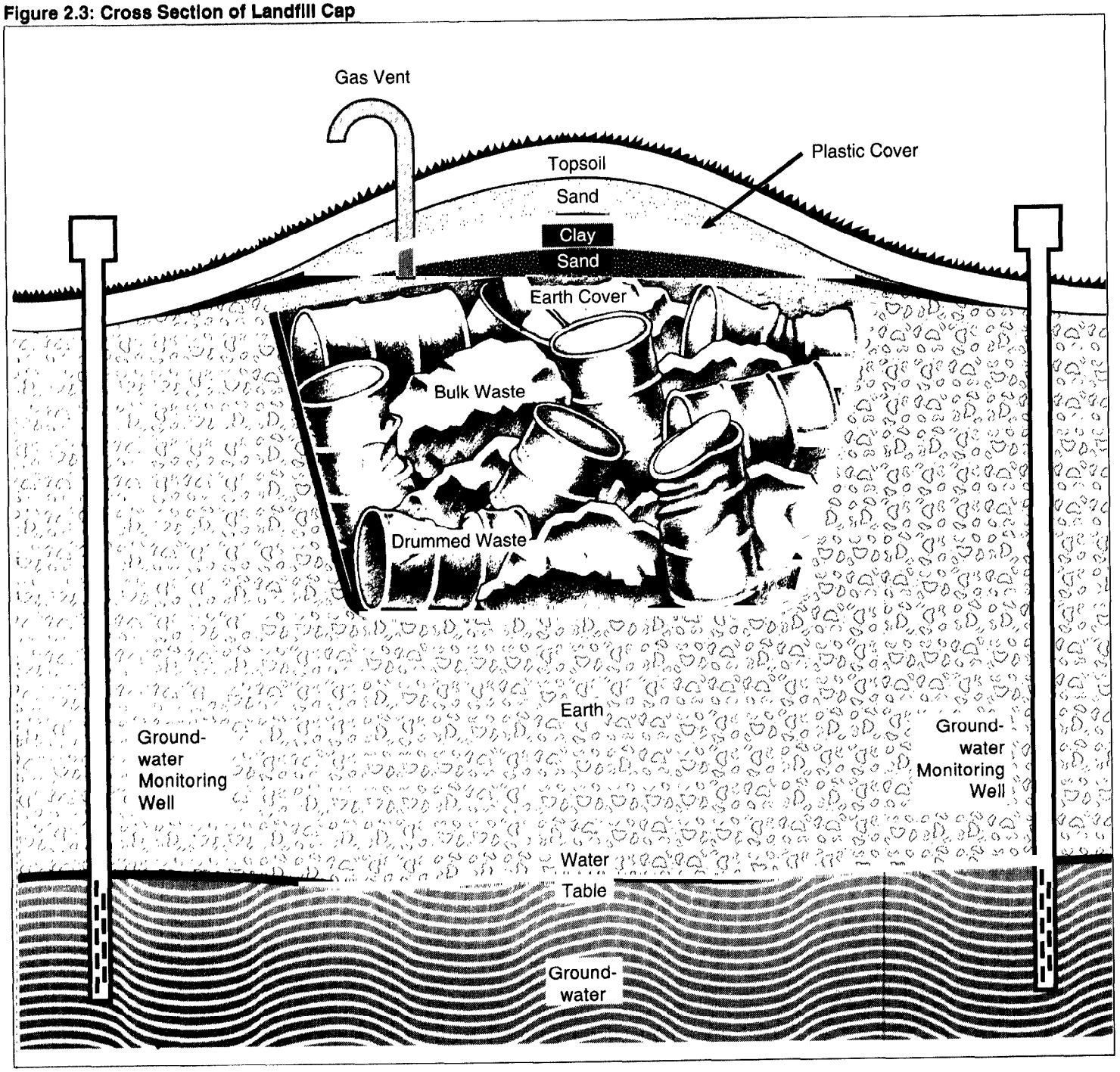
On-Site Containment

EPA used on-site containment to address surface contamination at 38 of the construction-complete and deleted sites. Although the legislation reauthorizing Superfund in 1986 (SARA) explicitly stressed a preference

that EPA use treatment technologies that permanently reduce toxicity, mobility, or volume of waste when practicable, EPA guidance recognizes that the most likely response action for some sites, such as landfills that have a large volume of low-toxicity waste, is the use of containment technology. In fact, some type of containment technology was used at about half of the 30 construction-complete landfill sites.

Waste containment offers the advantage of preventing exposure to the waste, immobilizing it, and reducing the amount of contamination that could leach into underlying groundwater. Containment may be accomplished by covering waste with an impermeable material, such as clay, followed by soil and grass cover. (See fig. 2.3.) To ensure that the cap continues to contain the waste, it must be periodically inspected to detect erosion. In addition, any land use that would require excavation must be prohibited where a cap has been installed.

Figure 2.3: Cross Section of Landfill Cap



Source: GAO's illustration based on EPA's data.

At the Belvidere Municipal Landfill site in Belvidere, Illinois, EPA used containment to control large volumes of waste. The site contains a 20-acre landfill that accepted municipal waste and industrial wastes, such as paint, oil, and sewage sludge. EPA placed Belvidere on the first NPL in 1983. Although the landfill was closed in 1973, EPA and the state of Illinois found metals, PCBs (polychlorinated biphenyls), and organic chemical contamination in site groundwater and soil, or sediments in the nearby river during investigations from 1984 to 1988. During site studies in 1986, investigators discovered about 100 barrels next to the landfill. Soil under the barrel disposal area was contaminated with PCBs and was later contained under the landfill cap. EPA used the removal program to transport the barrels to a hazardous waste landfill.

Under EPA's oversight, the responsible parties began the remedial action at Belvidere in 1990. They constructed a landfill cap and a groundwater extraction system. The cap at the site consists of an impermeable layer covered by drainage materials and grass, supplemented with gas vents to release landfill gases. The structure of the cap should prevent surface water from penetrating through the waste and transporting pollutants into the groundwater. To prevent contaminated groundwater from flowing into the nearby river, the responsible parties built an extraction system that captures groundwater as it flows from the landfill toward the river. This system sends the contaminated groundwater to the municipal water treatment plant. In addition, the responsible parties fenced the area and arranged to limit future use of the land through a deed restriction.

Long-term maintenance of this cleanup is crucial to its continued effectiveness. Periodic inspections of the site are necessary to detect erosion and to look for burrowing animals or vegetation that could harm the cap. EPA also monitors the quality of the groundwater and will require that the extraction system be kept in operation until cleanup standards are met. On a visit to the site, we observed the responsible parties taking groundwater samples and maintaining the extraction system. EPA incurred costs of about $1.5 million at this site. The responsible parties report spending about $8 million.[1]

Off-Site Disposal

EPA used off-site disposal technologies at 46 of the sites with surface contamination. Off-site disposal can efficiently remove highly contaminated waste without the operations and maintenance needed for containment or treatment technologies. Off-site disposal is effective in

[1]This cost information was not audited for reliability. All EPA expenditures are expressed in 1992 dollars. These expenditures represent EPA's total site costs, not including any reimbursement from states or the responsible party.

removing drums, buildings, or contaminated material not suitable for treatment on site. However, both RCRA, which governs current disposal of hazardous waste, and SARA discourage disposal of untreated hazardous waste in order to avoid creating additional hazardous waste sites.

EPA used off-site disposal to remove waste from the Jibboom Junkyard site in Sacramento, California. The site was used for metal salvage activities between 1950 and 1965, and three-fourths of the 9-acre site was subsequently covered by an interstate highway. Jibboom is adjacent to a river that serves as a drinking water source for Sacramento. A site study between 1981 and 1985 showed high levels of metals, including lead, in the soil. EPA decided to excavate all soil with more than 500 parts per million of lead—anticipated to be about 5,000 tons—and dispose of it in a hazardous waste facility in Utah.

