Coming Clean: Superfund Problems Can Be Solved...

October 1989

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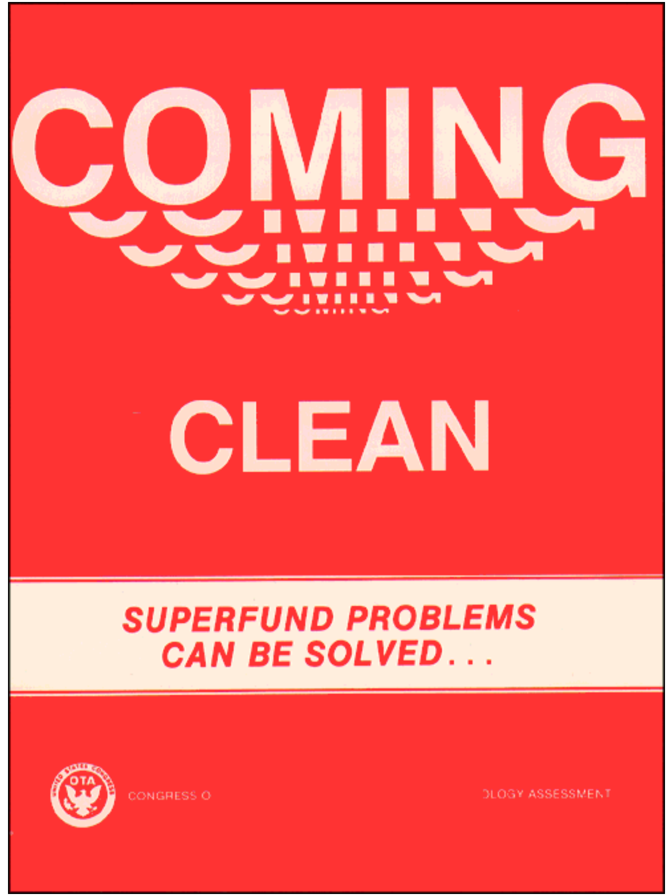

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Foreword

This report, which responds to requests from the House Committee on Public Works and Transportation and the House Committee on Energy and Commerce, examines the implementation of the Superfund Amendments and Reauthorization Act of 1986. An additional request was received from the Senate Subcommittee on Superfund, Ocean and Water Protection. Before the currnt assessment, OTA had responded to a number of other congressional requests to examine various aspects of the Superfund program. Previous OTA works on Superfund include *Technologies and Management Strategies for Hazardous Waste Control* (March 1983), *Habitability of the Love Canal Area* (technical memorandum, June 1983), *Superfund Strategy* (April 1985), and a number of special responses on specific Superfund sites. OTA has also published two earlier documents as part of this assessment: Are We *Cleaning Up.” 10 Superfund Case Studies* (special report. June 1988); and *Assessing Contractor Use in Superfund* (background paper, January 1989);

OTA recognizes the enormous challenge posed by the Nation’s commitment to clean up uncontrolled toxic waste sites. The challenge is to our scientific knowledge about properties, environmental transport, and health effects of toxic substances; to our technological capabilities to manage hazardous waste and cleanups; to our national workforce which, prior to Superfund, had little experience in site cleanup; to the government institutions charged with implementing Superfund, notably the U.S. Environmental Protection Agency; and last, but certainly not least, to everyone’s patience.

From its beginning. controversy has surrounded Superfund, and the program has had to cope with an unusually high level of public scrutiny, criticism, and debate. OTA is sensitive to the frustrations of many hard-working people trying to meet the Superfund challenge and recognizes that people are still learning. And a great deal has been accomplished, although it is easy to lose sight of the accomplishments amidst all the criticism. For example. hundreds of emergency responses have been successfully carried out, an enormous amount of contamination of land and groundwater has been carefully documented. and the major. near-term threats at many sites have been eliminated. Yet most of the national cleanup job lies ahead of us and the need to get increasing effectiveness per dollar spent is bound to grow.

In this report, OTA concludes that there is ample reason to be optimistic about the potential of the Superfund program and presents a number of possible strategic initiatives and incremental program changes in some detail. As difficult as the national cleanup job is, there are many ways to build a better balance between health and environmental needs and the limitations that technology, experience, and economics will always impose. OTA thanks the project’s advisory panel members for their invaluable assistance and appreciates the contributions made by all the other reviewers of the drafts of this report. But the contents of this report are solely OTA’s responsibility.

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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Summary, Introduction, and Policy Options

OVERVIEW

Superfund started out in 1980 as a short-term crash cleanup effort. By 1985, when Congress debated reauthorizing Superfund for a second 5 years, it had become controversial and confrontational. It has remained so. Superfund still lacks:

1. a carefully crafted strategy with implementation policies to spell out environmental priorities and goals;
2. an effective partnership among government, site communities, and private sector parties responsible for cleanup; and
3. a unified national infrastructure of education, training, databases, research, and development.

Superfund has not yet balanced protection of public health and environment against constraints of information, technology, time, and money very well.

Unless serious consideration is soon given to making **fundamental changes** in the structure and policies of the Superfund program through strategic initiatives, OTA's assessment is that significant risks to public health and environment will remain poorly managed, public expectations will remain unmet, and public confidence will worsen. Fine-tuning or incremental program changes are feasible and necessary too, but they alone will probably not suffice.

Another general OTA finding is that reducing excessive flexibility in Superfund implementation is critical to reducing the constant confrontation among nearly everyone affected by and working in the program. OTA calls the current adversarial condition the Superfund syndrome. Public fears of toxic waste and toxic chemicals set high expectations for Superfund; site communities perceive substantial risks to their health and environment and they want effective and stringent cleanups from the Environmental Protection Agency (EPA), regardless of cost; but communities have experienced slow, incomplete, and uncertain cleanups. EPA tries to limit fund-financed cleanups by getting parties held liable for sites to voluntarily pay for cleanups. However, responsible parties often believe that their liabilities are largely unfair, that risks are not as bad as communities think they are, that cleanup objectives are unnecessarily stringent, and, therefore, that they must work hard to minimize their cleanup costs. Unless everyone breaks out of the Superfund syndrome, most cleanups will seem to do too little or too much. Billions more dollars will be spent. Hardly anyone will be satisfied. Hardly anyone will feel treated fairly. Hardly anyone will seem in control.

Another general OTA finding is that Superfund's environmental mission is being undermined because of inefficient spending. OTA estimates that between 50 and 70 percent of spending by government and industry is inefficient because:

1. about 50 percent of cleanups address speculative future risks which preempts spending to identify and reduce current risks at many other sites;
2. about 75 percent of cleanups are unlikely to work over the long term; and
3. there are many unnecessarily high or avoidable administrative, study, and transaction (negotiation and litigation) costs.

OTA has found that many of the problems plaguing the Superfund program can be grouped in three areas: health and environmental protection priorities and goals; workers and technology; and government management. A three-point restructuring of the program focusing on these areas is possible. We summarize below our detailed findings in these areas. Later in this chapter, we discuss 38 policy options that, separately or in combination, Congress may wish to consider to improve the Superfund program. There are so many options because the problems identified by OTA in Superfund implementation are numerous and complex. The 38 policy options have been divided into two categories: *strategic initiatives,* which would be major new directions in the program, any significant number of which would result in program restructuring; and *program changes,* which are more modest in scope and which could be integrated into the existing program. Table 1-1 lists the ***38*** options within the two categories and three problem areas.

Health and Environmental Priorities and Goals

Clearer priorities and less maneuvering room in environmental goals can make the Superfund system work better, fairer, and faster. By not setting clear priorities, government has fed unrealistic public expectations, making management of Superfund with limited resources a thankless task. Government has largely ignored the front-end of Superfund; for example, there is no Federal site discovery program. New National Priorities List (NPL) sites are no less hazardous than sites discovered earlier, according to EPA data. But sites in the program may wait years for significant attention. The size of the NPL is a policy choice, and cleanups are channeled from Superfund to other less stringent cleanup programs in the shadow of Superfund. Thus, Superfund may increasingly become a re-cleanup program.

A central conclusion of OTA's 1985 report ***Superfund*** *Strategy* was the critical need for taking faster, but *limited,* actions at *all* sites nationwide to reduce immediate threats and reduce the spread of contamination.[1] Today, the critical question is: Which expensive final cleanups are truly necessary ***now? The*** distinction between significant, current threats v. speculative, potential ones could be used to answer this tough question. Prudent use of the current-future risk distinction could get more sites into and through the system faster, at least through site stabilization to reduce current risks. Although, permanent cleanups would have to wait at sites where only future risks existed. The current large backlog of sites at the front and middle of the Superfund process could be traded for a backlog at the end, producing more rapid risk reduction for more people.

Workers and Technology

The relatively young and inexperienced national cleanup workforce requires better management, information, and technical assistance. Long-term government support is needed for basic research, R&D on critical problems, and education programs to improve and expand the national workforce. Frontline Superfund workers need more stringent policies on technology evaluation and selection, more information on what is and is not working in cleanups, and more access to technical experts. EPA needs more staff, to reduce its dependence on contractors, but it faces recruitment problems. The enormous potential size of the cleanup business has touched off a ferment of R&D and the emergence of hundreds of new companies with advanced cleanup technologies. But use of better, but often more expensive technologies, is limited by decisionmakers who are overly cautious, have poor information, or are primarily interested in minimizing front-end costs. It is equally important to recognize that some contamination problems do not yet have good solutions. For large contaminated aquifers, pumping and treating contaminated groundwater is less effective than previously believed. For large landfills, capping is an impermanent solution.

1 And in subsequent, interim reports *Are We Cleaning Up? 10 Superfund Case Studies* (June 1988) and *Assessing Contractor Use in Superfund* (January 1989), as well as in testimony at a number of congressional hearings OTA identified many implementation problems, particularly at the front-end of the program. However, nearly all public attention on Superfund still pertains (o remedial cleanup and the backlog at the front-end of Superfund remains.

Table 1 -l—Policy Options

STRATEGIC INITIATIVES

Setting Cleanup Priorities and Goals

1. Set Priorities on Basis of Current or Future Risks
2. Establish a Federal Site Discovery Program
3. Use Environmental Criteria to Eliminate Sites at PA and S1 Screening Stages
4. Remove Range of Acceptable Risk Objectives
5. Establish National Minimum Cleanup Standards
6. Define and Limit Meaning of Permanent Cleanup

Developing Workers and Technologies

7. Reduce Dependency on Contractors, Expand EPA Workforce
8. Establish a Hierarchy of Cleanup Technologies and Methods
9. Restrict Use of Groundwater Cleanup Technology
10. Establish Generic Site Assistance Program, Including Expert Systems
11. Establish Technologies Assistance Program
12. Better Define Mission of SITE Technology Demonstration Program

Improving Government Management

13: Use Generic Site Classification
14. Limit Responsible Parties to Implementation of Remedies
15. Reexamine Financing and Enforcement of Liabilities to Improve Environmental Performance
16. Strengthen EPA Headquarters Direction and Oversight of Regional Implementation
17. Commit to a Permanent Superfund Program
18. Establish an All Inclusive List of Cleanup Sites in the United States
19. Begin Examination of Moving Superfund Implementation Outside of EPA

PROGRAM CHANGES

Setting Cleanup Priorities and Goals

20. Use Hazard Ranking System in More Limited Way
21. Reassess and Limit Use of Indicator Chemicals for Site Studies, Risk Assessments
22, Clarify and Strengthen Cost-Effectiveness Requirement for Remedy Selection, Reject Use of Cost-Benefit Analysis
23. Better Integrate Community Perspective Into Enforcement Site Decisions

Developing Workers and Technologies

24. Make Site Managers Responsible for Sites From the Front-End of the Program Through Final Disposition
25. Establish Program for Certified Public Environmental Auditors
26. Strengthen Effort to Offset Current Limitations of the Government and Contractor Workforce
27. Establish a Bureau of Mines Superfund Support Program
28. Establish a Superfund Support Program at the U.S. Geological Survey
29. Increase R& Depending, With Focus on Groundwater Cleanup

Improving Government Management

30. Combine Preliminary Assessment, Site Inspection, HRS Scoring, and Remedial Investigation Phases into Single Site Evaluation Program
31. Combine Removal and Remedial Programs Into Single Site Cleanup Program
32. Reexamine Current Statutorily Required Program Performance Schedules
33. For Records of Decision, Require a Statement of inconsistency for Selected Remedy
34. Reduce Need for Formal Regulatory Compliance for Onsite Cleanup
35. Establish a Formal Evaluation Program for Completed Site Cleanups and Long Term Ones in Progress
36. Establish Formal Measures of the Program's Environmental Progress
37. Address Conflicts of Interest Associated With Technology Selection
38. Reauthorize Superfund for 10 Years

Government Management

By clarifying statutory requirements and improving EPA's compliance with them, public policy, statutory requirements, regulations, funding, and program administration could work together with less confrontation and friction. Congress, EPA, and States can find common ground in providing protection of health and environment without threatening the public welfare economically. Many of EPA's actions, such as its interpretation of cost-effectiveness, seem inconsistent with statute. Many statutory provisions provide insufficient direction to EPA on how to resolve competing goals; for example, what is a permanent remedy and when does fund-balancing identify excessively costly fund-financed cleanups?

The tension between obtaining more cleanups and industry's interest in minimizing costs has not been resolved satisfactorily. Allowing responsible parties to conduct site investigations and feasibility studies, which guide cleanup decisions, poses a conflict of interest between minimizing costs and assuring effective protection; it gives an advantage to responsible parties over communities. Superfund site communities want as much influence as the companies found liable for cleanup costs.

Responsible parties are paying for over 50 percent of site studies and cleanups through voluntary settlements; EPA wants to increase this contribution. OTA's analysis shows, though, that many of those cleanups are less stringent than government-paid ones. In fiscal year 1988, for example, 75 percent of remedies based on land disposal were for enforcement Records of Decisions (RODS) which are likely to lead to responsible party cleanups; 78 percent of remedies based on waste destruction technology were for fund RODS, which are likely to lead to fund-financed cleanups. **These and other OTA findings show a pattern of EPA selecting less stringent cleanup technologies to obtain voluntary or negotiated settlements with responsible parties. Excessively flexible government policies and rules allow significantly different cleanups at similar sites.** But an affected community cares more about getting effective cleanups than whether the government or responsible parties pay.

Conclusion of This Report

The task facing Superfund is formidable—cleaning up over 1,200 toxic waste sites currently on the NPL as well as another 900 sites (EPA's estimate) to 9,000 sites (OTA's estimate) which could be added over the next 10 years+ specially in light of tight Federal budgets and shortages of technologies and experienced workers. Fortunately, though, opportunities exist for making both the strategic and incremental changes in the program that would allow it to fulfill its mission. Making Superfund a *permanent* program would be a logical first step in this effort because achieving complete, rapid, and permanent cleanups everywhere in a decade or two is impossible. Over many decades, spending by all parties on cleaning up toxic waste sites could total $500 billion, unless there are major technological innovations that bring the costs of permanent remedies down.

BACKGROUND

Key Superfund Questions

As the time approaches for Congress to reauthorize Superfund a second time, after a decade of experience, there is ample reason to ask: Can Superfund perform effectively—not perfectly-to address the environmental problem of uncontrolled toxic waste sites? Can we develop a strategy consistent with time, money, and technology constraints? Can Superfund earn public confidence? OTA's findings support positive, optimistic answers to these questions.

The Superfund system is complex (see box l-A) and it is easy to lose sight of the basic technical driving forces. Which sites require cleanup? How much cleanup is necessary? What cleanup technologies can do the job? The answers to these questions determine the human and financial resources and *time for cleanup.* But there are few unequivocal, scientific right or wrong answers for the Superfund program, and often few (if any) *precise* answers for individual contaminated sites much less for all sites. The need for judgment is constant. Consensus and trusted answers are scarce. Are procedures and systems for site evaluations as effective as they could be? If not, are sites being rejected which truly need attention? Yes, they are. Has the dilemma of spending a lot quickly on a few sites while many more sites wait long times been resolved? No, the backlog of sites waiting to be evaluated in a preliminary way remains substantial.

Bringing more sites into the program, following statutory cleanup standards, and using effective technology would require a lot more money. More payments by responsible parties seem necessary. But will more enforcement mean a faster, more complete national cleanup effort? Not necessarily. Determining who pays for cleanup and building a strong legal case takes time and the legal and administrative transaction costs are high. And building a successful legal case is not necessarily consis-

Box l-A-How Does Superfund Operate?

The Superfund system is complex. Sites are identified and enter an inventory because they may require a cleanup. At this point, or at any time, a site may receive a **Removal Action** because of emergency conditions that require fast action or because the site could get a lot worse before a remedial cleanup could be implemented. (Most of SARA's requirements for remedial cleanups do not apply to removal actions, even though removal actions can cost several million dollars and resemble a cleanup.) In the preremedial process, sites receive a **Preliminary Assessment** (PA); some then go forward to a **Site Inspection (SI), with** some of those sites scored by the **Hazard Ranking System (HRS).** If the score is high enough, the site is placed on the **National Priorities List** (NPL) and becomes eligible for a remedial cleanup paid for by the government, if necessary, or by responsible parties identified as having contributed to creating the uncontrolled toxic waste site. Undercurrent procedures, only about 10 percent of sites which enter the system are likely to be placed on the NPL. Some States have their own lists of sites which require cleanup; **these often** contain sites not on the NPL.

NPL sites receive a **Remedial Investigation and Feasibility Study** (RIFS) to define contamination and environmental problems and to evaluate cleanup alternatives. The public is given an opportunity to comment on the RIFS and EPA's preferred cleanup alternative. Then, EPA issues a **Record of Decision** (ROD) which says what remedy the government has chosen and the reasons for doing so; the decision may be that no cleanup is necessary. A ROD may only deal with part of a site's cleanup and several RODS maybe necessary for a site. The ROD also contains a summary of EPA's responses to public comments. EPA chooses the cleanup goals and technology in the ROD. In actual fact a number of actions involving different technologies are likely to be chosen for any but the simplest sites. The ROD is like a contract in which the government makes a commitment to actions which will render the site safe. If responsible parties agree to clean up the site, they sign a negotiated consent decree with the government; this stipulates the exact details of how the responsible parties will proceed. If the cleanup uses Superfund money, the State must agree to pay 10 percent of the cleanup cost.

In the post-ROD process, the site receives a **Remedial Design** (RD) study to provide details on how the chosen remedy will be engineered and constructed. The whole process ends with the **Remedial Action (RA), the** actual implementation of the selected remedy. Many cleanups include long-term monitoring to determine whether the cleanup is effective and if more cleanup is necessary. A ROD may be reopened and amended because of new information discovered or difficulties encountered during the design and remedial action. When a cleanup is deemed complete and effective, the site can be delisted by EPA from the NPL.

SOURCE: U.S. Congress, Office of Technology Assessment, *Are We Cleaning Up? 10 Superfund Case Studies*, OTA-ITE-362 (Washington, DC: U.S. Government Printing Office, June 19ss).

tent with engineering a good cleanup solution. Obtaining settlements with responsible parties tests EPA's resistance to compromising environmental goals and incurs high oversight costs.

Even if we had enough money and technology, experienced and expert technical people in government and in the contracting pool are in short supply. Are special efforts needed to increase and strengthen the national cleanup workforce, especially at EPA where turnover is high? OTA's 1989 report on contractor use showed how important this problem is, and a number of the policy options in this report address this issue. In the short term, can we use information technology, special teams of experts, and stronger, central management controls to offset the limitations of a largely inexperienced workforce? In theory, yes, -but new programs must be created.