When cleanup began in 1986, excavators encountered a series of large subsurface objects that, according to an EPA regional official, delayed the cleanup. These objects included a concrete foundation, piping, and a septic tank. Three gas cylinders were also found, leading the cleanup workers to evacuate the site and notify the local fire department and bomb squad. Soil and excavated objects were sampled throughout the excavation to ensure that soil in contaminated areas was being removed. By the time excavation was finished, over 12,000 tons of material had been removed from the site. Subsequent soil and groundwater sampling confirmed that cleanup standards have been achieved, and EPA has now covered the site with soil and vegetation. EPA incurred cleanup costs of about $5.8 million and is currently taking action against the responsible parties.

Waste Treatment

EPA used on-site waste treatment technologies at 20 of the sites with surface contamination, although EPA anticipates greater use of these technologies for sites currently undergoing cleanups. According to an EPA report, cleanup remedies selected since 1986, when SARA emphasized permanent remedies, have increasingly featured such treatment. Examples of waste treatment include incinerating the waste to destroy it, solidifying the waste to immobilize it, and applying a vacuum system to remove contaminated waste from the soil.

EPA used a treatment technology to address contamination problems at the Bruin Lagoon site in Butler County, Pennsylvania. The technology consisted of stabilizing and neutralizing highly contaminated sludges and soil. The site was originally used for disposal of by-products of mineral oil

refining, which created open lagoons containing acidic sludge and various metal and acidic contaminants. Bruin Lagoon was added to the NPL in 1983. Before the site was added to the NPL, the lagoon overflowed, killing at least 4 million fish in the Allegheny River and endangering public water supplies.

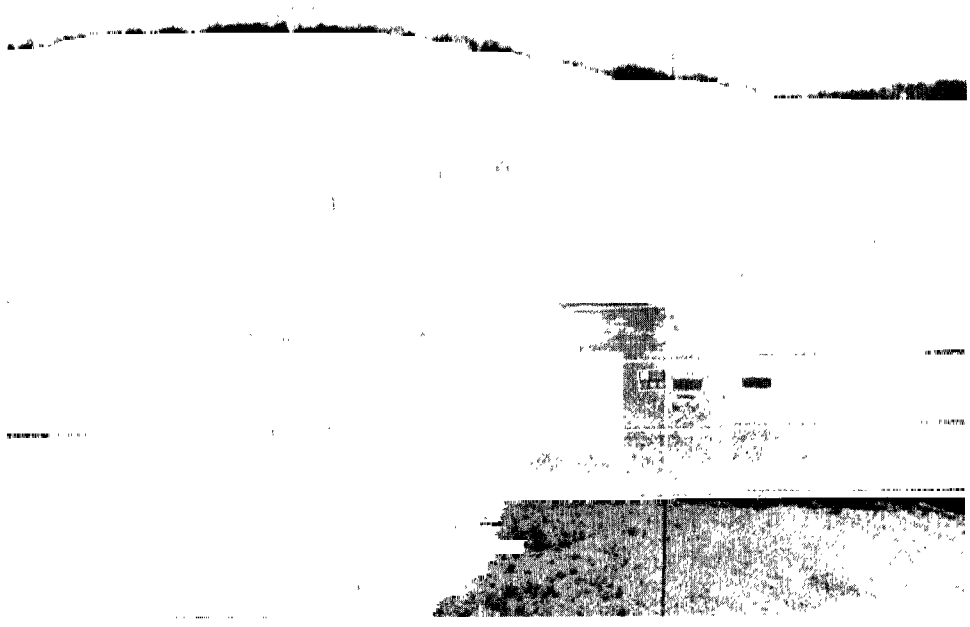
EPA began work at the site in 1983, planning to remove liquids from the lagoon, stabilize it, and cap the site. Site cleanup was delayed on several occasions. For example, when contractors broke through a crust layer on the lagoon in 1984, releasing potentially hazardous gas and mist, EPA evacuated nearby residents, according to the site's manager. As a result, EPA conducted a removal action that included installing gas monitoring wells and covering the lagoon with sludge. EPA decided to conduct another site study and design a new remedial action after the emergency.

Site cleanup, which began in 1989, consisted of excavating and mixing lagoon sludge with substances designed to stabilize it and reduce its acidity. (See figs 2.4 and 2.5.) Each sludge batch was sampled to ensure that the acidity had been adequately reduced. Sludge treatment was delayed during the winter, according to the site's manager, because chemicals used during treatment solidified at 45 degrees Fahrenheit. Once all the sludge was stabilized, in 1990, EPA's contractors constructed an impermeable cap over the site and built a trench around it. These actions prevented direct exposure to the waste and reduced the chance that rain or groundwater would carry any waste into the nearby creek. The state of Pennsylvania is expected to operate and maintain the site, controlling erosion, mowing, maintaining the fence, and sampling groundwater. EPA incurred about $13.8 million in costs for the cleanup.

Figure 2.4: Bruin Lagoon Site Before Cleanup Actions

Source: EPA.

Figure 2.5: Bruin Lagoon Site After Cleanup Actions



Source: EPA.

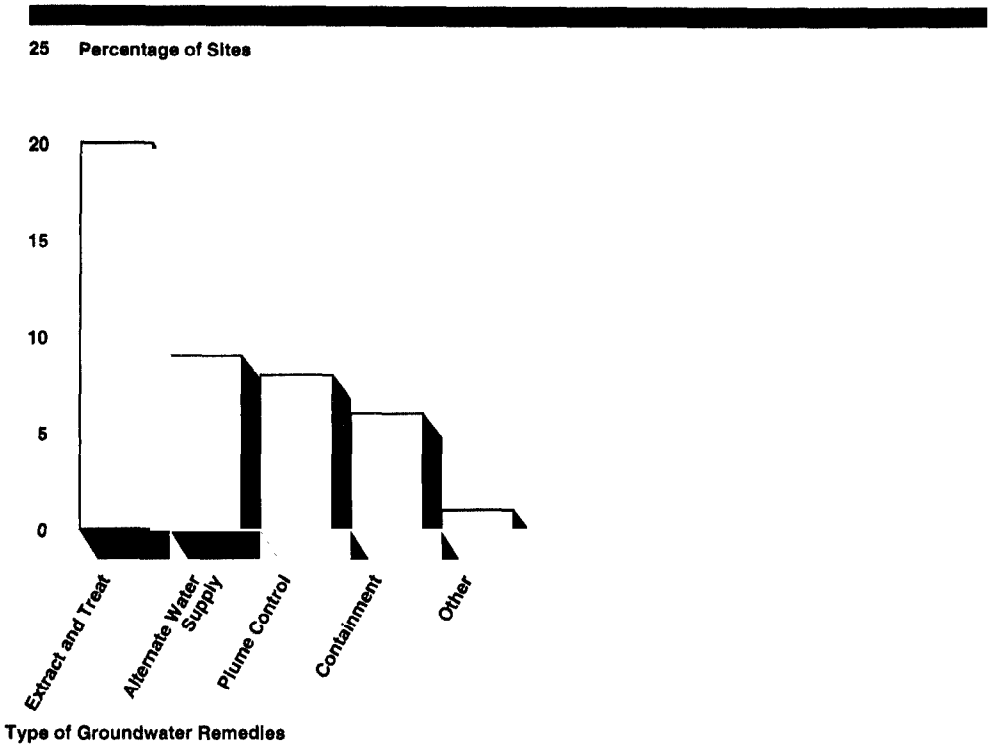
Long-Term Groundwater Cleanups Reduce Waste and Control Contaminant Migration

EPA addressed groundwater contamination problems at 46, or nearly one-third, of the 149 sites, often in combination with a surface waste remedy. EPA identified solvents, organic chemicals, and metals as the primary source of contamination in about half of the of 46 sites.

As figure 2.6 shows, EPA most commonly addressed groundwater contamination by using treatment, providing alternative water supplies to residents, or taking measures to control groundwater flow. At 30 of the sites, EPA treated groundwater by either constructing an on-site treatment facility or using a local municipal water treatment plant. At 13 sites, EPA determined it was best to provide affected residents with an alternate water supply. At 12 sites, EPA used a plume control technique[2] in an attempt to prevent polluted groundwater from migrating from the site.