Public Demand for Cleanup

Without intense public demand for cleanup, there would be no Superfund program. But the general public and Superfund site communities, for the most part, have little confidence in the Superfund program.

As a new, large, technically complex program born in a crisis atmosphere in 1980, Superfund faced many difficulties under the pressure of high public expectations and intense fears about toxic waste. Public expectations have remained high. But the issue is not perfection. The public wants open and honest communication and information, opportunities to participate, and environmental results. **The public is not the cause of Superfund's poor performance to date.** OTA's research finds that the government has not yet balanced necessary environmental goals with real world constraints of money, information, technology, and time.

Sometimes the public must be-and is—told that their expectations exceed technical or economic resources. The issue is the credibility of government reasons for ***not*** providing the most stringent cleanups. Should the community be content to wait for an indefinite period for reliable site information and for a complete, permanent cleanup? Or with full information, might the community consent to accept an interim action which greatly reduced immediate threats, even though that meant waiting for something more complete later on? Understanding this choice and participating in its resolution requires complete and timely information and participatory opportunities. The government has not yet achieved these routinely. **Sometimes the need and choice seems clear to the community and to others; it is the government that seems reluctant to do what is environmentally necessary and feasible.**

Regaining Public Confidence

How the government identities and communicates cleanup needs and solutions shapes public confidence. Superfund implementation needs commonsense practices. Analyses which make sense only to technical experts do not breed public confidence. When Superfund's managers depend solely on risk assessments, cost-benefit and other technical analyses to defend their policies and actions they do not succeed. Some Superfund managers do not speak in plain English. They justify their actions in terms of bureaucratic schedules and arcane regulations rather than environmental goals. Of course, within Superfund there *are* government people saying and doing the right things. But it is difficult for government workers to look (or feel) good when the public criticizes the program they work in.

What does a permanent cleanup mean to an ordinary person? It means that more studies, tests, and cleanup will not be needed, unless the most unexpected and unpredictable event occurs. In terms of safety, permanence means that people living near Superfund sites do not have to worry about exposure to toxic chemicals left in their community. People understand that some sites are very complicated and that new information obtained during the cleanup process may force significant changes. But people rightly lose confidence when they are told it is safe and effective to leave toxic waste in the ground and cover it up with soil, or to bury untreated toxic chemicals in a landfill, or to let groundwater slowly flush contaminants into a river.

Can a community accept a higher residual level of contamination compared to another community? Not if the real explanation seems to be who is paying for cleanup. People living near Superfund sites can understand that some legitimate technical factors (like a difference in route of exposure or the presence of a sensitive group of people or animal species) explain different cleanup standards. But understanding complex technical factors requires good information and effective dialog.

Do people who live near a Superfund site want their toxic waste shipped to a landfill in some other community? Based on what people have said during open discussions about remedy selection, for the most part the answer is no. When they do, they may be poorly informed about the feasibility and safety of onsite waste treatment, which the law prefers, but which may be under attack because of higher costs.

Lack of public confidence in Superfund and criticism of Superfund may cause some people to discount the real environmental problem and abandon the effort. **With billions of dollars at**

stake and widespread concern about competing environmental problems and harm to American industries, building public confidence in Superfund is more necessary than ever.

SUMMARY OF OTA'S FINDINGS

Superfund's primary purpose is not to punish guilty parties, not to sustain a cleanup industry, and not to respond to people's fears about toxic chemicals. Superfund's essential mission is to clean up land and water that are so contaminated that they constitute threats to human health and the environment. Therefore, OTA has examined Superfund from technical and environmental perspectives. However, OTA finds that the widespread interest in stronger enforcement to get more financing of cleanups by ' 'responsible parties' must be addressed because settlements with these parties are affecting some cleanup decisions adversely. Therefore, this dimension of the enforcement issue is important in this study.

There are three other chapters in this report and OTA urges the reader to examine them because only a small fraction of the detailed information and analysis in them t's given in chapter 1.

- Chapter 2 presents OTA's research results on the front-end stages of the Superfund system, starting with site discovery, including several levels of site screening and investigation, and ending with the listing of some sites on the National Priorities List (NPL). Even though the Superfund program has received so much attention, few people know much about the preremedial part of the program, yet it is critical to understanding the issue of setting priorities for the program and understanding potential resource needs.
- Chapter 3 covers cleanups and cleanup technologies. A number of key issues are examined, including the meaning of permanent cleanup and distinctions among different kinds of cleanup technologies, and obstacles to using new cleanup technology. There is also an extensive analysis of recent cleanup decisions which identifies the impact of settlements with responsible parties.
- Chapter 4 presents information on the whole national cleanup system and the many different cleanup programs in it, focusing on potential significant impacts on Superfund implementation and future resource needs.

General Conclusions

Accomplishments and startup problems notwithstanding, Superfund's overall poor performance is not a result of inadequate funding,[2] lack of cost-effective technology, inadequate legal authority for the government to get responsible parties to pay for cleanups, insufficient policy direction from Congress, or low public support. Superfund has not been neglected, ignored, or short-changed. OTA finds two root causes for Superfund's current low level of performance: 1) ineffective management of the Superfund program by EPA; and 2) unsuccessful congressional actions.

The closer one gets to Superfund's implementation the more that many cleanups look like decisionmaking has worked backwards, that is: 1) on the basis of some rough measures of the site's problem an amount of money for a site cleanup was determined, based on what responsible parties or the government were willing to spend; 2) some set of technologies and responses were chosen; 3) the combination of the first two determined the targeted level of cleanup. Of course this overstates and over simplifies the process. But money and bureau-

[2]The one exception was in fiscal year 1986 when delay of congressional reauthorization did have a significant disruptive impact on Superfund implementation.

cratic imperatives to show that something is being done seem to dominate Superfund, instead of independent scientific assessment of sites, cleanup objectives based on health or environmental effects, and engineering analysis of cleanup options.

This study has identified options for a three-point restructuring of Superfund:

1. **Health and Environmental Priorities and Goals:** Establish general and site priorities explicitly based on environmental goals so that money is spent to rapidly reduce the greatest and most imminent risks at the greatest number of places;[3]
2. **Workers and Technology:** Improve the quality of work and reduce costs by improving the government and contractor workforce and the technologies and procedures it works with; and
3. **Government Management:** Clarify statutory requirements and congressional intent and improve compliance with them by EPA policy and program management.

The 38 policy options presented in the last section of this chapter could be used to implement this restructuring, separately or in combination, if Congress chooses to do so.

Specific Problems and Findings

In each of the three areas described above, we identify first EPA's and then Congress' contribution to OTA's identification of particular problems. Then, we briefly discuss OTA's key findings.

Health and Environmental Priorities and Goals

Problem: Loss of the first priority, Superfund's environmental mission.

EPA—It has subordinated the environmental mission of the program to short-term fiscal and administrative objectives by, for example, limiting the number of sites placed on the National Priorities List and using an accounting approach to measure program performance instead of environmental accomplishments.

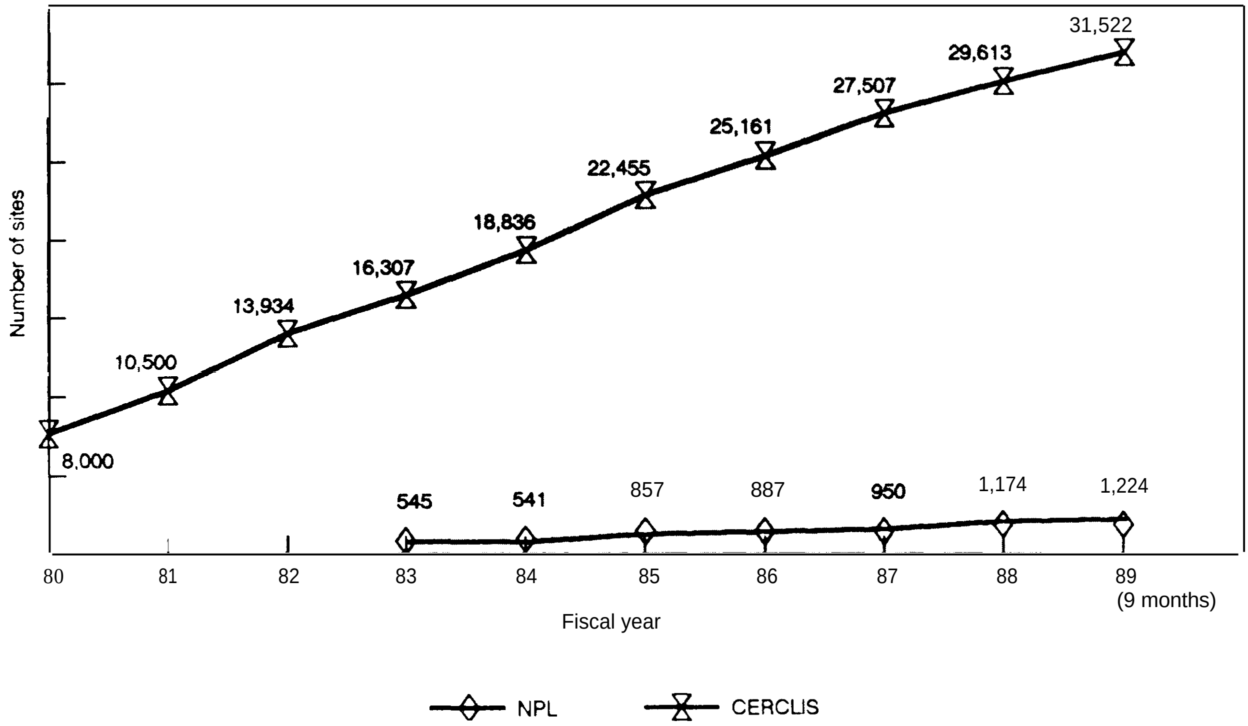
Congress—Some statutory directives have led to actions which are counterproductive to environmental goals---ego, non-environmental performance schedules—which drive EPA to an accounting measure of success. Such statutory requirements provide incentives to artificially shrink the size of the cleanup problem or to shorten and undermine the quality of studies.

OTA Findings*—Limiting program size through controlling site discovery.* Current EPA data on how many sites require cleanup under Superfund underestimate the true scope of the national problem. But, as figure 1-1 shows, looking at the past rate of increase in Superfund inventory sites and National Priorities List sites conveys a key message. Cleanup is a growth business. This is despite the fact that EPA has not carried out a comprehensive and systematic site discovery program nationwide, even though they have developed and, to some extent, verified such a program in a few parts of the country. Sites are also kept out of the inventory, because once in it, they must be processed within certain times.

Eliminating sites which really require cleanup. EPA's screening procedures for determining whether sites require remedial cleanup under Superfund incorrectly eliminate some sites which really do require cleanup. EPA has not estimated the magnitude of these false negative decisions, but OTA has. From 240 to 2,000 false negative decisions may exist. The criterion for deciding whether a site qualifies for detailed examination

[3] The Superfund Amendments and Reauthorization Act (SARA) of 1986 strengthened EPA's ability to perform limited cleanup actions under its removal program. But there is no evidence that the program has shifted its focus substantially to faster, partial remedies, even taking into account the use of operable units in the remedial program. Moreover, EPA current public discussions of setting priorities so that the worst sites get addressed first does not include consideration of carrying out site discovery, moving all sites entered into Superfund's inventory through preremedial evaluation quickly, or being concerned about incorrectly eliminating sites during preremedial evaluation which really require cleanup.

Figure 1-14 ERCLIS Inventory and National Priorities List Sites



SOURCE Office of Technology Assessment, 1989.

has changed significantly. Originally, there was a strict, but simple environmental criterion applied at the earliest screening stage (the Preliminary Assessment): Does it look like the site may require cleanup? Lately, the criterion has changed to: Is the site contaminated bad *enough* to warrant cleanup under Superfund? Indeed, the Hazard Ranking System (HRS) was originally applied as the third and last screening step. Now, the HRS is applied at the beginning of the preremedial process when information about a site is weakest. The question should nor be: Do we know enough to keep the site in Superfund? And, the response should not be to eliminate it if we do not. The question should be: Do we know enough to eliminate it from Superfund? And, the response should be to keep it in if we do not. The percent of inventory sites examined in the preremedial process that made it to the National priorities List sites started out at over 20 percent, decreased in the past few years to less than 10 percent, and must decrease further if EPA is not to exceed its estimate of a 2,100 site NPL by the year 2000.[4] A different *choice is* possible. **With site discovery, with improved procedures for examining and selecting sites, and without massive deferral of cleanups to other programs, particularly State programs, the NPL could ultimately reach 10,000 sites or more, conceivably by the year 2000 with a full-throttle effort. The size of the NPL is a policy choice which controls the distribution of cleanups among Superfund and other cleanup programs.**

[4]Many inventory sites, however, receive removal actions prior to or instead of placement on the NPL. However, there is little public accountability for removal actions and EPA now defers them to responsible parties and State and local government agencies before it considers performing them.

Problem: Luck of setting clear, environmentally based program priorities.

EPA—It has not made sharp enough distinctions between sites that really require major cleanup in the near term and those that can wait, nor has it used alternatives to actions that cannot provide permanent, cost-effective cleanups. There is too much bureaucratic separation between preremedial and remedial activities.

Congress—It has not adequately established program priorities. Conflicting goals have often been compromised as EPA tries to do a little bit toward meeting them all.

OTA Findings—Permanent *clogged preremedial pipeline.* **Under current procedures, the program will never eliminate its large backlog of unassessed sites which still require a Site Inspection and possibly application of the HRS.** For example, it could take 10 years to move all currently known sites through the preremedial stages and then there would be another 10 years of backlogged sites because of newly discovered sites. At times it has been suggested that the backlog is not that significant because the Nation's worst sites have already been identified and are on the NPL.

However, **OTA's analysis of HRS site scores shows that newly identified Superfund sites pose about the same level of environmental threat as older ones.** Letting sites wait for years before they receive significant examination and attention, therefore, can be a serious problem. To illustrate current delays, OTA examined the 229 June 1988 additions to the NPL; from the time of initial site discovery, one-third of sites waited 8 years or more, one-third waited between 4 and 7 years, and one-third waited 3 years or less to get proposed for the NPL. Analysis of the 47 April 1989 additions to EPA's site inventory database (i.e., sites with completed site inspections) found that, from the time of initial site discovery, over 50 percent of sites waited 8 years or more while fewer than 20 percent waited 3 years or less.

All risks considered equal when they are not, With few exceptions, EPA has not made a distinction between estimated risks which are real and current versus those which are more speculative and contingent on uncertain future uses of contaminated land or water or uncertain migration of contaminants. If it did so, EPA would have an important way to establish priorities and postpone major spending. (However, this would complicate attempts to get voluntary settlements with responsible parties.)

From examining several hundred cleanup decisions over several years, OTA concluded that as many as 50 percent of cleanup decisions (some sites have more than one) addressed future, uncertain risks. Confirmation of this observation comes from a study by Oak Ridge National Laboratory; it found that two-thirds of groundwater cleanups and one-third of soil cleanups were for sites without current risks (considering both cleanup categories, the average was 50 percent cleanups for sites without current risk).[5] At the same time, EPA has implicitly or explicitly deferred actions at sites that pose significant, more certain, and nearer term risks.[6]

There are limits to speeding up cleanups, but room for improvement. Detailed data on how a

[5] C.B. Doty and C.C. Travis, "The Superfund Remedial Action Decision Process' draft, undated; received by OTA on May 30, 1989; 50 out of 74 fiscal year 1987 RODS were examined; this is the same set of RODS from which OTA selected 6 positive and 10 negative examples for its June 1988 report. (Released as ORNL/M-780, September 1989)

[6] The following conclusion supports the importance of this issue and this finding: "The most important policy need is to develop realistic criteria for making remediation decisions. We need to find a balance between technical and economic criteria, identify statutory constraints on what remedies can be implemented and what cleanup standards, if any, limit the selection of remedies, . . .[G]reater attention should be focused on developing criteria to guide the decisions concerning whether to undertake remediation and when to stop remediation." Glen D. Anderson, *What Needs To Be Done: A Policy Perspective on Ground Water and Soil Remediation*, presented at Researching Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?—a colloquium by the National Research Council, March 1989, Washington, DC.

site moves through the entire Superfund system (given in OTA's 1988 report) show that between 4 and 5 years pass from when a site is first identified until the Remedial Investigation and Feasibility Study at a site is started; a complete cleanup can take 10 years or more. But very fast complete cleanups at complex sites would often be inconsistent with technically sound cleanups. No one should underestimate the technical difficulties in fully understanding a site's problem(s) and selecting a cleanup remedy.[7] However, a major way to speed up overall protection of health and environment is to move sites through the early stages of Superfund faster. And EPA's preference for eliminating sites from Superfund, incomplete and impermanent cleanups, and unstringent cleanup standards help produce statistical progress instead of measured environmental performance. No good measures of environmental performance either at the site or program level are currently used.

Other cleanup programs exist but offer less stringency. A myth has developed that Superfund is *the* national cleanup program for toxic waste and other types of chemically contaminated sites. It is not. Superfund is just the visible tip of an expanding national pyramid of cleanup programs. All cleanup programs draw on the same national workforce and technologies. Some of the most important aspects of Superfund are missing in other cleanup programs; for example, in other cleanup efforts there typically is no preference for permanent cleanups, less opportunity for effective public participation in the entire cleanup process, less attention to all significant risks to both health and environment, and less public accountability.

Implementation of other cleanup programs are ***uncertain.*** **By** ignoring site discovery and controlling the preremedial process and the size of the NPL, EPA diverts increasingly more removals and remedial cleanups to other programs, especially to State programs. But few States have effective cleanup programs. Current information indicates that State programs rely extensively on land disposal and containment remedies, which ultimately will prove to be impermanent.

Information on several major State programs (e.g., California, Minnesota, and New York) indicate that about 80 percent of cleanups, not counting groundwater cleanup, bury or cover hazardous site material already buried, compared to 26 percent for Superfund's remedial program. However, the figure for land disposal and containment is close to 90 percent for Superfund's removal program, in which smaller, more urgent actions are taken (one-third are classic emergency responses). In other words, State cleanups are more like smaller Superfund removal actions (both are likely to cost several hundred thousand dollars, rather than tens of millions of dollars for remedial cleanups). See box 1-B for an example of a State cleanup which is inconsistent with current Superfund practice.

Because Superfund is the most stringent cleanup program, there is more and more shopping around for alternatives to Superfund. The flight from Superfund can be viewed as a significant national problem to the extent that cleanups outside of Superfund are less comprehensive, effective, or permanent environmental solutions. **Ironically, Superfund may increasingly be required to fix poor cleanups of the past from other programs, just as it was originally conceived to address poor past waste disposal practices.**

[7]Experienced Superfund contractor professionals have observed: "Using current site investigation and remediation technologies, it is not possible to locate all significant contamination, nor can anyone accurately predict contaminant movement, fate, exposure, effects, or remedial technology performance." William A. Wallace and David R. Lincoln, *How Scientists Make Decisions About Groundwater and Soil Remediation*, paper presented at Remediating Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?—a colloquium of the National Research Council, April 1989, Washington, DC.

Box l-B—How a State Cleanup Can Differ Substantially From a Superfund Cleanup

In May 1989, the Minnesota Pollution Control Agency released its proposed cleanup plan for the Ashland Oil site in Cottage Grove. **As an** industrial site where a variety of wastes were land disposed, the site is typical of many Superfund sites. At the request of the State, the responsible party conducted the Remedial Investigation and Feasibility Study, and it has indicated that it will implement the cleanup. It took about 5 years to reach the site study stage, after the site was first identified as possibly requiring cleanup. Different levels of soil contamination, low levels of groundwater contamination, and buried drums were found. Contaminants include various asphalt and oil wastes as well as some volatile organic chemicals. Ten cleanup alternatives were examined, including no action. The cleanup plan selected by the State has three components: 1) offsite disposal of excavated drums; 2) excavation and consolidation of contaminated soils under a hazardous waste cap onsite; and 3) regular groundwater monitoring to detect any significant increase in contamination. The cost of the selected remedy is estimated at $500,000.