[2]A plume is a body of contaminated groundwater flowing from a specific source.

Figure 2.6: Percentage of Construction-Complete or Deleted Sites Where Various Types of Groundwater Remedies Were Used



Note: Based on 149 construction-complete or deleted sites. Percentages do not add to 100 because not all sites required groundwater remedies, and some sites had more than one type of remedy.

Source: GAO's analysis of EPA's data.

For example, at the Fairchild Semiconductor site in San Jose, California, EPA used a combination of groundwater treatment and containment to clean up water contaminated with solvents. The Fairchild plant manufactured semiconductors from 1977 until 1983. During that time, an underground tank leaked about 58,000 gallons of a mixture including water and solvents that contaminated soil and groundwater. The responsible party began cleanup in 1982 under the state of California's supervision. EPA included the site on the NPL in 1989, after most of the cleanup system was already built.

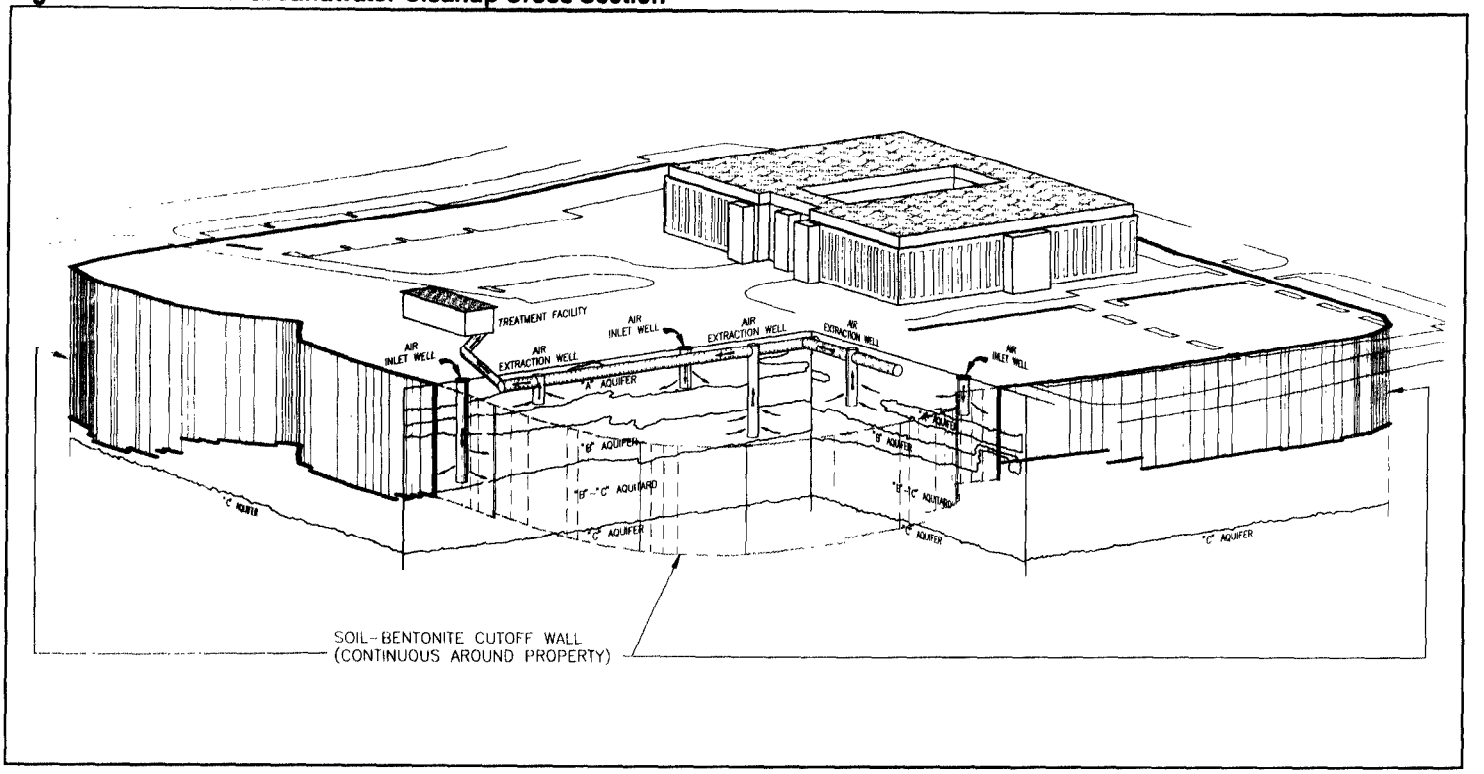
To reduce direct exposure to the waste and remove its source, the responsible party excavated the storage tank and contaminated soil, disposing of it off site. Then, a soil vapor extraction system was installed

to remove residual solvents. In addition, an underground barrier of soil mixed with bentonite clay was constructed around the property to prevent additional contaminated groundwater from flowing off site.[3] Groundwater was extracted from wells inside and outside the clay barrier and treated. Currently, because pollution levels in the groundwater off site have reached federal standards, the treatment system has been turned off, although it can be turned back on if contamination increases.

Because contamination within the clay barrier still exceeds cleanup standards established for the site, groundwater treatment continues on site. To help ensure that the on-site cleanup meets cleanup standards, EPA required the responsible party to restrict land use so that the clay barrier is not disturbed and to prohibit the drinking of water extracted from within the property's boundaries. EPA incurred costs of about $117,000 at this site, which the responsible party agreed to pay. The responsible party reports spending about $45 million.

[3]The clay barrier extends from the surface to the aquitard that lies underneath the contaminated aquifers. An aquitard is a relatively impermeable layer of soil, clay, or rock that separates aquifers.

Figure 2.7: Fairchild Groundwater Cleanup Cross Section



Source: Canonie Environmental Corporation.

In another cleanup that addressed contaminated groundwater, at the Lehillier/Mankato site near Mankato, Minnesota, a combination of groundwater plume control and groundwater treatment was used to clean up organic chemical contamination. The state of Minnesota discovered TCE, a carcinogen, in private wells in Lehillier in 1981. EPA investigations in 1982 and 1983 identified a TCE plume that had moved to within one-quarter mile of the city of Mankato's water supply well. EPA closed private wells in Lehillier and supplied residents with bottled water until a new water supply system was constructed in 1984.

Despite historical research and sampling, EPA was not able to find the TCE source. To protect Mankato's drinking water supply and reduce groundwater contamination, EPA and the state of Minnesota built a series of seven extraction wells in 1989. Six wells were placed between the plume and the water supply wells to extract contaminated groundwater

and discharge it into a local river. The seventh well is located in the area of highest contamination and is equipped with a treatment system to attempt to lower the TCE concentration. Monitoring results show that the plume is being contained; however, it is unclear how long the treatment system will have to operate until cleanup standards are reached. Because it is not known whether a TCE source still exists in the area, EPA estimates the cleanup will continue for 2 to 12 years. The city of Mankato is currently operating the well system under contract to the state of Minnesota. EPA incurred about $3.1 million in costs at the Lehillier/Mankato site.

One-Third of Construction-Complete or Deleted Sites Required No Remedial Action

Thirty-four percent of the 149 sites did not require remedial action. At 28 of these 51 sites, EPA's removal program controlled site risks and, after further evaluation, EPA concluded that levels of contamination at these sites did not merit additional cleanup, as figure 2.1 showed. At the remaining 23 sites, EPA took no removal or remedial action because studies showed that these sites posed no threat to human health and the environment.