The Minnesota cleanup program has generally received high marks and a lot of attention because it emphasizes settlements with responsible parties. This cleanup seems representative of others in Minnesota and other States. Compared to Superfund, however, a number of concerns can be raised:

- Not one of the cleanup alternatives considered involved the use of treatment technology to permanently destroy hazardous material, unlike normal Superfund practice for a feasibility study. The type of chemical contamination at the site could be so treated.
- The selected ***remedy is based on OffSite and onsite*** land disposal, the least preferred type of Superfund remedy. The Superfund preference for a permanent remedy was not met. The source of potential increased contamination of the groundwater, for the most part, remains onsite. No hazardous waste landfill liner was selected, which would offer another level of protection against migration of buried contaminants into groundwater.
- The proposed remedy plan does not tell the public of any specific risks to health or environment posed by the site, nor any specific cleanup standards, unlike normal Superfund practice. It does acknowledge a current (pre-cleanup) risk as human skin exposure for people entering the site without protective clothing. Them is uncertainty about what level of detected increases in groundwater contamination would trigger further cleanup action.

This example shows that successful settlements with responsible parties for State cleanups, like some Superfund sites, can result in cleanups which are inconsistent with Superfund goals and requirements. Cleanup of this site under current Superfund rules, without the influence of settlement, would have likely involved substantial use of onsite treatment, such as incineration, increasing the cost to several million dollars. Even with a land disposal approach, cleanup under Superfund would probably have required a hazardous waste landfill liner, especially because of the evidence of groundwater contamination and because the site is along the Mississippi River. This would have increased the cost significantly. In fact, this site was scored with EPA's Hazard Ranking System and was scored high enough to qualify for placement on the National Priorities List. But many States retain sites for their own cleanup programs.

Workers and Technology

Problem: Decentralized decisions by an inexperienced workforce.

EPA--Superfund's managers have not effectively addressed organizational and workforce problems, such as the need to closely monitor activities by 10 EPA regional offices and to provide a young, inexperienced government and contractor workforce with better information and technical assistance, more explicit policies, and closer supervision.

Congress—It has appropriated enormous amounts of money quickly and put many pressures on EPA to spend that money. There has been little anticipatory concern about inefficient implementation resulting from excessive demand for contractors, technical information and methodologies, and cleanup technologies.

OTA Findings—Regionalized management. Demand has outstripped the ability of government to respond efficiently, especially in EPA's 10 regions. EPA Regional Administrators have been granted extraordinary autonomy to implement Superfund. **EPA headquarters has done little to assure that regional cleanup decisions meet high standards and are consistent on key issues like cleanup goals and technologies.** Nor do EPA regions learn effectively from each other's experiences, both positive and negative. Regionalized management has also stood in the way of developing effective national databases and developing major support from key Federal technical agencies.

[nexperienced Superfund workforce. The Superfund workforce in EPA, States, and contractors has been given enormous responsibilities in a high-pressure environment that demands quick solutions to new and complex technical problems. But as already noted, the Superfund workforce is largely inexperienced, untrained, and poorly supervised. There is insufficient technical oversight of critical studies, analyses, and decisions. There is insufficient access to and use of the latest, reliable information on cleanup technologies and past cleanup failures and successes.[8]

Poor site studies and questionable cleanup decisions. The costly and lengthy studies of site problems—a scientific pursuit of knowledge—and cleanup alternatives—an engineering analysis on how to construct a remedy—all too often are riddled with inaccurate and incomplete technical information and analyses (see OTA's 1988 study). Poor studies help to explain why the government does not routinely select the most advanced, permanent, and cost-effective cleanup technologies. EPA's data on remedy selection, for example, show that in fiscal year 1987 and fiscal year 1988 only about 25 percent of source control RODS chose permanent remedies, using OTA's criterion of destruction or recovery of hazardous material. The Oak Ridge National Laboratory study mentioned above concluded that 19 percent of remedy selections could be interpreted to offer a permanent remedy; it also found that nearly 50 percent of soil cleanup decisions lacked specific cleanup goals and that RODS and backup studies do not provide discussions or rationales to support the selection of remedy based on a cost-effectiveness criterion.

Heavy use of contractors. Nearly all Superfund activities are performed by contractors, including some that should not be, such as policy-related work (see OTA's exert enormous influence over Superfund policies and programs, because government depends on them not merely for carrying out engineering and construction, but for the core technical expertise, information, and analysis which form the backbone of Superfund policies, programs, and decisions. Contractors frequently work both for the government and for companies the government is regulating and trying to get to pay for cleanups.

High spending levels cause inefficiency. The rapid demand for Superfund contractor services has been caused by the rapid escalation of spending demanded by many groups and provided by Congress. Moreover, at the same time, other cleanup programs have also geared up. The result is predicted by classic economics. Excessive demand creates a market which provides easy entry for inexperienced firms and too many jobs for inexperienced people as older companies expand. This contributes to low productivities and efficiencies, and it causes widespread and rapid turnover of the relatively few experienced workers and escalation of

[8] An important observation about the workforce problem and environmental performance has been made by an experienced environmental professional: "The Superfund program suffers from a combination of a shortage of human resources and extraordinarily stringent environmental objectives. On the one hand the nation is faced with a shortage of trained and experienced environmental scientists capable of evaluating complex risk and exposure models at Superfund sites. On the other hand, the system has delegated to these same overworked and relatively inexperienced people the responsibility for making risk balancing decisions which the [EPA] Administrator has frequently been unable or unwilling to make. Walter C. Barber, *Environmental Legislation and Regulatory Practice*, paper prepared for Environmental Quality and Industrial Competitiveness workshop, American Academy of Environmental Engineers, April 1989, Baltimore.

salaries. Expertise has been drained away from government to higher paying industry jobs. Currently, the government provides too few incentives for quality work, too little management control and auditing of contractors, and too little attention to layers of contractors and subcontractors with high overhead costs.

Government Management

Problem: Conflicts between the statute and its administration.

EPA—The agency often seems ambivalent about implementing statutory policies and directives, such as the goal of minimizing impermanent remedies based on containment and land disposal, and making technical assistance grants to communities. Interpretations which are inconsistent with congressional intent are a problem, such as converting cost-effectiveness into cost-benefit decisionmaking.

Congress—Some statutory provisions lack clarity, especially on resolving competition among objectives, or provide what gives, in retrospect, too much flexibility to EPA—such as the preference for permanent remedies which does not define what permanent means nor which treatment technologies are preferred.

OTA Findings—Mixed *results from the removal program.* Most actions are sound emergency and site stabilization responses to immediate threats, but some large removals circumvent statutory requirements for remedial cleanups. Removals frequently use offsite land disposal. EPA frost tries to defer actions to responsible parties and States. There is little easily accessible public information on removal actions. EPA's Inspector General recently reported not being able to find valid documentation for ***30*** percent of removal activities in Regions' files.[9]

Key *remedial cleanup decisions inconsistent with statute.* With too few exceptions, EPA's key remedial cleanup decisions—Records of Decision (RODs) are inconsistent with statutory requirements. They often are assertions or expectations instead of closely reasoned decisions supported by data and thorough analysis. Various kinds of environmental risks may be ignored or discounted. Consequently, it is not clear how the cleanups will be implemented or how effective they will be. Descriptions of decisions and remedies are frequently misleading (see OTA's 1988 report). For example, a ROD might say a cleanup is permanent, even though the cleanup relies on land disposal, or uncertain institutional measures such as deed restriction on future land use, or the uncertain outcomes of future tests, studies, and monitoring. The study by Oak Ridge National Laboratory mentioned above found that 68 percent of final remedial RODS required additional studies to confirm the extent of contamination, effectiveness of a technology, or applicability of the selected remedy to the site conditions. A ROD might say treatment technology will be used, when in fact land disposal will be used for most or much of the sites contaminants. For example, the cleanup at the Brown Wood Preserving site in Florida consisted of sending 94 percent of the carcinogenic contaminants to a landfill in Alabama, leaving 6 percent for a biological onsite treatment whose effectiveness is uncertain.

The cost-effectiveness criterion turned into cost-benefit. Everyone knows that cleanup cost has to be considered. However, EPA has transformed the statutory directive to minimize cost, after cleanup objectives are identified, into a cost-benefit approach which can reduce cleanup objectives to reduce cleanup cost. **Cost-benefit thinking allows nearly any kind of cleanup decision to be rationalized and undermines the environmental goals of Superfund. Cost-benefit reasoning backs up the selection of impermanent remedies because of excessive**

[9] U.S. Environmental Protection Agency, *Progress Toward Implementing Superfund—Fiscal Year 1987-Report to Congress,* April 1989.

flexibility in cleanup goals. RODS compare cleanup alternatives which do not offer comparable environmental protection and, on the basis of cost-benefit analysis, select low-cost remedies because a judgment has been made that they provide enough of a cleanup.[10] Communities often want more environmentally stringent remedies which, however, cost more money than the ones preferred by EPA, States, and responsible parties.

Problem: Conflict between enforcement and environmental protection.

EPA—It has not emphasized using the strong enforcement tools provided by statute and, therefore, has relied on making voluntary or negotiated settlements with responsible parties which sometimes are less stringent and less costly than fund-financed cleanups at sites where settlement is not feasible.

Congress-Congress has paid little attention to the intrinsic conflict of interest EPA faces as it pursues enforcement and settlement (to minimize cleanups paid for by the trust fund) while trying to uphold its environmental mission and adhere to strict statutory environmental provisions.[11]

OTA Findings-Cleanup decisions affected by desire for settlement with responsible parties. The selection of remedy as embodied in the ROD should be, but often is not, disconnected from enforcement and funding considerations .12 For example, RODS from the enforcement division show substantially greater use of containment and less use of permanent treatment remedies than do RODS from the fund financed part of the program. In fiscal year 1988, 14 percent of enforcement RODS (backed up by responsible party studies) selected treatment technologies which permanently destroy toxic waste (chiefly incineration and biological treatment); 44 percent of fund-financed studies and RODS selected destruction technology. Cleanup standards at sites where settlement with responsible parties is a factor are frequently substantially less stringent than at sites with fund-fina.need cleanups. An extreme example is for two similar wood preserving sites, one in Florida and one in Maryland. The cleanup standard agreed to for the enforcement site in Florida was 100 times higher (i.e., less stringent) than the standard for the fund site in Maryland. Based on its analysis of fiscal year

[10]The Oak Ridge National Laboratory study mentioned above found that 34 percent of RODS selected either no action or the least cost alternative *other than* no action; only *8* percent selected the most costly remedy. OTA's June 1988 report said ''The average estimated cost of the cleanups in the six good RODS. . was $20 million. In contrast, the average estimated cost of not-so-good cleanups in the 10 case studies. . was $12 million.

[11]This observation supports this perspective: ***''In*** some respects, Congress has never explicitly resolved the policy issue as to whether the Superfund program is basically a public works program (through the Fund-financed cleanups), a public health program, or a regulatory/enforcement program, though SARA tips the balance more toward the latter. A consequence of a regulatory/enforcement focus is the demand for technical information you can go into court with, thus leading to more intensive site studies to provide 'enforcement quality' data. . . this may be one of the root causes, at least from a policy perspective, for the slow progress toward actual cleanups. ' Glenn Paulson, *Tools and Resources Available Policy Issues,* paper presented at Remediating Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?—a colloquium of the National Research Council, April 1989, Washington, DC.

[12]A recent public statement of this problem was: ' 'The problem arises precisely because the risk assessment model has resulted in a further downturn in the Superfund program credibility with waste site communities, which cumulatively include millions of Americans. .[T]hese fears boil down to a conviction that the government is more interested in justifying partial cleanups which do not offend the pocketbooks of industry than it is in having an honest dialogue with affected citizens. " Rena I. Steinzor, *Decisions Based* on ***Public Policies*** and ***Perceptions,*** paper presented at Remediating Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?—a colloquium of the National Research Council, April 1989, Washington, DC. A study of EPA RODS noted that how closely a cleanup approaches legal mandates can be influenced by responsible parties: ''when the PRP [potentially responsible party] plays an active role (provided that public acceptance is possible), the EPA may be willing to negotiate and accommodate. Negotiation allows the EPA to gain PRP participation and financial resources where the alternative would likely be *litigation*. ,.. *'clean'* becomes whatever can be done at a reasonable cost with the technology available and that will be accepted by the public. ' C.F. Baes III and G. Marland, Evaluation of Cleanup Levels for Remedial Action at CERCLA Sites Based on a Review of EPA Records of Decision, Oak Ridge National Laboratory, January 1989.

1988 RODS, OTA concludes that responsible parties may eventually save as much as 50 percent or as much as $1 billion for those actions, compared to more stringent remedies.

With settlements and consent decrees, much can happen after a ROD is issued. For the Rose Township site in Michigan, EPA changed the selected remedy after the ROD in order to obtain a settlement with responsible parties. The change will reduce the cleanup cost by $19 million to $24 million. However, in EPA's proposed settlement plan and explanation of significant differences it did not inform the public that the settlement involved more than replacing some incineration of contaminated soil with soil flushing to remove volatile organic chemicals. (Soil flushing had been considered originally by EPA but not selected.) In fact, a stringent numerical cleanup goal in the original ROD was dropped and the consent decree allows the responsible parties to propose cleanup standards during the implementation of the cleanup.

Several conflicts of interest risk the environmental performance of Superfund actions. Responsible parties have a conflict between minimizing their costs and providing the public with environmental protection. In accordance with the basic congressional strategy of restricting fund-financed cleanups, EPA has decided to emphasize the tactic of shifting workloads and decisions to responsible parties. But letting responsible parties exercise control over the definition of contamination problems, the selection of remedies, and the implementation of remedies requires closer, effective government oversight. Increasingly, there is also a conflict between a responsible party using its own cleanup technology or business versus someone else's technology or services that might be more effective environmentally.

THE BACKGROUND FOR PUBLIC POLICY DEVELOPMENT

Breaking Out of the Superfund Syndrome

After examining Superfund implementation since its beginning, OTA has found it instructive to define a condition it calls the "Superfund syndrome' which can help us understand perceptions and problems of this program, as well as the adversarial nature of Superfund implementation. A syndrome is a set of complex symptoms of an undesirable condition. For Superfund, the undesirable condition is constant confrontation among nearly everyone affected by and working in the program. Mutually reinforcing but opposing values, interests, and objectives make program management and program improvements exceedingly difficult. For example, there are community-government disputes over technical issues and cleanup objectives; there are responsible party-government disputes about technical issues and cleanup costs. The Superfund syndrome forestalls consensus on identifying key issues and resolving them. "Analysis breeds paralysis" as stakeholders with different perceptions of risk and different priorities fight data with data. Contractors keep busy, reports pile up, contamination spreads into soil and groundwater, many sites wait to get into the system. It is very difficult to break gridlock situations by invoking explicit policy direction, and litigation waits in the shadows. The syndrome slows improving program effectiveness and efficiency through upward movement on a learning curve.

OTA has identified two causes of the syndrome: 1) opposing views of risks to public health and environment and, therefore, of necessary cleanup costs; and 2) excessive flexibility in the statutory structure and implementation policies of the program. The first factor has no near-term solution, but the second cause does. The result of these two factors is a system in which competing interests find too many opportunities to achieve their objectives at too great an expense to their adversaries. Site-specific circumstances and variations among communities, responsible parties, and government officials determine who ''wins' and who ''loses. ' With the Superfund syndrome, the system tears itself apart as it overresponds or underresponds at sites. Only rarely do cleanup **decisions satisfy all parties and meet the full range of statutory preferences and requirements.**

First, consider the root causes of the opposing views on cleanup risks and costs. One one side, there are people who are primarily concerned about risks to health and environment: the general public who knows Superfund indirectly through news media coverage and people in affected communities who have had direct experience with Superfund implementation. Repeated sharp visual images of leaking drums of toxic waste, pools of foul liquid waste, discolored streams and creeks, and abandoned homes near Superfund sites have etched permanent impressions in the minds of most Americans. Superfund's implementation has documented much chemical contamination of land and water nationwide. For years, the public has heard a steady stream of disturbing information about political scandals related to Superfund, criminal behavior of some toxic waste companies, continued conflicts between Congress and executive agencies over Superfund implementation, and slow, patch-work, and ineffective government actions documented in many reports by OTA, GAO, congressional committees, and environmental organizations. After a decade of such indirect experiences based on many sources of information, the American public has a lot of fear and anxiety about toxic waste sites.

At the community level, experience with the government's ineffective implementation of Superfund, as well as feelings about involuntary and catastrophic risk, cause outrage and distrust, dread, fear, and confusion. Again and again, people living near sites say they feel victimized; they face risks to health, environment, jobs, and home values; they feel left out of key decisions affecting their lives.[13] These experiences and emotions have increased people's perception of risks posed by toxic waste sites and made cleanup costs a secondary issue compared to obtaining effective protection of health and environment.[14]

Pressures from responsible parties push in the opposite direction. These pressures result, in part, from a perception that the toxic waste problem has been blown out of proportion and has caused an expensive over-reaction by government. In fact, the actual health effects of many chemicals are questionable or unknown, although many have known dangers. Natural processes of dispersion, dilution, and degradation can sometimes reduce health and environmental effects of released site contaminants, but this cannot be assumed. And chemical contamination of land and water does not *necessarily* translate to exposures to those chemicals and, hence, significant health or environmental risks or effects. For some people, therefore, perceived risk from toxic waste sites seems small compared to other environmental problems and too small to justify the large amounts of money being drained from specific companies and the general economy.

Many responsible parties believe that they have much more than money to contribute to

[13]EPA's routine community relations efforts are insufficient to prevent discontent in communities through early public participation and early dissemination of information. For sites managed under EPA's enforcement program, effective public participation is limited by the government 's interest in building a strong legal case.

[14]OTA has found it critically important to understand an important finding of risk communication: risk = hazard + outrage. (see peter M. Sandman, ''Hazard Versus Outrage in the Public Perception of Risk, '' in *Effective Risk Communication*, Vincent T. Covello et al. (eds.), (New York, NY: Plenum Press 1989), pp. 45-49. Hazard reflects scientific information about chemical contaminants, their health effects, and exposures to them. The outrage factor is a result of diverse experiences and feelings; for toxic waste it is higher than for other environmental problems, This explains why many Americans view toxic waste sites as more threatening than other environmental problems, even though more people are affected by other environmental problems (e.g., air pollution and radon contamination of homes), which pose high health risks.

Superfund's implementation, including technical expertise, project management experience, and more interest in trying innovative cleanup technologies than government. An expensive cleanup is not necessarily a truly effective cleanup, they argue and, as OTA's reviews of cleanup decisions have verified, that is often correct. As much as community people feel left out of the decisionmaking process, so do many responsible parties. Moreover, as much as community people may feel like victims because of threats from toxic waste, many responsible parties feel like victims because the liability imposed on them is not related to past violations of laws or regulations then in place.