Removals Sufficiently Controlled Threats at Some Sites

Removal actions were sufficient to clean 28 of the 149 construction-complete and deleted sites. For example, EPA used a removal action to sufficiently resolve contamination problems at the Sealand Limited site in Mount Pleasant, Delaware. In 1982 and 1983, waste oil, tar, creosote, and other wastes were accepted at the site for recycling. The operators abandoned the site in 1983, leaving various leaking tanks and barrels. In 1983, EPA began removing barrels and the contents of tanks, cleaning the tanks, capping various portions of the site, and installing groundwater monitoring wells. According to the EPA project manager for this site, samples from one of the monitoring wells later showed high levels of carcinogenic polycyclic aromatic hydrocarbons in the groundwater. These samples prompted further study, and EPA placed the site on the NPL in 1990. After a site study showed that groundwater and soil were not contaminated above acceptable levels, EPA determined that no further cleanup was necessary and placed the site in the construction-complete category in 1992. In all, EPA incurred costs of about $1.7 million at this site, which it recovered from the responsible parties, according to a regional official.

Some Sites Required No Cleanups

Twenty-three of the 149 sites (15 percent) required no remedial or removal actions at all. After these sites were included on the NPL, additional study by EPA showed that any contaminants found at the site posed no threat to

human health and the environment. In 1991, EPA revised procedures for evaluating and placing sites on the NPL. We were not able to determine as part of this review what, if any, impact this revised evaluation procedure will have on identifying sites that do not require cleanup to prevent their inclusion on the NPL.

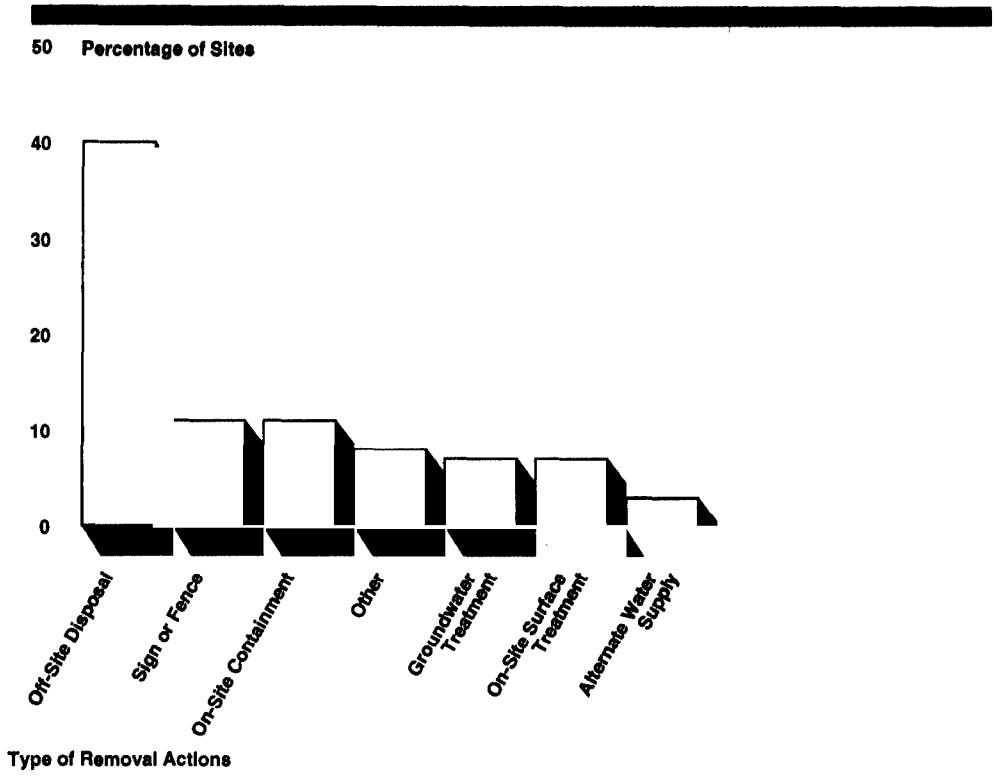
One such site that was deleted from the NPL without any cleanup was the Morris Arsenic Dump site in Morris, Minnesota. This site was reported to have been used as a dumping ground for arsenic-bearing grasshopper bait in the 1940s. EPA listed the site in 1983 on the basis of these historical records and the results of some groundwater samples that showed elevated levels of arsenic. Later site studies were unable to find arsenic in soil or groundwater above normal levels. EPA believes an error in the sampling technique caused the apparent high arsenic levels in the original samples. EPA deleted the site from the NPL in 1986 after concluding that it did not pose any risk to human health and the environment. EPA reports incurring costs of $250,000 at the Morris Arsenic site.

Removal Program Was Instrumental in Completing Cleanups

EPA's removal program, which generally allows the agency to take immediate action for one year and spend up to $2 million, was instrumental in stabilizing contamination risks and mitigating and resolving contamination problems at over half of the construction-complete and deleted sites. Through 1992, EPA had begun over 3,200 removal actions at hazardous waste sites; 958 of these actions were conducted at sites on the NPL.

EPA conducted a total of 125 removal actions involving 82 of the 149 construction-complete or deleted sites. As figure 2.8 shows, removal actions at these sites were generally directed at preventing access to the waste either by removing some waste, such as drums containing hazardous waste, and disposing of it off site, or by placing a fence or warning signs around the site. These removal actions usually preceded or were used in combination with a remedial action. In 10 of our 17 case studies that included removals, these activities played a role in reducing the threat of immediate exposure; in three of these cases, removals constituted the only action taken before categorization as construction-complete or deletion.

Figure 2.8: Percentage of Sites Where Removal Actions Were Used



Note: Based on 149 construction-complete or deleted sites. Percentages do not add to 100 because not all sites required removal actions, and some sites had multiple removal actions.

Source: GAO's analysis of EPA's data.

For example, the entire cleanup at the Union Scrap Iron and Metal site in Minneapolis, Minnesota, was accomplished through the removal program. The site was contaminated with lead battery fragments left over from a battery recycling operation. From 1985 to 1988, EPA conducted a series of removal actions that included covering the fragments with tarpaulins to prevent air pollution and fencing the site to control access. Subsequently, EPA, with assistance from the responsible party, disposed of all battery debris and contaminated soil off site, demolished site buildings, and covered the entire area with unpolluted soil. A subsequent site study showed the removal actions had achieved the cleanup standards, and the site has been deleted from the NPL. EPA incurred about $1.6 million in costs at the site.

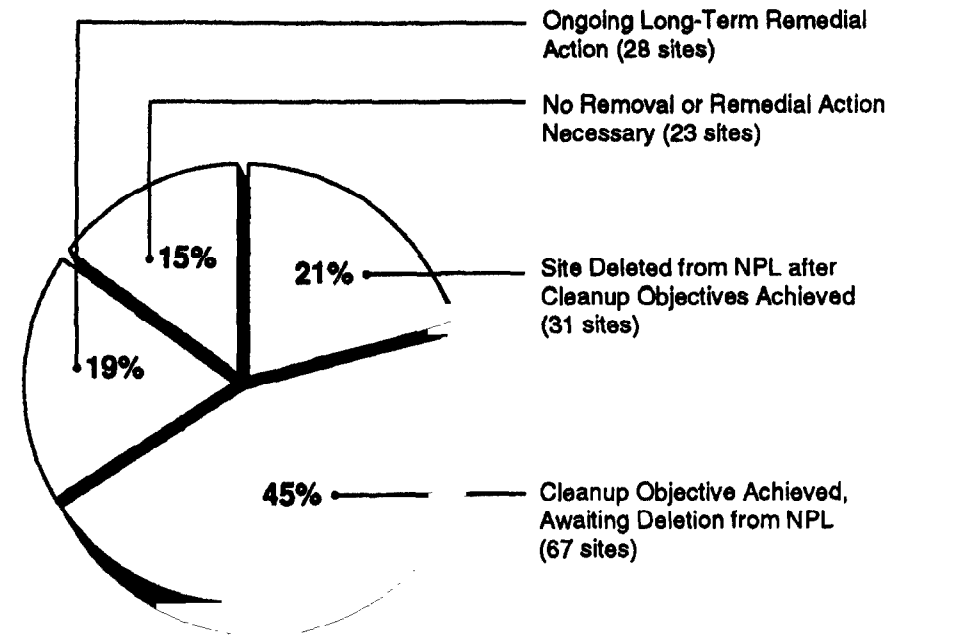
At other sites, removals were an integral part of final cleanup. For example, the Del Norte County Pesticide Storage Area in Crescent City, California, served as a storage facility for pesticide and herbicide containers. The state of California discovered in 1981 that, as a result of the rinsing of these containers, soil and groundwater at the site had been contaminated. EPA added the site to the NPL in 1983 and concluded the site study in 1985. In 1987, while developing the design for the remedy, EPA used the removal program to excavate and dispose of contaminated soil and debris from the site, effectively removing the pollution source. EPA subsequently built a groundwater extraction system and is currently treating groundwater, but cleanup standards have yet to be reached. EPA has incurred costs of $3.1 million at this site.