Economics affects risk perception. For those being asked to pay cleanup costs, perceived risk is usually lower than it is seen to be in Superfund communities. (This lower perceived risk often changes when responsible parties become members of an affected community.) If risk is underestimated, then there is a potential for underresponses by the cleanup program. Moreover, this economic perturbation of risk sometimes occurs with EPA officials who, like responsible parties, place high value on minimizing individual cleanup costs in order to spread Federal money around to more sites. And they too may believe that risks are not as high as affected citizens believe them to be. Indeed, EPA has said this officially.[15]

Next, consider the causes and characteristics of excessive program flexibility. Normally, flexibility is valuable. Indeed, at the beginning of the program, flexibility was critically needed. Superfund was a new government program and cleaning up toxic waste sites was a new and largely unknown challenge. There was a true need for flexibility because there was little reliable information or experience to fine-tune policies and objectives. Today, after nearly a decade of experience and a lot of information, the flexibility in the program seems excessive, and seems to the public like a way to minimize costs by lowering protection.[16] There are too many opportunities for opposing interests—including the public—to achieve their objectives at too great an expense to others. **Government officials have too much room to make different kinds of decisions, and often contradictory ones at different sites, depending on circumstances and bureaucratic goals, such as obtaining settlements with responsible parties.**

Excessive flexibility means that there are few safeguards against underestimating risk and cleanup needs, and designing cleanups accordingly. This ultimately increases public concerns, which results in the public seeing more risk. Increased perception of risk leads to greater public demands, making it harder for government to satisfy expectations. But, excessive flexibility also allows over responses to heightened perceptions of risk. Selecting an overly stringent cleanup at a site or giving high priority to what seems like a less serious situation often prompts responsible parties and some government officials to fight the desired remedy or to reduce costs at other sites. And in some cases, there are several community groups expressing diametrically opposite views on cleanup objectives and remedies. This contributes to gridlock at the site level. If responsible parties refuse to go along with a stringent cleanup and EPA cannot compromise because of strong community positions, then the State may become the

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15 U.S. Environmental Protection Agency, *Unfinished Business: A Comparative Assessment of Environmental Problems*, February 1987.

16 "Dubbed the 'maximum flexibility/yninimum accountability' approach by community groups living around the dump sites, this approach allows EPA to take into account numerous variables, most notably cost, in addition to the need to protect human health and the environment when cleaning up sites. . . [T]k major objection that environmental and community groups have about the current EPA approach is that it does not guarantee a minimum level of protection to citizens across the country; rather, a number of factors, many of which are never quantified or explicitly discussed, appear to determine the amount of contamination that will remain at the site after cleanup. " Linda E. Greer, "How Clean is Clean? An Environmentalist perspective," *Hazardous Waste Site Management: Water Quality Issues*, Report on a Colloquium Sponsored by the Water and Technology Board (Washington, DC: National Academy Press, 1988).

controlling factor because it may not provide the required 10 percent matching funds for what it considers an overly expensive fund-financed cleanup. The Superfund syndrome is sustained.

Excessive program flexibility entails:

- a great deal of EPA regional autonomy, permitting different interpretations of statute and EPA headquarters' policies (i.e., how much protection from toxic waste a person receives depends on where in the United States that person happens to live);
- a widespread belief among EPA staff that every cleanup is unique;
- a broad range of acceptable risk for setting cleanup objectives;
- no official definition for permanent cleanup;
- little distinction among the environmental results of very different cleanup technologies and methods;
- using cost-benefit instead of cost-effectiveness to justify selected remedies;
- using public opposition to an expensive treatment cleanup alternative to help reject it, but ignoring public opposition to a low-cost, land disposal alternative in order to select it;
- no specific criteria for using the statutory fund-balancing provision to reject high-cost cleanup alternatives; and
- selective use of different enforcement mechanisms.

Theoretically, responsible party concerns about cleanup cost might balance the demands for more stringent and effective cleanups by people at risk. But instead of opposing priorities creating optimum cleanups, the Superfund system often creates site decisions that individually overrespond or underrespond to site hazards. Site outcomes depend on the relative strengths of affected citizens and responsible parties at specific sites and often the views of the State. Without viable responsible parties, articulate community groups may obtain overly stringent cleanups. Without well-organized community groups, settlement cleanups may be weak. At those sites where there are both strong, united community and responsible party interests, gridlock is likely. [17]

In addition to the general public and affected communities, there are tens of thousands of people implementing Superfund, both government employees and contractors, who think that they have done the best they could with an impossible situation. Some people in Congress think that no matter what they do the program remains deeply troubled. Nearly everyone is frustrated, but nearly everyone has learned to find opportunities within the system excessive flexibility to achieve their goals, at least some of the time, or to prevent remedies they oppose, or to make implementation of them difficult. Cleanup decisions can be reopened or changed considerably during their implementation.

There is another complication. Spending billions of dollars has created a new industry. A legal, consulting, technology, and site and laboratory services industry thrives on Superfund and other cleanup programs. National cleanup spending is between $2 billion and $3 billion annually—and growing at a high rate, probably 20 to 40 percent for most companies in the business of cleanup. Changing Superfund inevitably affects the financial interests of this cleanup industry as a whole and, in a more complicated way, the relative competitive interests of different companies. Of course this industry is filled with people who genuinely care about the cleanup problem and about doing a good job. They too have to live with Superfund implementation problems, and they would like

[17] The effective organization of community interests into a single set of well-articulated demands and activities to achieve them seems to be determined by several factors. For example, the clearer and more imminent the threat to public health, the more likely it is that the community will rally around a particular set of cleanup objectives and remedies. Another factor is whether the community is able to tap the resources of a national environmental or public interest organization or local technical experts, such as engineering faculty. in some cases there may be a strong relationship with the prime responsible party which also is the community's chief source of employment.

to see them solved. But, overall, the cleanup industry pays little penalty for Superfund's ineffectiveness and inefficiency. Nor does it receive much incentive from the government for improved performance. Because of strong public support for Superfund, a backlash effect which would diminish cleanup activity has seemed unlikely. And the cleanup industry has benefited from other, growing cleanup programs. For the most part, this industry is viewed with distrust by communities because it works for the government and responsible parties which, as discussed above, are seen to have different priorities than communities.

Do Superfund Sites Pose Significant Health Risks?

Superfund was not created on the basis of lengthy, detailed studies which made the case for its need. Sup-fund was born out of something close to public hysteria, news stories about leaking toxic waste sites, vivid pictures of sites, and first-person accounts of health effects. **Do uncontrolled toxic waste sites in fact pose a problem that justifies a multibillion dollar program? The evidence available now indicates to OTA the answer is yes.**

First, mainly because of hundreds of Superfund studies (and the availability of advanced analytical techniques to detect smaller and smaller amounts of contaminants), there is massive documentation of substantial contamination of air, land, surface water, and groundwater in virtually every part of the United States. For many of the prevalent contaminants, there is undisputed information on adverse health and environmental effects.

Second, adverse health effects in populations exposed to releases of contaminants from cleanup sites have been documented (and some effects have not) through a few epidemiologic studies which, however, are almost always viewed by many professionals to have serious shortcomings. Examples of these are summarized in table 1-2; nearly all of them are controversial. Such studies are difficult and costly to conduct. Proving the contribution of *past exposures* to *currently* identifiable health effects, having many other possible causes, and in a mobile population is very difficult.

Third, Superfund has produced many exposure and risk assessments. These have documented past, current, and future exposures and risks through a variety of routes of exposure, including ingestion, inhalation, and dermal absorption, and for different types of people, including workers, residents, and occasional visitors. Risk assessment methodology has major limitations, often yields imprecise estimates, and produces numbers that very much depend on who does the work.[18] Using seemingly the same methodology, people working for the government or a responsible party can analyze a site and produce estimates of risk differing by a factor of 10 or 100, or even more. But the point is that many of Superfund's assessments have yielded undisputed high estimated current risks like 1 in 10 or 1 in 100 excess cancer deaths.[19] EPA's decision document for the cleanup of the Rose Township site in Michigan noted an excess cancer risk as high as 0.7 (i.e., 70 percent of exposed population dying of cancer) for consumption of groundwater contaminated principally with PCBs, vinyl chloride, and arsenic; and a non-carcinogenic risk as high as over 100 times the safe value, arising principally from

[18] The use of EPA's *Superfund Public Health Evaluation Manual* does not eliminate these problems. Also see Joel S. Hirschhorn et al., "Using Risk Concepts m Superfund," *Superfund* '87, proceedings of November 1987 conference, Hazardous Materials Research Institute, Silver Spring, MD.

[19] Other cleanups are justified only on the basis of estimated and, to a large degree, hypothethized future exposures and risks. Will residences be built on the land, groundwater be used as drinking water, or institutional controls such as fences and deed restrictions always be effective? *The uncertainly for future, potential risks is inevitably larger than for current risk.* But the statute requires cleanups for potential as well as current risks. And this requirement demands thinking through what *might* happen at a site. However, EPA has not routinely made an explicit distinction between future potential risks and significant *current* risks.

Table I-2--Summaries of Results of Some Epidemiologic Studies for **Toxic Waste Sites**

Hardeman County, Tennessee By 1977, 5 years after burial of pesticide production wastes had stopped, local residents were complaining of bad-tasting, smelly well water and were reporting health problems. Groundwater testing confirmed that a variety of chlorinated solvents had leached from the site, including carbon tetrachloride, chloroform, methylene chloride, and tetrachloroethylene. Providing a new water supply for some residents resulted in the disappearance of acute symptoms, such as nausea, diarrhea, skin and eye irritation, and upper respiratory infections But persisting problems were identified 2 years later, including enlarged livers and eye problems. Eleven county residents were hospitalized with a variety of symptoms. A limited health survey by the University of Cincinnati found evidence of liver dysfunction.

San Jose, California A water supply had been contaminated by leakage from an underground storage tank; 1,1,1-trichloroethane and 1,1-dichloroethylene were found in a municipal well. A study by the California Department of Health Services in 1980 and 1981 documented a doubled rate of spontaneous abortions in the exposed area as compared to a control area. The study also found a nearly four-fold increase in all birth defects combined. After the well was closed, a 1986 follow-up study found no excess malformations. In a different study, the rates of cardiac defects in the affected area were compared against the rest of the county. An excess number of major cardiac defects occurred in babies born to residents in the affected area for 1981. In May 1988 the State sad, that the leak, was an "unlikely" cause of the observed health problems, but also that "it probably will never be possible to determine conclusively what the role the leak played ."

Love Canal, New York In the 1970s there was ample evidence to residents of leaking toxic waste from the former disposal site. Testing confirmed heavy contamination in air, water, and soil, Beginning in 1976, local residents began reporting elevated incidence of a variety of health symptoms, Residents reported elevated incidences of miscarriages and children with multiple birth defects, severe asthma, and congenital heart defects, A 1978 preliminary health survey of over 100 residents by the Love Canal Home Owner's Association showed an increase in health problems; these included urinary tract problems, central nervous system disorders, and adverse reproductive outcomes such as miscarriages, stillbirths, and birth defects In August 1978 the State declared a health emergency.

Woburn, Massachusetts Drinking water was found to be contaminated with solvents at concentrations one-tenth of those in San Jose, California. Some residents were supplied with contaminated water to a much greater degree than others. In 1984, a team from Harvard University conducted a study The study groups were women who received less than 20 percent or more than 20 percent of their drinking water from contaminated wells. Relative risks were found to be elevated for eye and ear birth defects and for birth defects generally considered associated with environmental exposures, such as spina bifida, central nervous system problems, and cleft palate During the 3 years after use of the contaminated wells was discontinued, the relative risks of perinatal death and birth defects among exposed mothers were comparable to those in other parts of the community, Also, the incidence of childhood leukemla was Increased In Woburn, especially in the areas receiving almost all water from the contaminated wells. Childhood leukemia continues to be studied In exposed adults in Woburn, neurological damage, immunologic problems, and cardiac arrhythmias persisted for at least 5 years

SOURCE. Contractor work for OTA by ENVIRON Corp 1989

chlorobenzene in the groundwater. But these risks were for a ''hypothetical exposure' not a current exposure to the contaminated groundwater.

Table 1-3 gives a summary of descriptions of significant estimated risks at seven Superfund sites, based on EPA site documents. These examples illustrate the kind of results being obtained at Superfund sites, including sites for which cleanup has been justified only or partly on the basis of future potential risks. However, many times, actions are taken on the basis of information obtained about current releases of contaminants, likely exposures to them, and possible health effects. For example, New Jersey recently decided that it had to recontrol 86 sites contaminated with chromium by covering them with asphalt for perhaps 2 years until a final remedy is selected. Monitoring had found high levels of chromium in dust in a school.[20] Controlling windblown chromium dust to minimize health risks was the stated goal.

Other Reasons for Cleaning Up Sites

As important as health risks are, there are other reasons for cleaning up sites. Protecting the environment is important in itself. Also, damage to sensitive parts of the environment can signal future damage to human health for two reasons. First, toxic chemicals may enter our food chain, but take long times to manifest themselves as a cause of human health problems. Second, environmental damage may happen at low concentration levels, but contami-

The New York Times, July 26, 1989.

Table I-3-Examples of Use of Risk **Assessment to Justify Superfund** Cleanups

Baird and McGuire site, Massachusetts Future risk. Out of 102 contaminants, 53 critical contaminants were selected using methods suggested by EPA; they included 26 carcinogens, 11 noncarcinogens, and many suspected carcinogens. Because the site is not homogeneous in its geology, hydrology, and contamination, it was divided into 10 zones. The risk assessment focused on potential risks under hypothetical future conditions, because groundwater was not being used, a fence prevents direct contact with soil and surface water, there was no current fishing or recreational uses of the area. All the zones were found to have at least one pathway for exposure with the estimated incremental lifetime cancer risk greater than 1 in 10,000 and several pathways pose risks greater than 1 in 100. Moreover, all but two of the zones have at least one pathway with the Hazard Index for noncarcinogenic substances greater than the cutoff of one. The pathway showing the greatest potential risks was groundwater ingestion by adults.

Price Landfill **site, New** Jersey Future risk. Major groundwater contamination exists. The primary route of exposure was found to be ingestion of contaminated groundwater. Past and current exposures were evaluated for municipal and private water supply users. Actual concentrations of volatile organic chemicals in the groundwater supply wells were used. Although past risks were high for the municipal water users, current risks were low, even if it was assumed that the wells had not been taken out of production, which they had been. Risks for the private well users had in some cases been as high as 4 in 10,000 cancer risk, but the homes had been connected to public wells. A major groundwater cleanup was selected for the site, presumably because of potential future use of the groundwater. A qualitative risk assessment showed that ingestion of soil inorganic contaminants by children posed a significant risk which justified site capping and fencing.

Tinkam's Garage, Now Hampshire Future risk. Indicator contaminants were chosen based on concentrations of volatile organic chemicals found in groundwater, surface water, and soil, and their toxicity; there were 10 carcinogens and 10 noncarcinogens. Future risks were estimated on the assumption that an alternative water supply had not been installed, and residents continued to consume contaminated groundwater under two scenarios: either at the levels measured in supply wells, or at the maximum concentrations measured in site monitoring wells. The latter produced estimated cumulative cancer risk of 2 in 100 compared to 3 in 10,000 for the lower concentrations at the well point. For the noncarcinogens, the Hazard Index was over 30 for the higher site concentrations and 2 for the well concentrations. Two scenarios for children with oral and dermal routes of exposure to contaminated soil were used: a worst-case scenario assumed contaminant concentrations equal to the maximum measured values; a more-likely scenario assumed contaminant concentrations equal to the average measured values. The worst-case produced a cumulative cancer risk of 1 in 1,000 and the more-likely scenario 5 in 100,000. For noncarcinogens the Hazard Index was 1.7 for the worst-case and less than the cutoff of one for the more-likely case.

Summit Nationai **site, Ohio** Current and future risks. Studies showed the presence of more than 100 chemicals in different media on and offsite. Indicator chemicals were selected for groundwater, soil, and sediment, Under current use of the site and surrounding area, these exposure pathways were of concern: ingestion of site soils by trespassers, ingestion of offsite soils by residents and workers, and ingestion of sediments, Ingestion of groundwater under the current use scenario was not considered because onsite wells were not being used and local residential wells had not been found to be contaminated. For current use, the worst case cancer risks were in the 1 in 10,000 to 1 in 1 million range but the average exposures did not warrant cleanup using a cutoff of 1 in 1 million; nearly all of the Hazard Indices were below 1. The potential future use scenario considered ingestion of groundwater and soils by onsite workers and residents. An average (based on geometric mean contaminant concentration) and worst case (based on maximum detected value of contaminant) exposure were calculated. For future use, both the average and worst case scenarios could justify cleanup, with the worst case risks being as high as the 1 in 10 and 1 in 100 levels for the groundwater ingestion route; the Hazard Indices were very high for the worst case groundwater route, as much as 400.

Leetown Pesticide site, West Virginia Current and future risks. Risks were determined for exposure to most of the pesticides detected and arsenic. Ail major site contaminants were considered carcinogens. The current exposure route was ingestion of milk by local residents from cows fed silage grown in areas of soil contamination, assuming either all milk drunk was contaminated or that the daily mixed contaminated milk with noncontaminated milk. Only under the all-contaminated milk scenario was the risk significant enough to justify cleanup; it was at the 1 in 10,000 level. The future exposures were inhalation of contaminated dust and dermal exposure to contaminated soil by farmers tilling fields; this scenario assumed that the former orchards, then used mostly for pasture, might change to more intensive agriculture. Site sampling did not indicate groundwater contamination. Cumulative cancer risks for different areas were based on average contaminant concentration. For nearly all areas and for both inhalation and dermal exposure, the risks were high enough to justify cleanup, with inhalation risks being much higher and ranging from the 1 in 100 to 1 in 1,000 levels in four areas out of six.

Wildcat Landfill site, Delaware Current and future risks. Of 80 contaminants of heavy metals, PCBs, and other organic chemicals, 60 were used in the risk assessment. Current exposure pathways examined were: ingestion of groundwater by off site residents, incidental ingestion of surface waster from nearby river by occasional site users, ingestion of contaminated fish from river by occasional users, and direct contact with soil and surface leachate by occasional users. High excess lifetime cancer risk was estimated for current site users through inadvertent ingestion of contaminated soil (1 in 1,000) and through surface water (8 in 100,000). The cancer risk for current offsite groundwater users was 1 in 1 million. Future use exposure scenarios examined were: ingestion of groundwater by future onsite and offsite residents, and direct contact of soil and leachate by future site residents. The future potential risk for onsite residents consuming contaminated groundwater produced the highest lifetime cancer risk (4 in 1,000) and noncarcinogenic hazard index (104).

Sol Lynn/Industrial Transformer site, Texas Current risk. Site investigations found PCB and TCE in soil, plus several other organic contaminants. Risks were estimated for soil under current use scenarios. Only the risk of exposure to PCB through ingestion and dermal absorption was estimated. Due to the proximity of people within one mile (the Houston area) of the contaminated soil, exposure concentrations for PCB were assumed to equal maximum concentrations. The exposed population included workers, trespassers, and clientele of the businesses which currently operate at the site. Excess lifetime cancer risk associated with exposure to PCBs at the site was estimated to be 1 in 1,000.

SOURCE: Contractor work for OTA by Environ Corp., 1989.

nants may later be concentrated to high enough levels in food chains to affect human health.

Another reason for cleaning up chemical contamination of land and water is ethical. Many Americans believe that they, as individuals and as a society, have a moral obligation as guardian, steward, or conservator of the planet to keep our environment inhabitable-and to pass on to future generations an environment which is in as good or better shape than when we inherited it. They believe that cleaning up sites is important even without quantified certainty about health or environmental risk, or even if the costs of cleanup seem high relative to the benefits. American society does many things in the name of this environmental ethic, some of them expensive, which are not justified strictly on the basis of specific health benefits. Public concern about littering is a manifestation of the ethic. Superfund cleans up chemical littering which is as visible in people's minds as street or highway litter is to their eyes.

It seems that the moral or social reason for cleanup has a lot to do with the public's desire for permanent cleanups and for waste reduction at its source. Even after early cleanup actions have removed immediate health or environmental risks, going back to a site is important, in this view. For instance, addressing residual soil contamination or buried toxic waste (which may seem relatively immobile) fulfills the responsibility to leave the earth to future generations without our chemical litter. This moral value stands in contrast to a more materialistic perspective. Government officials are inclined to justify spending money on cleanups only when risk assessment and cost-benefit analysis support it.[21] Ethical considerations do not lend themselves to quantification.

Is Superfund Worth the Costs?

Inevitably, some people will focus on risk and cost information for cleanups to decide whether the costs and benefits of Superfund seem reasonable compared to other environmental programs, or even to very different government programs. In 1987, EPA's Administrator had a study done on risks from different environmental problems that concluded Superfund was an area of high agency priority and spending but low to medium health and environmental risks.[22] But EPA's conclusion about risks was not supported by analysis.[23] Another Cornparative examination concluded that "reduced lifetime cancer incidence is often very small for Superfund cleanups and, compared to a problem like radon contamination of homes, the Superfund program seems clearly misdirected.[24]

In fact, cleaning up uncontrolled hazardous waste sites is expensive and will remain so. For Superfund, OTA estimates that the average cost per life saved, the commonly used program evaluation criterion, varies greatly from site to site, but at a rough average is $5 million, if only

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[21] High marginal costs to achieve permanency and stringency are supported---demanded-by the public, because public cleanup demand = utility (protection) + morality. [See Amitai Etzioni, *The Moral Dimension* The Free Press, 1988.] But Superfund managers focus on utility, leaving some public expectations stemming from moral considerations unsatisfied. This contributes to the Superfund syndrome.

[22] U.S. Environmental Protection Agency, *Unfinished Business.' A Comparative Assessment of Environmental Problems*, February 1987. EPA 's view that "total health impacts do not appear to match public concerns in most areas' sets up an adversarial relationship between communities and EPA on the key issue of different perceptions of risk and cleanup needs.

[23] OTA's examination of this study found several issues, including: the methodology was based on "informed judgments" and "ex~~ opinion, ' rather than objective and quantitative analysis, from about 75 EPA managers and experts, only 2 of which were directly involved in Superfund implementation; there was no systematic compilation, presentation, and analysis of data from Superfund risk assessments or health effects studies; and the report acknowledged considerable uncertainty' for cancer risks because it considered only 6 chemicals and extrapolated information on 35 sites to a universe of *25,000* sites.

[24] Paul R. Portney, "Reforming Environmental Regulation: Three Modest Proposals, ' Issues *in Science and Technology,* Winter 1988.

cancer risks are considered.[25] Superfund costs are not absurdly high. To the contrary, they are comparable to those of other government programs, especially if about half of the spending is allocated to health, environmental, and social benefits other than preventing cancer deaths. These can be significant for many sites.[26] The larger issue is that unless Superfund's performance is improved, cleanup costs may increase and benefits may decrease, making the program seem economically irrational relative to other national needs.

Strategy v. Spending

Few people question cleaning up chemically contaminated land and water, both for our own sake and for the sake of future generations. The tough question is: How much cleanup is really necessary? Insisting on perfect, quick and certain solutions, and ignoring resource limits can defeat cleanups of specific sites and threaten the national program. Conversely, insisting on low-cost cleanups can compromise protection of health and environment. The unsuccessful attempt to balance Superfund's environmental goals against technical and economic resources has revealed the lack of a well-crafted, long-term strategy in statute or implementation.

Much of the past policy debate focused on Superfund funding levels and who pays, and not about strategy and priorities. Ideally, Superfund would eliminate all significant risks at all uncontrolled sites through permanent cleanups. In reality, however, limited financial, human, and technical resources make this ideal unattainable in the short term. The question, therefore, arises: what is the most efficient means of allocating Superfund's limited resources to achieve maximum protection of the public and environment? The answer to this question lies in how the spending is to be distributed with respect to sites and time. In other words, strategy, not just spending, has to be considered.[27]

Currently, spending is focused on relatively few sites and on complete, defensible cleanups at those sites, which are often, nonetheless, hotly debated. Many sites—both known and as yet undiscovered—remain largely unattended. **In trying to deal with resource constraints, a host of largely ad hoc policies minimize: 1) the number of sites entering the program; 2) the number of sites deemed to require cleanups under Superfund; 3) sometimes the level of site cleanup; 4) often the cost of site cleanup through remedy selection; and 5) expenditures from the fund through settle-**

[25] In comparison, the study mentioned in footnote 22 calculated a cost of onfy $2,500 per lifetime case of lung cancer prevented by radon remediation. The OTA estimate of $5 million per fatal cancer prevented from Superfund sites is based on the figures: 2,000 sites with a total of 10 million people at risk, a cancer risk reduction from 1 in 1,000 to 1 m 1,000,000, and an average cleanup cost of $25 million. The average exposed population of 5,000 people per site is consistent with EPA figures. (EPA, "Extent of the Hazardous Release problem and Future Funding Needs--< ERCLA Section 301(a)(l)(C) Study, December 1984. Mean populations exposed were 5,000 for groundwater and 3,600 for surface water; since HRS scores have not changed significantly, these figures still seem applicable.) However, because of uncertainties about risks and cleanup costs as well as large variations in site risks and cleanup costs, the cost per cancer death prevented probably vanes plus or minus a factor of 10, from about $500,()()0 to $50 million per cancer death prevented. Sites at the h@ end result from complex contamination, requiring expensive cleanup, but posing low health risks or affecting relatively few people, or both; however, *other* benefits for such sites may be signficant.

[26] Work for the Department of Energy's cleanup of hazardous waste sites uses a value of $5 million as Consistent with preventing a fatality. (Miley W. Merkhofer et al., "A Program Optimization System for Aiding Decisions to Fund the Cleanup of Hazardous Waste Sites at Department of Energy Defense Facilities, " *Superfund '88*, proceedings of November 1988 conference, Hazardous Materials Research institute, Silver Spring, MD.,) Other benefits include preventing or minimizing non-cancer health problems, loss of home values, and loss of a community's economic activity and development. Moreover, addressing environmental problems could be significant; for example, in 1984 EPA estimated that about half of NPL sites posed threats to sensitive environments such as freshwater wetlands, coastal wetlands, and critical habitats. Current EPA guidance suggests that a regulation is warranted if the cost per life saved is less than $1.5 million. Most Federal agencies regulate vigorously if the cost per life saved is about $2 million *or less.*

[27] Supporting this perspective is the following comment by Tom Grumbly, President of Clean Sites Inc.: "The EPA has a history of lurching from one tactic to another without having developed an overall strategy. . Although I'm sympathetic to the view that some of the Superfund commentary has been negative, criticism can be traced back to EPA's failure to articulate a definite strategy. " *Environmental Business Journal*, May 1989.

ments with responsible parties. Such actions erode public confidence in Superfund, making managing it even more difficult,

Two facts about the Superfund program are worth recalling. First, even after nearly a decade, Superfund is still in its experimental stages. It is an evolving program which *has* provided some benefits. For example, enormous amounts of toxic waste and contaminated soil and water have been identified and many sites which posed significant immediate threats to health and environment have been addressed through emergency and removal actions. But the **Nation has probably spent only about 1 or** *2* **percent of what ultimately might be spent by all parties** to clean up chemically contaminated sites—now roughly estimated by **OTA at $500 billion over 50 years.**

Second, although the program seems largely ineffective and inefficient in meeting its objectives, most attention has focused on specific events, sites, decisions, and narrow policies. This has blocked seeing the *whole,* complicated Superfund program and examining broad policy and implementation issues. After the original statute was passed in 1980, the accumulation of many administrative and legislative decisions (in the 1986 Superfund Amendments and Reauthorization Act—SARA) have shaped and reshaped Superfund. Congress, EPA, and the public have not had the benefit of a major policy discussion of where Superfund has come from, where it is today, and where it might go during the next 10 years and during the decades thereafter.

Different Perspectives on Fixing Superfund

Among those who see a need for change, there are fundamentally different perspectives on how to fix Superfund. Can incremental fine-tuning work or are fundamental changes necessary? In this report, *both* types of improvements are identified and discussed. **Incremental changes (called program changes in this report) tend to be easier to implement in the near term and are useful, but OTA's assessment is that fundamental changes (called strategic initiatives in this report) will be necessary for an effective long-term program.**

Many people see Superfund mostly in terms of its financial and legal dimensions and believe that how Superfund is financed, how much money it gets, how it is enforced, and how it imposes liabilities are key. For these people, some changes in these areas seem justified. But it is Superfund's environmental mission which is its reason for being, and environmental and community groups work hard to keep attention focused on that mission. All other issues pale in comparison. **Stressing non-environmental goals (e.g., numbers of cleanup decisions and actions, dollars obtained from responsible parties) polarizes environmental and community interests against those of industry and government, and it encourages EPA officials to lose sight of their mission.**

Moreover, there are clear links between certain groups and non-environmental issues; for example, major parts of American industry, which face paying for cleanups, and Superfund contractors would like changes in Superfund's liability provisions; by virtue of their training and interests, many people in the legal world and government are inclined to see enforcement as the key issue; industrial and insurance groups focus on level of funding and how the money is raised through taxes and fees. It is important to see whether, and if so how, addressing non-environmental issues affects the environmental performance of the Superfund program.

POLICY OPTIONS TO IMPROVE SUPERFUND

Summary Policy Overview in Three Key Areas

Health and Environmental Priorities and Goals

Expensive cleanup actions could be postponed when: 1) risks are not current, or 2) selected remedies are not to likely produce a

Box l-C—Three Kinds of Inefficient Superfund Spending[1]

(OTA estimates that between 50 and 70 percent of current Superfund program spending is inefficient and undermines the environmental mission of the program. We discuss below three kinds of inefficient spending and explain how we arrive at the estimate of 50 to 70 percent. At any one site, some or all types of inefficient spending may occur. Many of OTA's policy options are meant to address one or more of the three areas.

L Spending to address uncertain future exposures to hazardous substances released into the environment or remaining onsite and, therefore, speculative future risks to health and environment. OTA's examination of FY87 and FY88 RODS and **a study by Oak Ridge National Laboratory** of FY87 RODs[2] found that, overall, EPA finds about 50 percent of cleanups necessary primarily or, in many cases, solely because of hypothetical, speculative, and uncertain future exposures and risks. (See table 1-3 and discussion of policy option 1.) OTA analysis of data in the **ORNL report** substantiates that the percent of cleanup costs attributable to uncertain future risks is about the same as the percent of cleanup decisions. Therefore, about 50 percent of cleanup costs (whether paid by government or industry) are likely directed to reducing hypothetical risks which may not materialize. OTA calls such spending inefficient because of the opportunity costs, including: inadequate spending on site discovery and early site assessment, inspection, and ranking (i.e., EPA's preremedial activities); delayed cleanup of sites which pose current exposures and risks, and whose cleanup costs may escalate as contamination spreads into soil or groundwater; and the deferral of cleanups from Superfund to other, often less effective cleanup programs (e.g., States), motivated in part by the need to save Superfund money.

2. Spending on cleanup remedies which are unlikely to be permanent, leading to more spending in the long term for re-cleanups and perhaps posing expodures, risks, and damage to health and environment. OTA considers that a site has been permanently cleaned up when the contamination that was the cause of high enough risk to warrant cleanup (either current or future risk) is rendered irreversibly harmless through destruction (e.g., incineration or biological treatment) or recovery and muse of the hazardous substances (e.g., recovery of lead from contaminated soil and buried battery casings). Using this definition of a permanent cleanup, about 75 percent of FY87 and FY88 RODS selected impermanent remedies for cleanup of onsite hazardous waste and contaminated soil (see ch. **3). (An even higher percent of removal actions use impermanent remedies.) Also,** about 75 percent of groundwater cleanups use technology that experience is now showing to be unreliable in practice, even though it seemed to be permanent in theory. (See ch. 3's discussion of pump and treat for groundwater cleanup.) For these cases, the relationship between percent of decisions and percent of spending has not been assessed quantitatively. But on the basis of its examination of FY87 and FY88 RODS, OTA concludes that impermanent remedies contribute **substantially to inefficient spending on cleanups,** even though impermanent remedies usually cost less than permanent ones (see OTA's 1988 case study report and ch. 3). For example, if impermanent remedies on average cost one-third as much as permanent ones, and three-quarters of decisions are for impermanent remedies, then half of total spending is for impermanent remedies, and is inefficient. OTA calls such spending inefficient, because impermanent remedies provide uncertain long-tan pmection of health and environment and may lead to substantial future re-cleanup costs.

Now assume, in line with Point #l, above, that spending on impermanent remedies is distributed 50/50 between cleanups justified primarily or solely by future risks and those with current risks. Then, avoiding double counting of inefficient spending, 75 percent of spending is for impermanent remedies and future risks. And looking at the extremes, we see that, atone extreme, if all impermanent remedies are for future risk sites, then the total of inefficient spending is still 50 percent; at the other extreme, if all impermanent remedies are for current risk sites, then the total of inefficient spending is 100 percent. OTA concludes that probably 75 percent of the money spent on cleanups is inefficient because of the reasons discussed in Points #1 and #2. Forty percent (or $1.7 billion) out of EPA's Superfund total spending (of $4.4 billion) from FY86 through FY89 is for cleanup[3] and therefore, 30 percent of total program spending is probably inefficient because of the two reasons we have just discussed. **We discuss the other 60 percent of program spending in Point** #3, below.

3. Spending on the administration and management of the program, extensive site studies, and prolonged negotiations and litigation between government and industry (responsible parties) which is either unnecessarily **high or avoidable with different policies and program management.** From FY86 through FY89, about 16 percent (or $7(K) million) of EPA's Superfund total spending (of S4.4 billion) was for site studies and 44 percent (or $1.9 billion) was for all types of administration and management activities.

Examples of unnecessarily high or avoidable study costs are: 1) RIFSs which have been of such low quality that further studies by responsible parties, or work in the design phase or even work during actual cleanup has revealed the need to redo the EPA work; 2) RIFSs that have not made effective use of information from preremedial site studies, from removal actions, or earlier studies by responsible parties; 3) redundant, concurrent RIFSs by EPA and responsible parties motivated by distrust of the accuracy or completeness of the other's work; 4) RIFSs for site problems that could have been judged on the basis of prior information to pose only future risks and, therefore, which could have been deferred; and 5) many policies and program requirements which lead to excessive or ineffective analysis of cleanup alternatives. (See OTA's policy options on, for example, defining and limiting permanent cleanup, hierarchy of cleanup methods, using site generic classification, and using technical assistance experts in generic types of sites and technologies.)

Two examples of unnecessarily high or avoidable administrative and management costs are particularly important. The first concerns the large and complex system of contracts by which EPA spends about 90 percent of its funds. As we discussed in our background paper,[4] this contracting system has not been structured to achieve efficient spending nor has it been managed efficiently.[5] Secondly, the high level of autonomy given to EPA Regions, coupled with ineffective central management oversight and control by EPA headquarters mean that cleanup decisions are often vulnerable to challenge because they are inconsistent with EPA policies or statutory requirements.

In OTA's judgment, a major cause of unnecessarily high or avoidable costs for prolonged negotiations and litigation is the excessive flexibility inherent in the current program (see discussion at beginning of this chapter). As a consequence of excessive flexibility, there are many points of conflict or disagreement about cleanup objectives, about remedy selection, about enforcement of liability. These disagreements become the basis for prolonged and expensive negotiations and litigation between the government and responsible parties (and often among responsible parties). In turn, confrontational negotiations and litigation lead to excessive and overly defensive studies and analyses to bolster the positions of adversaries.

OTA sees no possibility for precise quantitative analysis of the linkage between these areas and spending. However, it is OTA's judgment that a substantial fraction of current spending on studies, administration, management, negotiation, and litigation is inefficient, Support for this view exists. EPA has recently said that it wants to reduce RIFS costs by about 32 percent, and a number of EPA Inspector General and GAO reports have documented wasteful spending in the Superfund program. Moreover, the Army Corps of Engineers, which carries out large, complex engineering projects, spends only about 10 percent of its total budget (which is about twice that of Superfund) on administration and management compared to Superfund's 44 Percent.[6] If we assume a range of one-third to perhaps two-thirds for inefficient spending, and apply it to the 60 percent of total program spending covering these efforts, then from 20 to 40 percent of total program spending is inefficient because of the reasons discussed here in Point #3. OTA defines as inefficient those administrative, management, study, and transaction costs that do not contribute to timely and effective cleanups. Unnecessary and avoidable spending outside of actual cleanups preempts spending time and money on identifying and solving significant current health and environmental problems.

Conclusion---Combining the 30 percent from Points #1 and #2 with the range of 20 to 40 percent for Point #3, we estimate that 50 to 70 percent of spending in the Superfund program is inefficient. This range probably also applies to private sector spending on Superfund activities. Responsible parties perform about half of current site studies and cleanups and many of their activities and problems mirror EPA's. For example, they also bear high administrative, management, and transaction costs. But the mix of private sector spending in the latter area is probably different than for EPA. Responsible parties are probably spending much more, proportionately, on litigation than on studies, administration, and management. In addition to negotiation and litigation with the government, responsible parties are in negotiation and litigation with other responsible parties, insurance companies, and private citizens and community groups. One recent review of Superfund concluded that 'of the total funds spent since 1980 . . . something between 30 and 60 percent has gone for legal expenses."[7] Of course, not all legal expenses are unnecessarily high or avoidable, but, here too, OTA believes it is fair to estimate that a significant portion of legal spending is unnecessarily high or avoidable and, therefore, inefficient.

[1] Not all inefficient spending is a *complete* waste, much of it produces something of value butt& spending is either suboptimal relative to program priorities (or what t& public thinks they should be) or it preempts mom productive spending.

[2] Carolyn B. Doty and Curtis C. Travis, *The Superfund Remedial Action Decision Process*—draft, undated, contract work performed for EPA. Fifty out of seventy-four RODs were examined.

[3] Based on OTA's analysis of EPA budget documents.

[4] U.S. Congress, Office of Technology Assesment, Assessing *Contractor Use in Superfund—Background Paper*, OTA-BP-ITE-51 (Washington, DC: Us. Government Printing Office, January 1989).

[5] Nor has contract procurement and contractor performance oversight been sufficient to identify and prevent fraud, waste, and • buse. Sea EPA's Inspector General reports on Superfund in March and September 1988, and a number of GAO reports on Superfund contracts.

[6] The comparison between Superfund and the Corps is approximate; for example, the Corps does not have expenses for cost recovery, but it faces costs for siting facilities, and these may offset each other.

[7] Maurice R. Greenberg, "To Clean Up the Residue of Progress, A National Environmen tal Trust Fund," *Financier*, April 1989. The observation seems *to have* been made for both government and private sector spending.

permanent remedy. Box 1-C presents a discussion of the kinds of inefficient spending, one of which is spending to address future risks and another on impermanent remedies. That spending could be used to bring more critical sites into and through the Superfund system, receiving fast interim attention and major—but not necessarily complete—risk reduction. Only when expensive thorough cleanups are necessary to address current risks would they be used, unless responsible parties wanted to finance cleanups for future risks. The cost for faster and more widely distributed near-term protection on the most hazardous sites is that many less hazardous sites would be waiting for their final cleanup. Essentially, with this strategy, the current backlog at the front-end and in the middle phases of Superfund would be exchanged for a backlog at the back-end of the program.

There are other components to the overall strategy. Another kind of inefficient spending is for umecessarily high or avoidable administrative, transaction, and study costs. This is the third factor discussed in box l-C.