EPA Could Do a Better Job of Reporting the Cleanup Status and Accomplishments of Sites

EPA could do a better job of reporting the extent of cleanup work performed and achieved at sites on the NPL. In recent testimony, EPA has not adequately described the range of actions taken at construction-complete and deleted sites. As we have discussed throughout this chapter, significant differences exist between sites where remedial action was not taken and sites that will require more extensive cleanup, as well as between sites that have been deleted from the NPL and those awaiting deletion after remedy construction is complete. Furthermore, some sites will not reach conditions that EPA believes are protective of human health and the environment for many years. EPA could better inform the Congress and the public about the actual status of these sites by using a classification system that fully reflects the extent to which cleanup objectives have been achieved.

We believe that by reporting all construction-complete and deleted sites as a single number, EPA is not making important distinctions about the cleanup accomplishments achieved. For example, figure 2.9 shows a breakdown of the 149 construction-complete and deleted sites by categories that reflect the extent to which cleanup objectives have been achieved.

Figure 2.9: Construction-Complete and Deleted Sites Classified by Attainment of Cleanup Objectives



Note: Based on 149 construction-complete or deleted sites. The category "Ongoing Long-Term Remedial Action" includes sites where treatment systems are operating; these sites have not yet achieved cleanup objectives. The category "Cleanup Objectives Achieved, Awaiting Deletion From NPL" includes sites where construction is complete and cleanup objectives have been achieved. The category "No Removal or Remedial Action Necessary" includes those sites where EPA determined that cleanup actions were not necessary; it includes nine sites deleted from the NPL.

Source: GAO's analysis of EPA's data, adjusted for known errors.

As the figure indicates, of the 149 sites that EPA has reported as construction-complete or deleted sites, 31 (21 percent) have achieved cleanup objectives and have met all the criteria for being deleted from the NPL. An additional 67 sites (45 percent) have achieved cleanup objectives but have still not met all criteria for deletion. That is, EPA has yet to fully document that cleanup activities have reduced site risk to a level that fully protects human health and the environment. In addition, at 28 sites (19 percent), construction of the cleanup remedy is complete, but long-term remedial action will be required before cleanup objectives can be achieved. Finally, at 23 (15 percent) of the sites that EPA has reported as construction-complete or deleted, no removal or other cleanup action has been taken at all.

For its internal use, EPA distinguishes between those construction-complete sites that are "awaiting deletion" and those where long-term remedial actions are operating. Our work also shows that EPA incorrectly listed at least three sites in the awaiting deletion category that should have been categorized as sites where long-term remedial actions are operating. Specifically, EPA's long-term remedial action list omits the Fairchild Semiconductor, Teledyne Semiconductor, and Spectra-Physics sites. Our review of documentation for these sites showed that cleanup work is still ongoing and the sites have yet to achieve cleanup standards. We pointed this out to responsible EPA officials, and they agreed to review these sites to determine whether they should be reclassified.

Conclusions

The Superfund program has made substantial progress in addressing the health and the environmental risks at the 149 sites where EPA considers cleanup construction to be complete or which it has deleted from the NPL. Our review of these sites identified the difficulties involved in eliminating health and environmental risks at these sites and implementing cleanup actions that effectively remedy the contamination problems. Our review also shows the critical role that the emergency removal program plays in reducing immediate risk, and the beneficial value the program has on remedial cleanup efforts at some sites.

Although EPA has made considerable efforts in constructing site remedies, the extent to which these efforts will continue to protect health and the environment has yet to be determined. Ensuring the long-term protectiveness of these sites will require periodic monitoring of site conditions and, in some cases, operation of treatment systems. Since the types of cleanups and measures of protection vary from site to site, EPA's method for classifying and reporting site cleanup status should avoid the implication that all sites are equally protective of human health and the environment. The Congress and the public would be better informed of the true status of these sites if the classification system fully reflected the extent to which cleanup objectives have been achieved.

Recommendation

To more accurately reflect the extent to which cleanup levels have been achieved at Superfund sites, we recommend that the Administrator, EPA, modify the classification of construction-complete and deleted sites to identify sites according to whether they have achieved their objectives of protecting human health and the environment and have been deleted or

are awaiting deletion from the NPL, required no removal or remedial action, or will require long-term efforts to achieve their cleanup objectives.

Significant Resources Can Be Required to Achieve and Sustain Long-Term Cleanup of Sites

Significant federal, state, and private-party resources will be needed to address contamination at Superfund sites and to attain cleanup goals at sites classified as construction-complete and deleted. EPA has spent about $374 million on cleanup work at the 149 construction-complete and deleted sites through September 30, 1992, with a median cost of $2.1 million for sites where it funded all site work. Future costs for Superfund sites still in the cleanup pipeline may be higher, since these sites are more complex and can be expected to demand higher outlays of resources to finance more extensive cleanups.

Furthermore, because containment or groundwater technologies have been used to address contamination in three-quarters of the sites, these sites will require significant, long-term operation, maintenance, and monitoring efforts and expenditures by EPA, the states, and responsible parties. For example, EPA estimates that states will incur about $1 billion in operation and maintenance costs over the next 7 years alone. If this commitment is not effectively fulfilled, the continued ability of cleanup remedies at Superfund sites to protect public health and the environment could be in jeopardy.

Despite this need for long-term vigilance, we found that some states are concerned that they will lack the resources to operate and maintain construction-complete sites and monitor the continued level of protection afforded at these sites. At a site where construction was completed, for example, we found that, because of resource and staffing shortages, the state did not take the yearly samples from site wells required by the site's monitoring plan. This problem may become more severe and widespread as additional financial demands are placed on the states to monitor, operate and maintain the ever-growing number of sites that are expected to emerge from the Superfund pipeline. Such financial concerns led nine states to legally challenge EPA's interpretation of CERCLA that states are responsible for all the costs of operating and maintaining these sites. The court recently upheld EPA's interpretation.

Future Superfund Cleanups Will Be Significantly More Difficult and Costly

Hazardous waste sites still in the Superfund pipeline will likely be more difficult and costly to clean up than recently deleted sites or sites where construction was recently completed. These cleanup costs and difficulties can be attributed partly to the relative complexity of contamination problems at these sites. But the type of cleanup action that will be needed to resolve these problems is also an important factor.

Cleanups of Superfund sites currently at earlier stages in the cleanup process can be expected to be more difficult and costly because of differences in site characteristics. Table 3.1 compares the characteristics of 149 construction-complete and deleted sites with those of sites still in the pipeline. As the table shows, these groups differ in the type and number of cleanup actions required, the expected duration of the cleanup, and their relative ranking on the NPL.

Table 3.1: Comparison of Construction-Complete or Deleted Sites With Sites Still in the Cleanup Pipeline

Site characteristics	Construction- complete or deleted sites[a]	Sites remaining in cleanup pipeline[b]
Type of cleanup action for surface waste	64 percent off-site disposal; 53 percent on-site containment; 28 percent on-site treatment[c]	70 percent waste treatment
Number of cleanup actions	One cleanup action per site for 87 percent of sites[d]	Average of two cleanup actions per site
Remedial action taken?	34 percent with no remedial action	Number of "no remedial action" sites unknown
Cleanup duration	Median of 6 years	10 years
Rank on NPL	Two-thirds in lower half of NPL	Distributed throughout the NPL

[a]Source: GAO's analysis of EPA's data.

[b]Source: EPA's estimates.

[c]Percents do not add to 100 because sites may use more than one type of cleanup. The percentages reported on surface cleanups are based on 72 sites where surface cleanup took place.

[d]The percentage reported was arrived at after excluding 51 no-action sites from the 149 construction-complete and deleted sites.

For example, in response to SARA, EPA is more frequently selecting treatment as the primary means of cleaning up surface waste for sites still in the pipeline. A 1990 EPA study reported that treatment technologies cost more to construct in the short term than containment technologies.[1] The frequency with which EPA selected treatment technologies for controlling surface waste grew from 54 percent in 1987 to 70 percent in 1990. That is, sites currently in the design or cleanup stages are increasingly relying on waste treatment. In contrast to this increased selection of treatment in recent years, on-site treatment was used in cleanups at the 149 construction-complete or deleted sites only about 13 percent of the time.

[1]Enhancing State Superfund Capabilities, U.S. Environmental Protection Agency (Washington, D.C.: 1990).

In addition to using treatment more often, sites still in the Superfund pipeline are relatively more hazardous than sites classified as construction-complete or deleted. For example, 95 (64 percent) of the 149 construction-complete or deleted sites were listed in the lower half of the NPL, on the basis of EPA's Hazard Ranking System (HRS) score. The ranking of these sites indicates that the relative risks posed by these sites were typically less than those of other NPL sites.[2]

As a final contrast to other sites on the NPL, construction-complete or deleted sites underwent fewer cleanup actions than sites in the earlier stages of cleanup. We found that at 85 of 98 sites undergoing long-term cleanups, the remedy involved a single cleanup action—or "operable unit," as EPA terms such actions. EPA forecasts that the average site on the NPL will involve two operable units and, consequently, will be more costly to clean up. Additionally, the remaining 51 (34 percent) of the 149 sites were mainly sites where no remedial action was taken. At sites where no cleanup action was taken, costs were generally lower (the median cost was $869,000) than they were at sites where long-term cleanup actions were needed (where the median cost was $3.5 million).

Although cost data were somewhat sketchy for both past and future cleanups, we believe that cleaning up the sites still in the Superfund pipeline is likely to cost significantly more than cleaning up the 149 construction-complete or deleted sites because of these differences in characteristics between the two groups. Our review of EPA's disbursement data shows that, as of September 30, 1992, EPA has spent about $374 million in 1992 dollars at construction-complete or deleted sites. The median cost at 79 sites where EPA funded all site studies and cleanup work was $2.1 million.[3] EPA estimates that the average cleanup at EPA-funded sites currently listed on the NPL will cost about $26 million.[4]

[2]Eleven of the sites in the top half were the top priorities of states, which EPA must place at the top of the NPL regardless of their HRS scores. The HRS provides some measure of the relative priority of sites on the NPL, but is not an absolute indicator of relative complexity, since it does not quantify the actual risks at the sites.

[3]Total spending at these sites is understated. First, EPA allocates its administrative or indirect costs to specific sites, but it estimated that only about 35 percent of indirect costs can be allocated in this manner. In 1992, EPA proposed a new indirect cost regulation that adds costs excluded under the current rule. Our analysis used the current rule. Second, some payments to states for cleanup management are excluded.

[4]EPA's estimate is not comparable to GAO's estimate of site costs because of differences in the methodology used in estimating these costs. First, EPA used a different set of sites for computations. Second, EPA used projections of costs rather than actual expenditures, and EPA acknowledges that these projections are subject to a high degree of variability. Third, EPA did not adjust the dollar values to a common-year dollar.

While our analysis showed that cleanup costs are likely to grow for both EPA and responsible parties, demands on EPA's cleanup resources may be mitigated somewhat by the growing proportion of cleanups funded by responsible parties. EPA spent considerably less at sites where responsible parties or states funded the work. For example, although these responsible-party-funded sites represented nearly half (68) of the construction-complete or deleted sites, they were responsible for only 22 percent of EPA's site expenditures, for a median cleanup cost of about $400,000.

Many Construction-Complete or Deleted Sites Will Require Long-Term Resource Commitments

Cleanup remedy selection can affect the long-term resources needed to ensure that the cleanup remains protective of health and the environment. Our analysis of the current list of construction-complete and deleted sites indicates that 61 (41 percent) of the 149 sites will require a long-term commitment of resources to operate and maintain the remedy. These resources could be significant. For example, groundwater contamination at some sites will require indefinite pumping and treatment to achieve cleanup goals, and sites with soil contamination will require long-term maintenance and monitoring of clay caps to ensure that the remedy continues to protect health and the environment. An additional eleven sites will require enactment and enforcement of land-use restrictions to protect the remedy.

Type of Action Taken at Site Affects Duration of Cleanup

Our analysis of construction-complete and deleted sites shows that groundwater treatment occurs at 20 percent of these sites. Groundwater contamination, which is present at more than 70 percent of the sites on the NPL, is one of the most challenging problems at Superfund sites. We found that remedies at sites where groundwater treatment remedies are used cost more to construct and operate (at a median cost of $3.6 million) than remedies at the average site (at a median cost of $2.1 million).

In a recent policy statement, EPA formally recognized the technological barriers to cleaning up sites with groundwater contamination, particularly those with nonaqueous phase liquid contamination or certain geological features.[5] According to a 1992 EPA memorandum from the Assistant Administrator of OSWER, if the agency determines that meeting groundwater cleanup standards is technically impracticable, alternative cleanup actions that prevent exposure to contaminated groundwater and

[5]Nonaqueous phase liquids are generally organic compounds that do not dissolve in water and are difficult to remove with current technologies. If they cannot be removed, their presence may continue to contaminate groundwater.

the migration of contaminants will have to continue for as long as the contaminant concentrations remain above cleanup standards. Operation and maintenance of these systems may be required for a very long or indefinite period of time.

The Teledyne and Spectra-Physics sites in Mountain View, California, demonstrate the technical difficulties and cost of cleaning up groundwater contamination. Teledyne Semiconductor has manufactured semiconductors since 1962. In 1982, investigations at the site revealed that the groundwater and soil were contaminated with organic solvents used in the manufacturing process. Furthermore, contaminated groundwater had migrated from the adjacent Spectra-Physics manufacturing site and merged with the contaminated plume of the Teledyne site. The state inspected the site and worked with both companies to develop a cleanup approach. Teledyne and Spectra-Physics jointly built a groundwater extraction system, and Spectra-Physics installed a soil vapor extraction system. A Teledyne official estimated that the company has spent $10.5 million to date in site remediation costs and plans to spend $1.2 million annually for operation and maintenance. A Spectra-Physics official said the company has spent about $6.9 million on its cleanup efforts.

According to both Teledyne and Spectra-Physics officials, the cleanup of the contaminated plume will take an indefinite period. Current plans call for the extraction system to be operated until 2022, and operation and maintenance costs will accrue annually. The presence of extensive groundwater contamination at this site also requires EPA and the state to expend resources, since EPA and the state must monitor the site for the duration of the groundwater treatment to ensure the effectiveness of the cleanup. EPA incurred costs of $386,000 for these sites. According to an EPA official, responsible parties have agreed to reimburse EPA. We did not obtain an estimate of the state's costs.

Containment Sites Require an Indefinite Monitoring Commitment

Contaminated waste remains at nearly half the construction-complete or deleted sites, either contained on site or in groundwater that is not yet clean. EPA or the states will have to monitor and maintain these sites indefinitely to ensure that their remedies protect human health and the environment. A 1990 EPA study showed that containment remedies may initially be less expensive to construct, but that the required operation and maintenance and the potential for failure increase their cost in the long run.