Workers and Technology:

1. Improve quality of government and contractor work to reduce costs of making and fixing mistakes in studies and actions.
2. Develop and use technologies and methods which reduce unit costs for site investigation and cleanup and provide better information for decisionmaking.

Government Management:

1. Through improved technical capabilities, make the system more efficient by reducing time and cost for necessary tasks, particularly site studies for a larger number of sites moved into the system, and by eliminating unnecessary tasks.
2. Reduce unnecessary and unproductive transaction costs and delays related to enforcement, lack of public confidence, and policy conflicts.
3. Provide clearer program needs, goals, and priorities to the private sector, and promote competition among private sector providers of services.

Policy options

There are many near- and long-term ways to improve the environmental effectiveness and economic efficiency of Superfund. The 38 policy options described below are comprehensive but not exhaustive. They are diverse—some are broad, substantial changes in the direction of the program and have been called *strategic initiatives.* Implementation of a significant number of the strategic initiatives would result in a restructuring of the program. By their nature, the strategic initiatives will engender strong support or opposition from different interest groups. Other policy options are called program *changes,* and these could be integrated into the current program. Each option has the potential to improve Superfund. They are *not* mutually exclusive or mutually dependent; each option stands on its own. All or some of the options could be implemented although, as discussed below, some of them are strongly related to others.

Although some of the following policy options might be implemented solely by EPA, the focus is on congressional actions. And even when an option might, theoretically, be implemented by EPA alone, considering the history of Superfund, it may be beneficial for Congress to express itself. When OTA's assessment had been nearly completed, EPA released its report *A Management Review of the Super-fund Program* (June 1989); it was the result of a limited 90-day EPA review of the Superfund program. OTA has not presented a detailed comparison between EPA's intended actions and OTA's findings and policy options. A follow-up EPA report will provide the necessary details on how EPA's recommendations will be implemented.[28]

EPA's report announced "a new long-term strategy for Superfund" and presented 50 recommendations for improving Superfund. In general, there is some agreement between EPA's

[28]The House Committee on Appropriations said ' 'While the report of the 90-day *management* review contains many thoughtful recommendations, it remains to be seen what decisions will be made and what actions will be taken to make these reforms a reality. Report 101-150, July 17, 1989.

and OTA's identification of major problems and issues. **The EPA report offers an important recognition of problems in the Superfund program, and its specific recommendations for improving the program are significant within the effort's attempt to fine-tune the program and not make major changes in it.** Many of the specific issues addressed by OTA and its policy options, however, are not similar to those in EPAs report, including, for example: site discovery, preremedial site evaluation, selection of remedy, permanent cleanup, cost-effectiveness, variable cleanup objectives, impact of settlements on cleanup decisions, and inconsistencies with statutory preferences and requirements.

Below, the basis and nature of each OTA option is discussed, then its benefits, and then implementation issues, including concerns, problems, and costs. Linkages to other options and chapters in the report are also made. Before reading all 38 policy option sections, the reader will probably find it useful to peruse table 1-1 to get some sense of their scope and diversity.

PART I: Strategic Initiatives

Setting Cleanup Priorities and Goals

OPTION 1: Set Priorities on Basis of Current or Future Risks

There is a desperate need to find an environmentally sound way of setting priorities and making hard choices. Current implementation is too influenced by non-environmental factors, such as the willingness of a responsible party to pay for cleanup, or the ability of communities to get political and news media attention as well as support from national organizations—which depends more on a community's affluence or education, than on environmental needs. With this option, a critical distinction would be made between current and future health and environmental risks posed by sites on the NPL. That decision could be made in an official EPA decision document, including the supporting facts and analysis, or it might be included as part of a site's initial proposal for the NPL or as part of an initial ROD. Box 1 -D presents questions likely to be raised about this option and OTA's responses to them.

Cleanup actions based solely or primarily on future potential risks would no longer compete on an equal standing with actions justified on the basis of current risks or damage to sensitive environments. For example, Class I sites would pose current risks to health or environmental damage and Class II sites would pose future potential health risks or environmental damage. However, the delayed cleanups for Class II sites would not replace the priority assigned to interim recontrol actions necessary to prevent sites from becoming worse through the spread of contaminants into the environment. Moreover, assignment to either Class would not be rigid; new information about a site or actions at a site could justify reclassification.

Major decisions and allocation of resources within all Superfund implementation phases would automatically put Class II sites into a second, lower priority state; within Classes priorities might be based on chronological order of initial site discovery or identification (which would serve as a worthwhile incentive for early site discovery), and/or relative levels of assessed risks.[29] Classification could change over time, as actions (what EPA now calls removals and operable units) are taken at a site to mitigate risks. The default option when too little information exists for making a judgment about current v. future risk would be a Class I designation.

Exposure and risk assessment are by nature imprecise and produce uncertain results which are dependent on who does the work. Neverthe-

[29] One approach could be to establish high, medium, and low ranges of risks within Classes I and II. For example, for carcinogenic risks, High = greater than 1 in 1,000, Low = less than 1 in 1, 000,000, Medium = the range between High and Low; for use of the Hazard Index for non carcinogenic materials, High = greater than 50, Low = less than 2, and Medium = the range in between.

Box I-D-Questions and Answers About Policy Option 1

Is This Idea Inconsistent With Current Law And Program?

The law requires a consideration of present and potential threats to health, welfare, and environment. From the very beginning of Superfund, it was recognized that some threats are imminent, even emergencies sometimes. Thus, the need for the removal part of the program. However, in the most expensive part of the program--remedial cleanups-an explicit distinction between current and future risks has not been made. If the scope of the national cleanup problem were small, it would not be important to make this distinction. But with so many sites requiring cleanup, not making this distinction means that some sites which pose risks in the near term may not get cleanups in the near term, while other sites which might pose some risk in the future will get cleanups in the near term.

Is This Idea Just a Way To Reduce Superfund Spending?

This option has no bearing necessarily on increasing or decreasing total Superfund spending. This option only provides away to decide priorities and to decide exactly how whatever money is appropriated or otherwise made available is spent.

How Do We Know Whether a Site Poses Current or Future Risks?

The key to moving beyond information about site contamination with hazardous substances to risks is to evaluate specific paths of exposures. Exposure pathways will be based on some current condition, such as people having contaminated groundwater as their only source of drinking water, or some possible future condition, such as people using a site for recreation or housing and children possibly eating contaminated soil. Cleanup may be wholly or mostly justified on the basis of current or future exposure, or some portion of a site may be assessed to pose current exposure and another only future exposure.

If Risk Assessment Has So Many Problem% How Can We Confidently Assess Current v. Future Risks?

Exposure assessment combines qualitative information about a site's contamination and human and ecological receptors which can contact the contamination. Formal, quantitative risk assessment, based on detailed dose-response relationships, has more uncertainty and is not necessary.

Will Addressing Current Risks First Mean Using More Low Cost Actions Like Land Disposal?

Placing the highest priority on addressing current risks may entail using recontrol and interim actions to reduce current risks to safe levels. Those actions may use permanent technology which is practical and cost-effective or they may use other kinds of treatment technology, land disposal or containment, and institutional controls. But no site would be considered finally and completely cleaned up--and delisted from the NPL-unless permanent cleanup technology had achieved a final cleanup.

Will Sites Ever Get Permanent, Final Cleanups?

Sites will get their current risks addressed, possibly with permanent cleanup technologies, but may have to wait for a final cleanup which addresses future risks. But eventually the government must provide such sites with final remedies which use permanent cleanup technologies to the maximum extent practical.

If Future Risks Are Not Worth Addressing Now, Why Spend a Lot of Money Later on Expensive Permanent Cleanups?

This option does not change the current law or national policy. The government is just as obligated to permanently clean up sites which pose potential risks as ones which pose current risks. The issue addressed by this option is the timing of final, permanent cleanups. The Nation has already decided that it is worth cleaning up sites to protect health, welfare, and environment. But since we cannot do everything at once, some environmentally sensible way of allocating scarce resources is necessary.

less, the uncertainty about future potential risks is intrinsically different qualitatively. Study of past Superfund site decisions shows that many cleanups are based on hypothesized scenarios, such as possible future use of land or groundwater (see box l-E). Indeed, EPA sometimes has

Box 1-E—Example of Using Current v. Future Risk in Cleanup Decisions

The approach in Policy Option 1, of using the distinction between current and future risk as a primary way to decide whether to clean up a site, is used currently, to some extent. The Record of Decision for the first operable unit of remedial cleanup for the Arkansas City Dump site in Arkansas City, Kansas was signed in September 1988.

A key part of the decision was that there was only one current risk which required near-term attention. That risk was direct exposure by onsite workers to acid sludge; workers might get burned if they came into contact with the 47,000 tons of the sludge onsite.

However, the groundwater under the site was found to be heavily contaminated with arsenic, beryllium, and a group of polynuclear aromatic hydrocarbons. The total carcinogenic risk resulting from long-term ingestion of the groundwater was said to be greater than 1 in 1,000 (actually, the figures in the ROD suggest a risk in the order of 1 in 100, which is very high). Testing of offsite groundwater did not find contamination from the site.

The ROD **said:** "It must be remembered, however, that the risk of cancer is present only if consumption of ground water from contaminated aquifers were to occur based on a 70-kilogram adult over a 70-year lifetime. At the present time there is no known consumption of onsite ground water, and consumption of offsite water poses no risk. ''

With this reasoning, EPA elected to postpone consideration of groundwater cleanup until **a second operable unit** ROD. However, from a discussion OTA staff had with the site's remedial project manager, it appears that EPA may not pursue groundwater cleanup. Indeed, on the basis of the absence of current risk and lack of evidence that contaminants are causing a problem in surrounding groundwater or the nearby Arkansas River, EPA could maintain the same reasoning used in the first operable unit ROD. The only complication is that EPA invoked the formal waiver provision of **SARA** in order to postpone groundwater cleanup in the first ROD. This was necessary because the groundwater contamination was found to exceed State and Federal drinking water standards. The issue for the future becomes whether EPA can postpone groundwater cleanup on the basis of no current **risk and,** if that is the case, also postpone addressing the source of the groundwater problem. The latter seems to be a large amount of subsurface petroleum material and buried metallic waste.

The estimated cost of the remedy selected in the frost ROD is less than $1 million; it is based on in situ neutralization of the acid sludge and a soil cover. If complete source **control** and groundwater cleanup were pursued, cleanup would probably cost from $20 million to $40 million.

With OTA's Policy Option 1, deferral of this groundwater cleanup and full source control would be acceptable, but the site would not be considered permanently cleaned up, it would not be delisted from the NPL, and there would be continued monitoring of the surrounding groundwater offsite as well as institutional controls prohibiting use of onsite groundwater. **As the above figures** show for this example, a relatively large amount of money would become available to address current risks at other sites. This example, however, also shows the difficulty of postponing expensive cleanup, for addressing future risks, under current statutory requirements.

SOURCE: Office of **Technology Assessment,** 1989.

applied this option, as illustrated in box l-E. This example shows the considerable potential for shifting spending with this option.

Benefits: It is sound environmental thinking to defer actions when risks are future, potential, and highly uncertain. The chief benefit would be channeling Superfund resources where they are most needed. At many sites, limited cleanup actions may effectively deal with current risks, while leaving future uncertain risks for future actions, as resources become available. This means that site studies would be smaller and faster, because whole final remedies require much more study. (Other options presented below would help reduce studies.) Interim remedial actions would be easier to define and implement.

The cost of not delaying final remedial cleanups is to postpone attending to sites with more certain current risks. Postponement means that people suffer health effects, sensitive parts of our ecology are damaged, and sites get worse from the spread of contamination.

Another benefit is that criticism of many cleanups would be reduced; what often now appears to be an inconsistent or ineffective final remedy may be a compromise remedy because the site only poses a future, uncertain risk. Currently, instead of not acting (or using a recontrol approach), a lower cost, less stringent final cleanup is chosen, in part because responsible parties and government officials want to reach closure on sites.[30]

Finally, delaying final cleanup probably increase the chances that an innovative treatment technology leading to better cleanup will be available.

Implementation: The current statute requires EPA to address future potential risks; it does not, however, preclude EPA from implementing this option. However, because this option would have major impacts, congressional action seems necessary. This option could be implemented along with the currently used Hazard Ranking System. With current site study and risk assessment practices it is possible to identify the difference between current and future risks, and to distinguish current or potential environmental damage. For example, consistent with OTA's observations, the Oak Ridge National Laboratory study was able to distinguish between current and future risks in all but 4 of the 50 RODS it examined.

The State of Missouri uses a site classification system which makes the kind of distinction discussed here. The State notes that:

> The relative need for action at each site is based solely upon the potential impact of the site on public health and the environment. The type of action required, the feasibility of such an action, and its cost benefit are not the primary factors in deciding whether the action is needed.[31]

The Missouri experience demonstrates an important aspect of current-future risk classification: it does not require detailed, quantitative risk assessment. Qualitative analysis of a site and exposure routes can be sufficient to identify the presence of future risks for all or part of a site. New Jersey has recently found it necessary to distinguish between 'proximate risk and long term priorities'' in order to ''ensure work on the 'worst' cases first' and to ''allocate resources to high priorities. A proximate risk remedy or

30A good example of this is the FY88 ROD for the Coshocton City Landfill site in Ohio (discussed in ch. 3). The responsible parties contested EPA's proposed containment remedy successfully and a less stringent containment cleanup was obtained. The responsible parties said: ''Gwen the neglible present risk and speculative future risk, the remedy would not seem to meet any kind of test for cost-effectiveness. . . In the absence of any significant present threat to human health and the environment, EPA appears to rely on the potential threat of future releases and their postulated impact on human health and the environment as a justification for requiring corrective action at the site. EPA admitted that potential threat of future releases was a' 'major factor' in its original remedy selection. OTA's point is that, with this option, EPA could have defended a need for a recontrol action-perhaps as stringent as its original containment remedy—and eventually had a strong case for a stringent final remedial cleanup. With the current ROD, there is considerable uncertainty about how future cleanup needs will be addressed after the likely settlement is obtained, and public accountability is minimal after the ROD. Similarly, the remedy selected in the fiscal year 1987 ROD for the large Bayou Sorrel site in Louisiana, which gets flooded periodically, essentially gave the responsible parties the containment remedy that they wanted in order to agree to a settlement, but which had been opposed by most of the comm unity and others. In an internal memorandum urging approval of the remedy, EPA staff noted that ''the endangerment posed by the site is questionable and the risk assessment for the site is not well prepared. With this option, the containment action would be considered a recontrol, interim remedy requiring close monitoring, rather than the final cleanup with delisting from the NPL. It also has become clear, since the completion of the Feasibility Study in early 1986, that the cost of the rejected onsite incineration option has become much lower than the one estimated originally.

31 Briefly, Missouri's Class I sites pose imminent danger and require immediate action; this is like EPA current emergency and, possibly, removal actions. Class II sites pose significant threat and require action; this is like EPA's current remedial cleanup program. But Class 111 sites are such that action may be deferred. Here are some examples of statements for specific Missouri sites which illustrate the nature of Class III sites, confirm the feasibility of identifying future risks, and show the consistency with the approach of this policy option: ' 'There are no known environmental problems at the present time, but there is the potential for surface and groundwater contamination at the site due to the leachable nature of the wastes. ''Following remedial actions at the site, residual contamination remains in the soil and groundwater. Groundwater in the area is not used for drinking. ''. . . the potential does exist for soil and surface water contamination if drums deteriorate. " ''No environmental problem exists at this site unless it is disturbed by construction and/or drilling. " "There is some possibility for contamination of groundwater due to permeability of the soils. Surface water contamination from erosion is also a possibility. Missouri Department of Natural Resources, Division of Environmental Quality, "Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri—Fiscal Year 1987 Annual Report. "

interim action addresses "areas of immediate environmental concern, in which it is possible and necessary to control the contaminant source and reduce or eliminate the threat to the potential receptors." [32]

An immediate question to raise is: What is current? A legitimate environmental concern is potential abuse of the current-future risk distinction by an over-zealous placement of sites into Class II. Functionally, the need is to define whether a cleanup action is necessary in the near term or whether it can wait for some years. The planning horizon for site cleanup is about 5 years, from serious site study to serious implementation of the selected remedy. Therefore, if an exposure currently exists or is likely within about 5 years, the risk could be considered current. If this period is increased (i.e., moving from what exposure is likely to what may possibly occur), then the intended benefits of making a distinction between current and future risks would be reduced.

A legitimate concern is whether the time would ever come when resources would be available for Class 11 sites. Would, for example, the continued discovery of Class I sites always preempt taking actions at Class II sites? Would political will and funding diminish for second priority actions'? Would the whole system move back to using impermanent remedies, converting current risks to future risks? These uncertainties cannot be completely removed. However, they should be compared with the probability that unless this risk distinction is made, the Superfund syndrome presented earlier will get worse and many sites will get worse from complete inattention. Honoring the national commitment to address Class 11 sites can be accomplished institutionally, for example, by keeping Class 11 sites on the NPL (not delisting them) or otherwise removing their visibility. Moreover, this option presumes site recontrol (controlling current exposures and preventing sites from getting worse) for Class 11 sites and that interim remedial actions (addressing current risks) for them fulfill the statutory preference for using treatment technologies.

On a more technical level, implementation could be made difficult by the quality of information and analysis during the history of a site. Site investigation is a continuing process which starts with the first evaluation of a site and continues throughout a site history until complete, final remedial cleanup is attained. Site risk classification must always be a professional judgment because qualitative or quantitative risk assessment is not a precise science, no matter who practices it. But it would be useful for successful implementation of this option if EPA provided more refined guidance for the conduct of risk assessments and made the analytic procedure more consistent by users in order to reduce variations in risk estimates (this is also important for Option 4).

Another potential problem is that communities might insist on more and more site investigations to prove a site would be safe as a Class II, thus effectively keeping sites in Class I. EPA needs to document its case for Class II designation with care. Conversely, certain safeguards from a community perspective are necessary. For example, assignment to Class II in EPA's official decision document could be subject to an appeal process. Moreover, assignment to Class II would not preclude a community from receiving a Technical Assistance Grant under Superfund. And there could be a formal procedure for petitioning reclassification to Class Ion the basis of new information obtained by parties other than EPA.

As information increases and becomes more complete and accurate, the assessment of whether the chief risks are current or future may change. Moreover, many factors not directly associated

[32]New Jersey Division of Water Resources/Hazardous Waste Programs Case Management Committee, *Case Management Strategy Manual*, draft, May 1989.

with the site, but which affect exposures—such as nearby residential development—and, therefore, risks may also change over time. These too must be a basis for reassessing site risk classification.[33]

Another implementation issue is whether this option would pose a serious obstacle to the government's obtaining complete payment of cleanup costs from responsible parties. Action would not have to be deferred because of future risk classification if one or more responsible parties are able and willing to pay for the necessary cleanup. But communities could see this penalizing fund financed deferred cleanups. Payment of an upfront cash premium to cover future costs for deferred cleanups is also possible (see Option 15).

Implementation could be thwarted because the States have the power to withhold the legally required 10 percent match for fund-financed cleanups. For example, a State could make cleanup of a Class I site impossible, even though EPA deemed it a high priority, and could offer **matching** funds for a Class II site for which EPA determined a sound basis for deferring action. This potential problem could probably be handled in most cases by negotiation between EPA and the highest levels of State government, if the public were kept informed. An example of this State authority being used in association with future risk recently occurred for the Saco Tannery Waste Pits site in Maine. The basis for EPA's original cleanup decision was future risk in the event of residential development. But, without viable responsible parties, the State wanted to reduce its cost. It convinced the EPA to switch from a $33.5 million cleanup based on chemical fixation of hazardous material to a $10 million one based on containment of the site, so it could save $2.35 million. The State must assure that no one will develop the site. EPA will avoid spending $21 million to address the future risk at the site.