Work Load for 5-Year Reviews Is Increasing

EPA has a continuing oversight responsibility to ensure that cleanups protect health and the environment through the evaluation of site monitoring data, periodic inspections, and 5-year reviews.[6] Since up to 48 percent of construction-complete or deleted sites will require 5-year reviews, EPA's work load for 5-year reviews is considerable. EPA regional staff have conducted or evaluated 16 of these reviews through March 1993 and estimate that about 170 are due to occur this year. Through the year 2000, according to OSWER officials, more than 700 5-year reviews will be scheduled, at a cost of about $35 million. Because of this large impending work load and limited agency resources, OSWER officials are considering ways to set priorities for the reviews. These choices could include reviewing sites that have not recently had any EPA staff on site and performing less extensive reviews at other sites.

Five-year reviews can be vital to the continued effectiveness of cleanups. For example, the draft 5-year review at the Mowbray Engineering site in Alabama showed that no one had collected required groundwater samples, maintained the site fence, or inspected and maintained the cap over the solidified contaminated material. Trees had begun to grow on the cap, and their roots threatened the cap's integrity. Because required samples had not been collected, EPA could not determine whether groundwater was contaminated. As a result of the review, responsible parties began to maintain the fence and cap and analyze the site's groundwater.

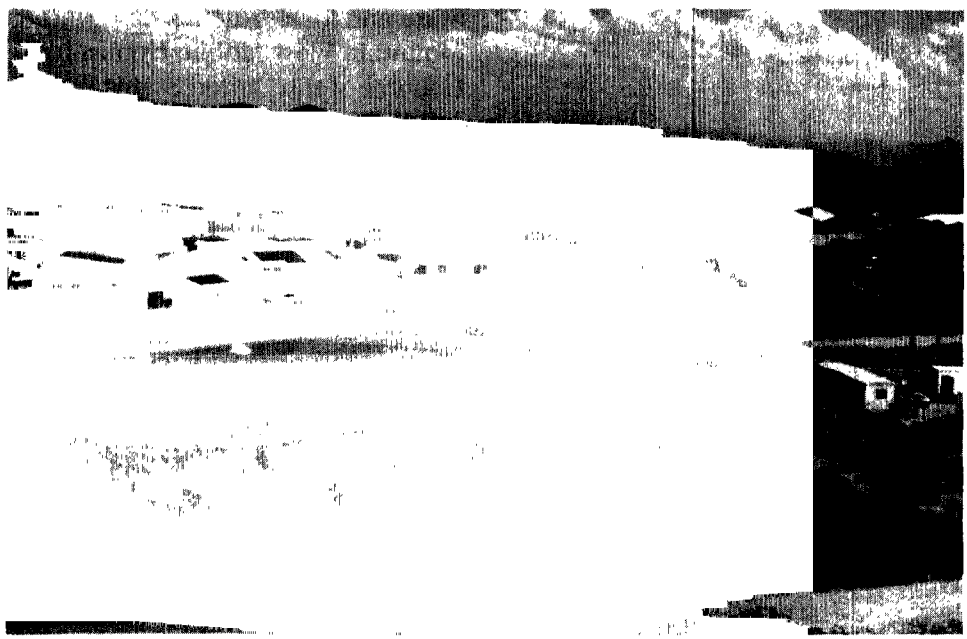
The Mountain View Mobile Homes site in Globe, Arizona, demonstrates the long-term commitment necessary to ensure that the cleanup protects health and the environment. After an extensive cleanup, the site will require 5-year reviews for an indefinite period. The 17-acre mobile home subdivision was developed in 1973 at the site of the Metate Asbestos Corporation asbestos mill. The mill processed asbestos ore for approximately 20 years until it was found to be in violation of EPA's air quality standards; it then ceased operations. Before a 1973 temporary injunction became permanent in 1974, the owner of the mill obtained a rezoning of the property, making it eligible for residential use. Asbestos tailings and contaminated soil were used as landfill to level the site, and the area was subdivided into 55 lots, 47 of which were occupied by 130 residents.

[6]The Superfund Amendments and Reauthorization Act of 1986 (SARA) requires a 5-year review for cleaned-up sites. For remedies that result in hazardous waste remaining on site, the review must be completed within 5 years of the beginning of cleanup construction, and every 5 years thereafter. As a matter of policy, EPA has decided to conduct 5-year reviews for all cleanups at sites that will be released for unlimited and unrestricted exposure, but where the cleanup standards will take 5 or more years to attain.

State and local officials discovered asbestos contamination in the soil at Mountain View Mobile Homes in 1979. In 1980, the Assistant Surgeon General of the United States recommended that all residents of the subdivision be immediately evacuated. Soon thereafter, the Governor of Arizona declared a state of emergency at the site. The state provided residents with temporary housing while it took mitigation measures at the site, including the demolition of adjacent mill buildings and installation of a 6-inch layer of soil over portions of the site. Following completion of these measures, the owner of the subdivision continued to sell lots. After the state discovered that erosion of the soil cover was exposing residents to asbestos fibers, the site was added to the NPL in 1983 as Arizona's highest-priority site.

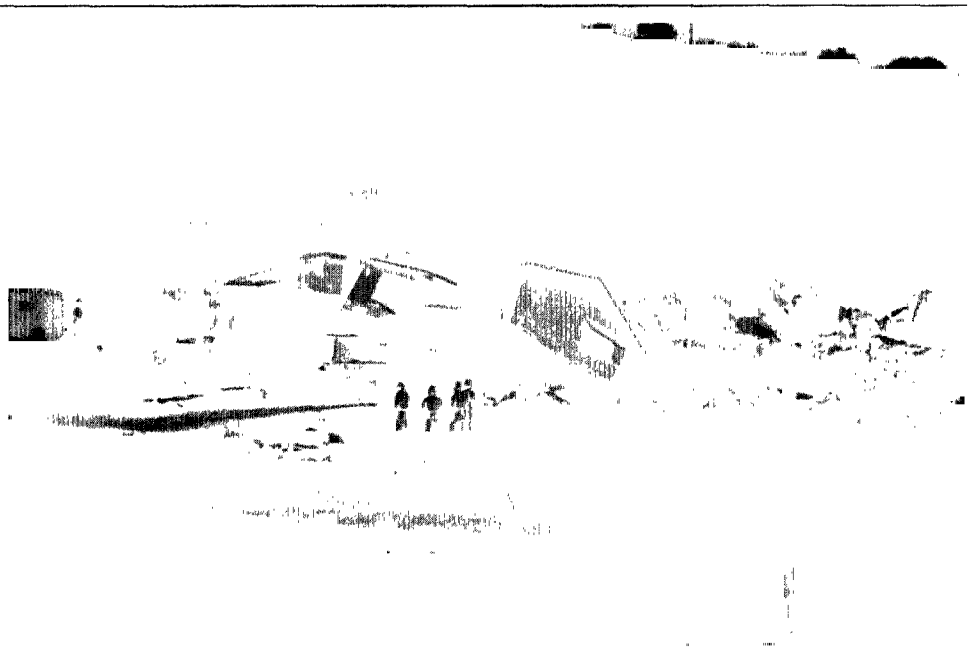
EPA's actions to clean up Mountain View Mobile Homes included permanent relocation of the subdivision residents, cleaning the site, demolishing and burying on site all of the homes and the subdivision's sewage treatment plant, capping the entire area, fencing, and periodic inspection and maintenance. (See figs. 3.1 and 3.2.) According to an EPA official involved in the 5-year review in 1990, the remedy continues to protect health and the environment. EPA incurred approximately $3.8 million in costs to clean up the subdivision, and EPA will continue to perform 5-year reviews and bear their costs indefinitely.

Figure 3.1: Mountain View Mobile Homes Subdivision Before the Cleanup



Source: EPA.

Figure 3.2: the Mountain View Mobile Homes Site While Vacated Residences Were Being Demolished



Source: EPA.

Institutional Controls Are Difficult to Enforce

For sites like Mountain View Mobile Homes, institutional controls, such as fences or restrictions on land or water use, imply an indefinite enforcement period to maintain the integrity of a cap or protect the public from contact with contaminated soils. Our analysis of construction-complete and deleted sites shows that 35 percent of the sites included institutional controls as an integral part of the cleanup strategy.