OPTION 2: Establish a Federal Site Discovery Program

The Federal Government could establish a site discovery program whose mission was to identify chemically contaminated sites which may require cleanup, including those which might not be managed within the Superfund program. A number of different approaches have been used on a limited basis with results good enough to justify full-scale national application. In particular, there is a large inventory of historical aerial photographs and procedures for analyzing them can identify likely chemical waste sites which are no longer readily apparent.

Benefits: It is in the national interest to know the full scope of the cleanup problem as soon as possible. Only in this way can effective and efficient national strategies, policies, and programs be conceived and implemented. Setting sharper and more useful cleanup priorities requires that program managers understand what their current and future workload really is or will likely be. Moreover, the laws of nature—principally entropy—mean that undiscovered contaminated sites will become more difficult to clean up over time. Contaminants will leave their original containers or places of disposal, spread into the environment, increasing the size and complexity of cleanup. Money spent on site discovery would be relatively small compared to almost all other Superfund activities. For example, a site discovery program that started at $5 million per year and increased to say $25 million per year over 5 years pales in comparison to site

[33] Some people may view this with alarm because, for example, it suggests that a developer might intentionally locate a new residential community near a Class II site in order to obtain a Class I rating and a permanent cleanup which removes a disadvantage of the location (and increases its market value). Given the time and uncertainties for achieving complete cleanups, this is not likely to be a significant problem. Moreover, the government could take the position that until the new exposure situation existed the site remained Class 11; this would make it difficult to initiate and implement the new development. But it can also be argued that providing this kind of incentive for final remedial cleanup (or removing the disincentive for worthwile use of the land) is not without merit.

study and cleanup costs. Moreover, identifying a few serious sites a year and taking early cleanup action could pay for the entire program several times over in reduced cleanup costs.

Implementation: Current cleanup staffs resist site discovery for different reasons. Adding more sites to the program makes achieving success and meeting performance goals seem more difficult; and discovering new serious cleanup sites also challenges conventional wisdom that the worst sites are already known (which OTA shows to be incorrect in ch. 2). EPA has resisted a formal site discovery program in part because sites would be identified which would not necessarily qualify for cleanup by Superfund. However, this should not block a site discovery program, because knowing what the appropriate cleanup program is cannot be determined until the sites are identified and assessed. This option requires congressional and EPA commitment, consistent with a long-term national cleanup program.

OPTION 3: Use Environmental Criteria to Eliminate Sites at PA and SI Screening Stages

Bureaucratic criteria now being used to control the flow of sites into and through the program, in order to achieve performance goals and meet resource constraints, would be replaced by environmental criteria. Instead of a site being judged-on the basis of very sparse information-to be contaminated **enough** to merit attention by Superfund, the critical decision would be whether or not the site appeared to require cleanup. **There is no information or analysis to support the contention that sites eliminated from the Superfund program that may require some degree of cleanup will receive adequate attention from other cleanup programs.** The presumption in this option is that a site eliminated from Superfund is not assured of cleanup elsewhere. Indeed, getting cleanup attention elsewhere is made difficult by: 1) the stigma of being eliminated from the Superfund program, and 2) the demand for resources in other programs to address the many sites which do make it through the Superfund system and on to the NPL. (For example, States must provide matching funds for government-financed cleanups and may have insufficient funds to carry out all other cleanups; responsible parties **and** Federal agencies would naturally devote resources to required cleanups.)

Benefits: Improving public confidence in Superfund and reducing public outrage requires that key program decisions be based on sound environmental thinking. Over time, by creating excessive flexibility, Superfund's management has met resource constraints, in part, by **bureaucratically** controlling the workload of the program. If Superfund is primarily a public health program, then it ought to employ standard thinking used in health screening. This means having as much, if not more concern, for false negative findings in the earliest stages of Superfund than for false positive ones. That is, making certain that sites which really do require cleanup are not eliminated should be of paramount concern to the government. Letting sites through which really do **not** require cleanup is important because money could be wasted, perhaps preventing action at sites which really require cleanup. However, subsequent site work can and sometimes does reveal the false positive problem. But a site falsely eliminated from Superfund may never be rediscovered—until, that is, the problem becomes evident through damage to health or environment.

Implementation: This option probably requires statutory direction to EPA. The key issue is the need to let sites proceed through the system until reliable information and its analysis can be used to make an environmentally sound decision about the need for cleanup.

OPTION 4: Remove Range of Acceptable **Risk Objectives**

Because environmental standards currently exist for only a tiny fraction of cleanup situations, especially for safe limits of contaminants in soil, EPA has appropriately used risk assessment as a means to set cleanup levels. However, the current broad range of acceptable risk (expressed as above normal deaths in a population), from 1 in 10,000 to 1 in 10 million poses opportunities to compromise environmental protection at sites and to have inconsistent cleanups nationwide.[34] With this option, the range would be replaced by a single value.[35]

What that value should be deserves attention beyond the scope of this study; however, it appears that a value of 1 in 1 million with a variance procedure is most consistent with current decisions. Moreover, the inherent limits to current practice (e.g., examining only indicator contaminants for which health effects data exist), and the need for a margin of safety relative to the considerable uncertainties of risk assessment support this level of risk. Yet another reason for a margin of safety is that whatever a cleanup objective is set at, corresponding to a risk of 1 in 1 million (e.g., concentration of contaminants in soil), the actual cleanup will have some statistical spread around that target. Some people may believe that this level of risk is overly stringent, but the popular belief that risk assessment is intrinsically overly conservative has recently been shown to be inaccurate.[36]

It should also be understood that the risk considered here refers to individual risk, not total population risk. This option presumes, of course, that explicit cleanup goals or standards for a site are set. But, in fact, this is not the case for many sites. One problem is that many cleanups are implicitly based on cleanup technology performance, for whatever cleanup technology is selected, which most of the time is not one based on destruction of hazardous material. Another way of seeing this current form of implementation is that there often is no explicit risk reduction identified as the goal of cleanup.

Benefits: Removing environmental protection as a variable in cleanup decisions can improve public confidence in Superfund. Current excessive flexibility would be reduced. From a long-term perspective, reducing cleanup costs through lowering of cleanup levels is not consistent with the basic environmental mission of Superfund. When circumstances exist to use a higher level of acceptable risk, then they should be articulated by the government and defended on technical or fund-balancing grounds. Using a single acceptable level of risk also offers an opportunity for more certainty in the operation of Superfund. It removes one issue over which there sometimes is considerable

[34] A recent examination of cleanup levels said, ". . . if the allowable level of risk is not held constant, "How Clean Is Clean?' levels become 'moving targets' and the probability that they will be applied inconsistently increases significantly. D. Killian, "'How Clean Is Clean?' contaminant remediation levels in soil," in *Management of Hazardous Materials* aria' *Wastes: Treatment, Minimization and Environmental Impacts.* Edited by S.K. Majumdar, E.W. Miller and R.F. Schmalz, 1989, The Pennsylvania Academy of Science.

[35] According to EPA, it has not used the lowest end of the risk range (i.e., 1 in 10 million). Moreover, in defending why the range should not be narrowed by reducing the lowest risk by a factor of 10 (to 1 in 1 million), as desired by the Office of Management and Budget to prevent higher cost cleanups, EPA also noted that its risk range "has not been a point of contention" with responsible parties. (EPA internal memorandum, identified as the notes of former Assistant Administrator J. Winston Porter, Sept. 30, 1988, in Committee Print 101-B, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, March 1989.) Why was EPA successful in convincing OMB to keep the original risk range? EPA told OMB that removing the lowest risk, which it had not used, would, however, lead to a '" firestorm'' which might 'destroy much of [its] flexibility. But the flexibility referred to by EPA was at the opposite end of the risk range; that is, higher risks (i.e., less than 1 in 1 million) have been used by EPA and sometimes have been important in selecting remedies with lower costs which have facilitated settlements with responsible parties. Selecting higher risk levels has been a point of contention with site communities.

[36] John C. Bailar, III, et al., "One-Hit Models of Carcinogenesis: Conservative or Not?" *Risk Analysis,* vol. 8, No. 4, 1988. The study found that underestimation of risk occurs in about 2.5 to 4 percent of the cases, and overestimates occur in about 5 to 7 percent of the cases. This paper has been instrumental in supporting the position that risk assessments of chemical hazards are not necessarily substantially conservative. In the case of vinyl chloride, for example, standard risk assessment methodology underestimated risk by a factor of 9.

confrontation and costly delay. This option, however, offers no benefits relative to cleanup decisions for sites posing threats from substances which cause health effects other than cancer and threats which are not now described in terms of numerical risks, such as threats to sensitive environments.

Implementation: Action by Congress seems necessary for such a critical policy change. Because of the sensitivity of the issue of not only selecting a specific level of risk, but of selecting what that risk is, it might be useful to begin with an independent study. The study would examine the issue and provide a recommendation for a national risk level for cleanup based on health and environmental protection criteria only. The National Research Council has performed a number of relevant studies in the past, such as on risk assessment and the Oak Ridge National Laboratory has performed very detailed work on the use of risk assessment in Superfund.

A major concern about this option, especially from responsible parties and government officials, is the inevitable loss of flexibility in determining site cleanup objectives. But to people living near Superfund sites, flexibility has meant the ability to legally reduce the stringency of cleanup in order to secure funding from either the government or responsible parties. In other words, the current range of acceptable risk automatically ***makes*** it legal to offer varying degrees of protection to people without explicitly explaining why that is appropriate or necessary. The public is especially sensitive to less stringent cleanups based on higher than normal (for Superfund) risk levels, because normally no benefits to the community are lost by demanding the most stringent cleanup. (One exception, which has occurred at several Superfund sites, is when a responsible party is also a major employer in a community.)

Another potential problem is that the inherent lack of precision in risk assessment and its susceptibility to subtle manipulation could make the use of a single value of acceptable risk ineffective. Refining guidance on risk assessment methodology to tighten its application, therefore, should be part of any study on this option.

Some consideration should also probably be given to the question of whether estimating risks at Superfund sites should take into account exposures to similar hazardous substances from nearby sources. For example, there may be other cleanup sites nearby. Or the government Toxic Release Inventory database obtained under Title III of SARA could be used to factor in exposures from industrial operations. It is difficult, from a health protection perspective, to judge cleanup need or extent in isolation, ignoring other exposures which, in some cases, might make the critical difference between cleanup or no cleanup, or affect cleanup standards significantly. This option does not preclude following the current statutory requirement to use applicable or relevant and appropriate regulations (ARARs), which, however, do not cover many contaminants and exposure routes at Superfund sites. Finally, the use of national cleanup standards, particularly for soil cleanup, is another way to achieve certainty and efficiency by stepping outside of the risk assessment methodology (see Option 5).

OPTION 5: Establish National Minimum Cleanup Standards

All cleanups of chemically contaminated sites, performed by any public or private entity, would have to comply with minimum Federal requirements comparable to those of Superfund. All available information indicates that very different procedures, actions, and results are occurring in different Federal, State, and private cleanup programs. For example, the use of land disposal is far more prevalent outside of Superfund (see ch. 4), the influence of those paying for cleanup on decisions about the scope and level of cleanup appears more significant in programs outside Superfund, and substantially different levels of residual contamination in soil and water pervade the national cleanup system. Federal requirements could include, for example: compliance with existing Federal numerical standards for safe levels of contamination in air, water, and soil when they exist, unless more stringent standards have been set by the State; setting numerical standards for cleanup goals of major types of contaminants unless a waiver was granted in response to a detailed environmental justification for so doing (e.g., acceptable residual levels in soil of lead, PCBs, and creosote chemicals); use of standard exposure and risk assessment methodology and acceptable level(s) or risk to establish cleanup objectives; the preference for permanent onsite treatment remedies; use of a Superfund hierarchy of cleanup technologies and methods; use of cost-effectiveness analysis as a means to minimize site cleanup costs after determination of site cleanup goals; full public participation from start to finish of the cleanup process; and 5-year reviews of sites where contamination remains.

Benefits: National standards would introduce consistency and certainty into the national cleanup effort. Excessive flexibility would be reduced. The flight from Superfund would largely be stopped and, therefore, **sites deferred out of Superfund would not be penalized by receiving less stringent cleanups;** this would also reduce future Superfund needs.[37] Those paying for cleanups, including all types of government agencies and companies, would have: 1) less incentive to shop around for a cleanup program which posed the least stringent requirements and, hence, minimized their costs, and 2) less trouble and costs dealing with different cleanup programs with different cleanup standards or procedures in obtaining them. **The current inequality and inconsistency in the array of cleanups nationwide, often providing uncertain, incomplete, and ineffective protection of health and environment would largely be eliminated.** Many studies, particularly risk assessments, could be eliminated because fixed cleanup standards could be used. Conversely, national standards could also reduce excessive cleanups, as well as reducing transaction costs by reducing confrontation over cleanup goals at sites and shifting of sites among different cleanup programs (see ch. **4).**

Eventually, this option would make it more feasible to shift implementation of Superfund to States (see Option 19), because of the assurance that their programs would provide comparable protection. State officials have concluded:

> The lack of development of cleanup standards or goals has been a major impediment in achieving a more rapid remediation of hazardous waste sites throughout the country. The ARAR concept is good, but States have looked to EPA for guidance in the development of national standards or models for the establishment of site specific cleanup goals without receiving much meaningful assistance. The National Superfund Program Strategy must include a commitment by EPA to develop, in conjunction with the States, tools to generically answer the question "How Clean is Clean?" . . . The overall goal of developing cleanup standards, models, and criteria should be to assure a consistent approach to the cleanup of hazardous waste sites.[38]

Implementation: This option requires statutory enactment. **Many parties would find this option objectionable because of, for example: losing flexibility, facing increased costs, and facing the need to make initial changes in existing State statutes, regulations, and programs. In** other words, implementation would be difficult and opposition to the option substan-

[37] At a Senate hearing on June 15, 1989 the EPA Administrator indicated that the agency would not pursue at that time its deferral proposal as part of the new NCP. The reasoning was that cleanups for sites deferred to other programs could not be assured to offer the same kind of remedies, standards, and procedures found in Superfund. Response of William K. Reilly to question from Senator Lautenberg; Superfund oversight hearing, Senate Subcommittee on Superfund, Ocean and Water Protection, June *15, 1989.*

[38] Association of State and Territorial Solid Waste Management of fficials, Washington, DC., position paper ''N~on~ Superfund Program Strategy—Getting More Done With Limited Public Funds," Apr. 28, 1989.

tial, as any such Federal environmental legislation has historically been. Actual implementation problems and costs would depend on the exact requirements, their enforcement, and on penalties for noncompliance, as well as incentives which might be used to motivate compliance. Analysis of these details is beyond the scope of this study, but implementation problems could be minimized by keeping requirements as simple as possible. **OTA concludes that the potential environmental and economic benefits justify serious consideration of this option for a permanent national cleanup effort.** A first step by Congress might be to have a l-year independent study of this option by, for example, the National Academy of Sciences or a university with experience in the cleanup area, such as the federally sponsored program at the Center for Environmental Management at Tufts University. One issue requiring study is the extent to which numerical cleanup standards for soils would define a very large universe of potential cleanup sites (e.g., areas near highways with heavy metal contamination).

OPTION 6: Define and Limit Meaning of Permanent Cleanup

Superfund is necessary because of past shortsighted waste management practices. **The idea of achieving a permanent cleanup has intrinsic merit. But "permanent cleanup" is not now well defined by statute or EPA policy.** However, EPA has recently explained the role of treatment technology, which according to OTA is the means of achieving permanence, versus containment technology, which according to OTA is not a permanent remedy. EPA said that treatment technology "will be used most often for highly toxic, highly mobile waste, whereas containment is generally reserved for low concentrations of toxic materials or relatively immobile wastes. '[39] This position makes containment an acceptable remedy for many types of sites, especially ones with soil contamination and low levels of groundwater contamination. (Moreover, EPA's application of the land disposal restrictions under the RCRA regulatory program to Superfund essentially promotes leaving hazardous site material in place and capping it, instead of treating the hazardous material or even containing it in a RCRA hazardous waste landfill with liners and leachate collection.[40]) In fact, EPA has indirectly defined sites for which the statutory preference for permanent remedy applies and sites for which it does not, a distinction the statute does not make. If permanence is not an overarching cleanup goal, then lower cost, impermanent remedies are likely to prevail; in the past 2 years at least 75 percent of selected remedies are impermanent, according to OTA's definition of permanent remedy (i.e., destruction or recovery of hazardous material). (See ch. 3.)

With this option, permanence would mean that cleanup objectives are achieved without further action at the original site or at any other site which has become a part of the cleanup, such as an offsite landfill that receives cleanup waste. People living near sites want to feel confident that there are not enough toxic chemicals left in land or water to threaten their health. Conversely, impermanent cleanup means--or should mean-permanent contamination of land or water, because hazardous substances remain hazardous and a potential threat through uncontrolled release or exposure. (Unlike radioactive materials, there is no natural predictable decay of the hazardous characteristics of chemical waste.)

[39] EPA Memorandum, ''Advancing the Use of Treatment Technologies for Superfund Remedies, OSWER Directive No. 9355.0-26, Feb. 21, 1989.

[40] Environmental Protection Agency, ''Policy for Superfund Compliance With the RCRA Land Disposal Restrictions, ' OSWER Directive 9347.1-02, Apr. 17, 1989 and "Land Diposal Restrictions as Relevant and Appropriate Requirements for CERCLA contaminated Soil and Debris, " OSWER Directive No, 9347.2-01, June 5, 1989. See discussion inch. 3.

Without definite cleanup goals it is impossible to know whether any action is permanent. Permanence does not imply reaching zero contamination or zero risk. Cleanup standards that are less protective of public health and environment make it easier to achieve permanence. But certain kinds of action are inconsistent with permanence, including any form of land disposal or containment, and any use of engineering or institutional controls, including long term monitoring for releases. All of these mean: 1) site hazardous material remains hazardous; 2) there is uncertainty about releases of hazardous material and, therefore, risks to health and environment; and 3) there are a host of uncontrollable possible future events which might compromise the effectiveness of the protection. Some important examples of problems are: deed restrictions which later are forgotten, ignored or overturned; physical failure of caps on buried waste which goes undetected or, even if known about, is not effectively and expeditiously dealt with by repair or replacement because of lack of money or confusion over who has responsibility; new commercial or residential uses of land or water which were not anticipated and which cannot be blocked legally; natural catastrophes, such as flooding of a capped landflll or a lightening hit on a leachate treatment system; monitoring systems which may fail, may not be operated properly, may not be properly maintained with required sensitivities, and may not be responded to with fast and effective remedial action.

OTA concludes that it is not technically correct to convert the concept of permanence into a variable parameter. That is, **OTA disagrees with the notion that land disposal or engineering or institutional controls provide a "degree of permanence."** What **varies is the** level of protection provided by different cleanup technologies and methods, not the degree of permanence. To tell the public that a remedy is permanent for perhaps a decade does not build public confidence. **However, impermanent actions have an important role to play in decontrolling sites to reduce or even eliminate current risks without, necessarily, producing a complete and permanent cleanup.**

Benefits: Current statutory provisions are too ambiguous and lack the clarity necessary for effective program management. With this option Congress could establish a clear policy for Superfund management and reduce excessive flexibility, that now is enjoyed by EPA staff. **OTA concludes that there is a net benefit to focusing on achieving permanence through reduction of the cause of the intrinsic hazard, such as toxicity, compared to current statutory attention to reducing mobility and volume.** Scientifically, reducing mobility is not achievable through techniques which offer certain long-term effectiveness on a par with destruction; reducing volume of hazardous material usually results from application of a technology which concentrates the truly hazardous component of some larger volume of soil or water or non-hazardous waste and, therefore, is not on a par environmentally with reducing hazard through destruction or recovery of valuable material.