Ensuring the efficacy of institutional controls is difficult, according to EPA officials at both headquarters and regional offices. For example, an EPA Region III official said that regional Superfund staff avoid using institutional controls as a primary component in a cleanup because they present significant enforcement challenges. EPA depends on responsible parties and local governments to impose and maintain institutional controls.

Financial Health of States and Responsible Parties Affects the Level of EPA's Resource Commitments

Although EPA is ultimately responsible for ensuring the protectiveness of cleanups, EPA interprets CERCLA as requiring that the states or responsible parties operate and maintain construction-complete and deleted sites. EPA estimates that the states spent $110 million on operation and maintenance from 1980 to 1993 alone. A 1991 EPA study shows that the states will incur $1 billion in operation and maintenance costs over the next 7 years,[7] and officials in five states question whether they will be able to meet these obligations. According to an EPA official, EPA does not plan to continue forecasting these costs. Thus, cost data will not be available to help EPA and the states plan for future resource requirements.

States May Have Difficulty Operating and Maintaining Sites

EPA has conducted several studies to assess the current and future capacities of the states to finance their hazardous waste programs. These studies showed that states vary in their capacity to operate their own hazardous waste programs, contribute to the cost of cleanup, and pay the administration cost of their programs. While some states are capable of managing their programs effectively with minimum intervention from EPA, the level of staffing or financial position of other states requires that EPA perform all or the majority of program activities at sites on the NPL. In addition, the states are responsible for cleaning up the thousands of hazardous waste sites that are not on the NPL. In any case, the availability of funds to operate and maintain sites is dependent on state budgetary processes.

[7]Record of Decision Operation and Maintenance Cost Analysis, U.S. Environmental Protection Agency (Washington, D.C.: June, 1991). These figures were based on estimates of future cleanup cost that are subject to variability.

Resource concerns led nine states to file suit against EPA. The lawsuit maintained that the Congress never intended the states to pay all operation and maintenance costs at sites on the NPL.[8] The Association of State and Territorial Solid Waste Management Officials (ASTSWMO) has also taken issue with EPA on similar grounds. ASTSWMO's position, similar to that of the lawsuit, is that the states should only pay 10 percent of all costs incurred during site cleanup until a site is deleted from the NPL. These costs would include operation and maintenance, any additional cleanup or treatment needed as a result of changes at the site, and all state oversight costs incurred during these project phases. On July 20, 1993, the United States Court of Appeals for the District of Columbia Circuit resolved the suit by ruling that states are responsible for all operations and maintenance costs. ASTSWMO also believes that the states should not be required to ensure that institutional controls are in place and effective. In ASTSWMO's view, many states do not have the legal authority to implement institutional controls.

In some cases, resource constraints at the state level have a direct impact on measuring the extent to which a cleanup protects health and the environment. For instance, according to the 5-year review completed in 1993, the state of Pennsylvania has not fully complied with its agreement to monitor and maintain the Wade site in Chester, Pennsylvania. From approximately 1950 until the early 1970s, the site was the location of a rubber recycling facility that shredded tires and other rubber products. During the early 1970s, the site was converted to an illegal industrial waste storage and disposal facility. Drums were emptied either directly onto the ground or into trenches, severely contaminating the soil and the groundwater. The cleanup of the Wade site consisted of removing and disposing of tires and tanks, waste piles, contaminated soils, and demolishing buildings. The site was then covered with topsoil and the cap seeded to minimize erosion. EPA incurred costs of approximately $2.8 million at this site.

According to the site's manager, the monitoring plan for this site calls for yearly sampling from its wells for 30 years. Nevertheless, the site's 5-year review shows that wells have only been sampled twice in the past 4 years. Due to problems with the validation of sampling results and sample collection methods, the samples were used for limited comparisons with the contaminant concentrations recorded in EPA's 1984 site studies. The EPA project manager said that the Pennsylvania Department of

[8]CERCLA states that a state will pay or ensure payment of (1) 10 percent of the cost of the remedial action, including all future maintenance, or (2) 50 percent or such greater amount of a cleanup at a facility that was operated by the state or a political subdivision.

Environmental Resources attributed noncompliance with the monitoring plan to understaffing and the low priority it has assigned to sampling at the site. The 5-year review recommends that the state routinely mow the vegetation on the site and repair and maintain the site's security fence and wells. It also recommends that future groundwater sampling be conducted according to accepted procedures. The 5-year review concludes that despite the state's noncompliance with the operation and maintenance plan for the site, the remedy remains protective of health and the environment, since the remaining contaminants have a negligible effect on water quality in the nearby Delaware River.

EPA Obtains Financial Assurances From Responsible Parties

To establish that responsible parties will pay for the cost of construction, operations, and maintenance, EPA is expected to include financial assurance provisions in its legal agreements with responsible parties. These provisions include options designed to set aside funds that ensure the availability of moneys for these costs, or financial tests designed to prove the parties have sufficient assets. EPA officials are not currently aware of the extent to which different types of financial assurances have been selected in the agreements, or whether all agreements negotiated before the 1991 guidance contained specific financial assurances. However, the legal agreements between EPA and responsible parties should allow EPA to fine or take other action against the responsible parties if they fail to perform site work or provide financial assurances.

EPA's model for negotiating agreements with responsible parties does not currently specify conditions for using financial assurances and relies on guidance in RCRA. However, the agency is currently developing new guidance addressing financial assurances. According to OSWER officials, this guidance identifies specific language to be used and discusses which type of assurance is appropriate for various circumstances.

Conclusions

Cleaning up the hazardous waste contamination at hundreds of NPL sites across the nation will require significant federal, state, and responsible-party resources. Resources will be needed not only to achieve desired cleanup goals at these sites, but also to sustain these goals and to maintain the cleanup's overall level of protectiveness of human health and the environment. Although EPA stresses a preference for using treatment technologies to permanently address contamination problems at Superfund sites, EPA is finding problems at sites that cannot be readily remedied using available treatment technologies. Consequently, because a

large proportion of sites require groundwater treatment or containment technologies, significant resources will be needed to continue the effective operation and maintenance of cleanups when waste remains on the site. The continued efficacy of the program therefore depends on the extent to which EPA, the states, and the responsible parties have the necessary resources to sustain the continuing technical and long-term financial challenges associated with these hazardous waste site cleanups.

Given these resource demands, a forecasted decrease in the Superfund operations budget, and the increased complexity of ongoing cleanups, estimates of EPA's future costs to monitor and inspect sites and the states' future costs to operate and maintain them could aid EPA and the states. These estimates could be used in determining resource needs and in planning and coordinating actions to meet those needs and commitments in the long term.

Recommendation

To address the challenges of increasing resource demands to clean up Superfund sites and plan for potential resource requirements at the federal and state level, we recommend that the EPA Administrator conduct additional studies to estimate the long-term cost to EPA of monitoring and inspecting construction-complete and deleted sites and the cost to states of operating and maintaining these sites.

Case Study Sites

Deleted Sites

EPA Region III

Wade (ABM), Chester, Pennsylvania

EPA Region V

Gratiot County Golf Course, St. Louis, Michigan
Union Scrap Iron and Metal, Minneapolis, Minnesota

EPA Region IX

Jibboom Junkyard, Sacramento, California
Mountain View Mobile Homes, Globe, Arizona

Construction-Complete Sites

EPA Region III

Bruin Lagoon, Bruin Borough, Butler County, Pennsylvania
Chisman Creek, York County, Virgina
Leetown Pesticides, Leetown, West Virginia
Sealand Limited, Mount Pleasant, Delaware

EPA Region V

Belvidere Municipal Landfill, Belvidere, Illinois
Lehillier/Mankato, Mankato, Minnesota
Northern Engraving Corporation, Sparta, Wisconsin

EPA Region IX

Del Norte County Pesticide Storage Area, Crescent City, California
Fairchild Semiconductor, San Jose, California
Firestone Tire and Rubber, Inc., Salinas, California
Spectra-Physics, Mountain View, California
Teledyne Semiconductor, Mountain View, California

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