The public intuitively understands the environmental, economic, and psychological benefits of a permanent cleanup. Permanent cleanups offer more certain and more effective environmental protection and can prevent future cleanup costs. But many cleanups have not and cannot, with available technology and resources, completely eliminate the source of the problem. Still, public confidence in Superfund and EPA's implementation of it would benefit substantially from a commitment to achieving permanent remedies. And the public can understand that achieving permanence for all Superfund sites (currently known and yet to be identified) is not technically or economically feasible in the near or even mid-term.

Under current statute, 5-year reviews are necessary when hazardous material remains onsite and many RODS acknowledge that future requirement. Whenever that requirement is invoked, the remedy is not permanent. (Nor is a remedy necessarily permanent if this provision is not invoked.) Current policy, however, means such sites can be delisted from the NPL. With this option such delisting would not occur.

Implementation: EPA could implement part of this option through revised policy and, if the current proposed NCP becomes final, through a regulatory change. However, because of the wide difference between past congressional actions and EPA interpretations, congressional action may be advisable. It would be difficult for EPA to implement this option without thoroughly revising its nine criteria for remedy selection. **Moreover, current statutory language about reducing toxicity, volume, or mobility through treatment as a cleanup preference must be addressed for complete implementation of this option.**

There would be major impacts on remedy selection and delisting which would raise concerns about implementation of this approach (see Option **22). The** trend of moving away from land disposal to treatment would become stronger, and the diverse set of treatment technologies would take on a different meaning. **Only some treatment technologies offer permanence (see *ch.* 3).** Costs might increase significantly in the short term. But R&D, technology demonstration, and competition would probably reduce costs in the longer term.[41] Increasing competition among an increasing number of destruction technologies and, for example, mobile incinerators, have already reduced costs. More effective separation technologies, which concentrate hazardous material for recovery or treatment by destruction technology, have also emerged rapidly and will continue to expand.

Implementation of this option could be made difficult because of the power States have in withholding their legally required 10 percent match for fund-financed cleanups, EPA may want to use a permanent but more expensive remedy at a site, but the State may only provide their matching funds for a lower cost, impermanent remedy. Indeed, this has happened already. One solution is for senior EPA officials to make this situation *known* to the public and to appeal such actions to the highest State officials.

Finally, this option can make use of the concept of Option 1, current versus future, uncertain risk. If there is an identifiable future, uncertain risk, the cleanup achieved to date may not be fully complete, even though a permanent treatment technology has been used. In such a cases, the remedy might be classified as an interim action and a permanent remedy might—or might not—be needed later.

Developing Workers and Technologies

OPTION 7: Reduce Dependency on Contractors, Expand EPA Workforce

Superfund implementation will always make extensive use of private sector contractors. But the current degree of dependence on contractors seems too high and, with this option, would be reduced. Too much dependence on contractors means a lack of **independent** technical expertise and information in government. **Improved public confidence in Superfund is contingent on the public believing that government workers, working in the public interest, know enough to solve cleanup problems.** The previous option as well as several others above also address this problem. Another aspect of contractor dependency is the use of contractors for inherently governmental work, particularly policy development and program implementation. Inevitably, reducing contractor dependence means

[41] EPA Currently uses figures which indicate that total site cleanup costs, including EPA's administration of the program, total about $30 million on average. OTA believes that implementation of this and some other options discussed in this report might increase the average site cleanup cost to $50 million, although variations among sites would remain very large. But this is really a worst-case scenario, because technological innovations and program restructuring, as discussed in the policy options of this report, could prevent such a large increase in average site cleanup cost.

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recognizing that Superfund is a permanent program and, therefore, accepting the necessity to increase EPA's workforce at headquarters and in its regional offices. There is also a need to increase Superfund activities in EPA's Inspector General's office, a need presented in OTA's 1989 Background Paper on contractor use.

Benefits: The effectiveness and efficiency of Superfund in the near term depends, in some significant measure, on building up EPA's workforce and reducing the dependence on contractors. This option recognizes the absolute, permanent need to use private contractors in Superfund implementation. With this option, however, balance would be restored between the roles of government and private sector workers. Some of the dependency on private contractors could also be reduced if EPA would make greater use of other Federal agencies, including the U.S. Geological Survey, the Bureau of Mines, and the National laboratories (see Options **27 and 28).**

Implementation: EPA could implement this option with congressional support for shifting funds from contracting to building up the permanent EPA staff. This option does not imply a net increase in funding.

OPTION 8: Establish a Hierarchy of Cleanup Technologies and Methods

A possible hierarchy is given in box l-F. Using a hierarchy is meant to introduce an environmentally sound logic into the identification and evaluation of cleanup alternatives. For remedy selection decisions it means that it would be necessary to demonstrate that alternatives higher on the hierarchy than the one selected had been carefully considered, and the reasons for their elimination provided. It does not imply that specific cleanup technologies or methods would be required by the government, nor does it rule out combinations of technologies and methods which taken together may provide an effective site remedy. The hierarchy would establish destruction and recovery technology at the top of the hierarchy; this means that it is the most preferred, using permanence of remedy (or permanent **risk reduction) and certainty of that outcome as the ranking criteria.[42] For combinations** of technologies and methods, the one lowest on the hierarchy is key. For instance, reduced certainty places separation plus destruction lower on the hierarchy than just destruction. When separation technology is used first, its effectiveness determines the overall achievement of permanence; however, the combination of separation and destruction technologies can achieve a permanent site remedy. Lower on the hierarchy is land disposal, containment, and other engineering controls, followed by institutional controls, including ongoing monitoring and provision of alternate water. Relying on natural conditions (e.g., biodegradation in a contaminated aquifer) usually offers far more uncertainty than a controlled treatment process and can correctly be considered a form of no action. In some instances, separation technology alone may offer a permanent remedy because the collected and released hazardous material may be so low in concentration (after dispersion) that destruction technology is unnecessary environmentally and impractical (e.g., air emission of very small amounts of volatile organic chemicals from groundwater air stripping). But this variation is best characterized by a combination of separation and natural treatment.

Benefits: It would be helpful to achieve a better understanding of the functional differ-

[42]Some people maintain that technologies and methods which reduce mobility or exposure (and therefore risk) without destroying or recoving a site's hazardous substances offer comparable protection. OTA's finding, as discussed in ch. 3, however, is that the long-term certainty of protection is maximized what hazardous substances are destroyed or recovered. With other technologies and methods, the duration of effectiveness cannot be assured and they are impermanent remedies, but in some cases they maybe the only feasible options, and they are especially important for emergency, recontrol, and interim cleanup actions.

Box I-F--A Hierarchy of Preferred Cleanup Technologies and Methods

Purpcme-The hierarchy recognizes the environmental preference for some outcomes and types of uncertainties over others.[a] Primarily, onsite permanent destruction or recovery of hazardous substances is favored. Note that SARA's use of "or" with regard to reducing toxicity, mobility or volume is inconsistent with a hierarchy of preferred environmental benefits. The hierarchy does not guarantee that the highest level of technology is used at a specific site because other factors must enter into the analysis, especially the type of action (e.g., recontrol v. final remedy). But the hierarchy provides a consistent framework for studies and decisions. The following is a possible hierarchy of Preferred cleanup technologies and methods:

Clam I: Destruction or Recovery-Actual destruction of hazardous organic substances to irreversibly eliminate the source of the problem. Examples: thermal, biological, and some chemical treatments (e.g., dechlrination). Recovery of pure metals or chemicals suitable for commercial use.

Class II: Separation Followed by Destruction--Technologies which separate hazardous from non-hazardous materials. Examples: extraction or stripping of volatile chemicals from soil or groundwater, gas venting, soil washing and flushing, precipitation, and carbon absorption of contaminants from groundwater.

Class 111: Stabilization-Any form of chemical fixation, stabilization, and solidification which cannot assure actual destruction of all hazardous components. There are numerous commercial forms which vary according to the materials mixed with the hazardous material. In some cases there are claims that organic molecules are permanently altered by the process, but this has not been well documented scientifically.[1] Effectiveness and reliability for toxic metals are well proven.

Class IV: Engineering Controls-A variety of methods can restrict the movement of contaminants or exposure to them. Although such methods are not permanent, they can recontrol a site by: 1) imposing physical barriers (e.g., slurry walls, landfill caps and liners, leachate or groundwater pumping); 2) keeping water away from hazardous material (e.g., diversion ditches, soil and plastic covers, storage vaults); and 3) keeping people away from hazardous material (e.g., fences, caps, and soil covers). Techniques in this class must be assessed routinely for failure or deterioration of materials. Repair and maintenance, as well as less than 100 percent effectiveness, pose unavoidable uncertainties. Onsite re-disposal of hazardous material, followed by engineering controls, provides more reliability than applying controls to hazardous material in their original condition (e.g., buried waste or contaminated soil).

Class V: Institutional Controls--These depend on people and organizatons to deal indirectly with hazardous contaminants by controlling exposures to them or by detecting the need for further action (e.g., restrictive deeds; alternate water supplies; relocation of residents; periodic monitoring, testing, or inspection). Unavoidable uncertaintiesrcsult from: l)potential failures of people or institutions to adequately fund or implement the controls, and 2) possible changes in the original cleanup objectives without public accountability.

Class VI: Natural Treatment-Any onsite or no-action approach which depends on a natural form of treatment being effective over the long-term (comparable to time over which hazardous properties persist) for expected but inevitably uncertain site conditions and future land and water use. Includes: natural biodegradation, chemical breakdown or decay of hazardous molecules, adsorption to soil. Dilution and dispersion of hazardous Substances into the environment which produce "safe" concentrations maybe considered by some people as natural treatment or attenuation.

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[1] b situ vitrification is likely to fall into this category because complete thermal destruction cannot be assured (EPA's SITE program places it in the stabilization category).

NOTE: For classes I-III, the first preference is onsite treatment; second, in situ treatment; third, transport and offsite treatment.

SOURCE: Office of Technology Assessment, 1989.

ences among waste treatment technologies. Past effort has focused on the distinction-between treatment technology and land disposal and containment. The hierarchy would reduce excessive program flexibility, introduce efficiencies into studies, help compliance with statutory requirements, help the public better understand analysis and selection of remedy,

help channel government R&D and private sector technology R&D and commercialization into the most productive areas, and motivate technology developers to provide better data. In particular, in too many past Feasibility Studies, significant options high up on the hierarchy have not been thoroughly considered; this has blunted compliance with statutory preferences and requirements and it has caused community people to fight selected remedies which they correctly perceived to offer lower levels of protection.

Implementation: **There is no statutory obstacle** to EPA's implementation of this option. Alternatively, Congress could define the hierarchy and require EPA to implement the hierarchy in all implementation efforts. Although there are bound to be legitimate concerns, there seem to be no major obstacles to implementation. But questions may arise as to whether a technology destroys hazardous material, or how a technology gets classified when it destroys only some hazardous substances at a site, or about the labeling of a technology which destroys some hazardous material but produces new hazardous byproducts.

Destruction can be dealt with through scientific enquiry; proponents of a technology should have the burden of demonstrating scientifically, through experimental results, that hazardous substances have been rendered nonhazardous without the production of hazardous byproducts. (The rendering to a nonhazardous state does not necessarily imply the loss of original chemical identity; for example, some metals are only significantly toxic in one electronic valence state which can be changed through treatment.) Currently, without a good distinction between destruction or recovery and other types of treatment technologies, some companies are making unsubstantiated claims of permanence.

With regard to partial destruction or recovery of site materials by a particular technology, the first scientific principle should be that **no** destruction technology can destroy or recover **all** conceivable hazardous substances. Therefore every destruction technology has limits; for example, incineration cannot destroy toxic metals. The second scientific principle is that no process can operate with 100-percent" efficiency. That is, every destruction technology inevitably must provide information about hazardous emissions and residuals due to incomplete destruction. The third principle is that any destruction or recovery technology may produce **new** hazardous substances; this is a well-known aspect of incineration but an often neglected issue for other technologies, such as biological treatment.

The question of incomplete *site* contaminant destruction is another matter; it requires addressing the use of destruction technology relative to the quantity of all hazardous site material and the use of other cleanup technologies. Information should be presented on the relative contribution of different site cleanup technologies when they are intended to be used at roughly the same time; for example, at a site at which incineration and land disposal is used, information should reveal what fraction of the hazardous material-the actual hazardous substances, not the total volume of soil or water which may contain the hazardous substances— has been destroyed, versus the fraction land disposed. The degree of site contaminant destruction may often be maximized by using a combination of destruction technologies, or by a combination of separation and destruction technologies. Using separation first can reduce total costs substantially because destruction technologies are usually more expensive per ton processed than separation technologies.

Another issue is whether a *natural* form of treatment qualifies as destruction technology, or as presented here as the lowest, most uncertain option on the hierarchy. Here too, scientific analysis must be used. For example, it may be argued that natural adsorption of a chemical to site soil is treatment; perhaps, but that treatment is not destruction, it is a form of separation technology. Moreover, it intrinsically has uncertainty, because soil conditions might change and reduce the adsorption, releasing the hazardous substance. Another important example, because it is frequently invoked in cleanups, is natural flushing. This means that water infiltrating contaminated soil removes contaminants and transports them away, typically into groundwater which may release the contaminants into a river. This too is a case of separation technology, with uncertain cleanup effectiveness and uncertain environmental effects due to subsequent exposures; natural or solar evaporation of volatile chemicals is similar. An example of natural destruction is biological destruction of an organic contaminant by naturally occurring microbes, in soil or groundwater, without, however, engineering controls to ensure continued effectiveness. Natural treatment may sometimes be used to make no-action seem more than it really is.

Adoption of the hierarchy does not impose options, but it does make it more difficult to choose an option low on the hierarchy without careful explanation of why ones above it have not been used. It is important to recognize that for some cleanup actions lower level options are appropriate, especially for emergency and recontrol actions.

Lastly, the impact of the hierarchy on treatability testing may raise concerns. Although treatability testing is critical to the maximum use of newer treatment technologies, the selection of specific technologies for evaluation remains an issue. The hierarchy would guide project managers in thinking about which technologies should be targeted for treatability testing. It is important to have representation of technologies from top to bottom, in case the most desirable one(s) are not found successful. In this way, the public can understand the **technical basis** of why more preferred technologies have not been selected.

OPTION 9: Restrict Use of Groundwater Cleanup Technology

The most common form of groundwater cleanup (other than providing alternate water) is pumping contaminated water to the surface and treating it through a variety of technologies, with the aim of rendering it suitable for use, discharge, or reinfection into the ground. But exactly when the program has substantially increased its use of pump and treat, research results and analyses have concluded that current practice does **not** offer predictable performance and success (see ch. 3) for complicated cleanups. Moreover, most decisions to clean up groundwater are for sites for which the government's analysis has shown no current risks, the source of the contamination has not been brought under control, and the underground aquifer is not yet well understood. **Although pump and treat can remove some contaminants, there is major uncertainty about the ultimate levels of contaminant reduction and the time to reach them. But this uncertainty is not communicated in RODS.** Over a year ago, a senior EPA official said:

> . . . a recent analysis by EPA's own Office of Research and Development strongly indicates that the groundwater pump and treat systems, which the agency has been selecting to control groundwater contamination, will not achieve the levels of cleanup required by agency standards in less than tens, perhaps hundreds, of years, ., . [T]his new data illustrates that there is still a great deal to learn about how to remediate some of the problems at these Sites.[43]

With this option, Superfund management would reassess the current selection of pump and treat as a proven, predictable, and effective groundwater cleanup remedy for nearly all situations. This means examining ways to improve the practice of pump and treat, and alternatives to pump and treat, including point-of-use treatment, hydraulic containment of the plume, in situ biological treatment and other

[43] Gene A. Lucero, ''Son of Superfund,'' *The Environmental Forum,* March/April 1989.

new **treatments, and natural attenuation and biodegradation. This** issue also highlights the need to pay more attention to identifying and eliminating the **source** of groundwater contamination at a site. **The greater the difficulty of cleaning up groundwater, the greater the urgency to remove the source of groundwater contamination.**

Benefits: The public's demand for action by Superfund is not well served in the long term by using an unreliable cleanup method. An enormous amount of money might better be spent on other sites, providing the public with more protection. Indeed, the current approach may be counterproductive environmentally. Expensive pump and treat cleanups may eventually be stopped because either the cleanup level is thought to be attained when in fact it has not been (e.g., because chemicals de-adsorb from subsurface soil), or because cleanup will be judged complete even though cleanup standards cannot be met (i.e., health effects standard is replaced by **a** technology performance standard). With this option, there would be more limited use of pump and treat, and more explicit institutional commitment to near-term monitoring and recontrol which, however, does not imply permanent cleanup.

Implementation: EPA could act on this option through, for example, a special high level task force study. Alternatively, Congress could require an independent study (perhaps by the U.S. Geological Survey which has developed improved pump and treat practices) which integrated the current state of scientific knowledge and the performance of current pump and treat practices at cleanup sites. The congressional route may be advisable, because EPA has shown little interest in addressing this issue, in part because of a natural tension between the Superfund program, with its primary interest in taking action, and the R&D program at EPA, with its primary interest in better understanding technology and its limits. Indeed, facing heavy public demand for action, it would be difficult for EPA on its own to shift away from the pump and treat approach, using it only when its effectiveness can be well substantiated (e.g., for contamination of a simple, well understood, and relatively small aquifer by only one chemical or a few similar contaminants).

Some people are concerned about underreaction to groundwater problems. But if spending large amounts of money on pump and treat at complicated sites is going to prove ultimately wasteful, then the public needs to understand that. If pump and treat is not a reliable permanent remedy for many types of sites, then it would be better to focus on recontrol actions to address current risks from groundwater contamination, careful monitoring of the problem, and the need for a major R&D program (see Policy Option 29). Moreover, it is possible to increase the chances for success of pump and treat by improving the technical methods used (see ch. 3), which mean increased costs.

OPTION 10: Establish Generic Site Assistance Program, Including Expert Systems

Groups of experts in generic types of cleanup sites (e.g., PCB, wood preserving, lead battery, municipal landfills) would be established at EPA headquarters. This means expertise centered around site problems rather than around cleanup technology (see following option). The key functions of the groups would be to: 1) provide technical assistance to front-line Superfund staff in EPA regional offices, Federal and State agencies, and contractors through telephone assistance, site visits, reviews of technical documents, and special reports; 2) develop and update expert systems (to replace or supplement technical guidance documents) for implementers to use on their own from the earliest site evaluations through assessment of the effectiveness of a permanent remedy;[44] and 3) provide formal peer review of RODS prior to their regional approval and release.

Benefits: This option would provide an efficient way to use the greatest technical expertise present in the Superfund system, improving technical work and information transfer. Low quality and unnecessary site study work could be cut substantially because of the expert help and systems; indeed, with this option it becomes feasible in many cases for EPA to perform Remedial Investigations and Feasibility Studies on its own. The impact on the program of front-line staff turnover would be reduced, because there would be a stable core of technical expertise for site managers to draw on. This group of experts would also provide the mechanism for transferring information and technology from R&D efforts into the field. The public would be better assured that the best available cleanup technology was being selected by the government. Expert systems compensate for inexperience; they could also be very useful for educating members of the community, making their public participation more effective. The placement of this effort within the Superfund office and not EPA's Office of Research 'and Development is important. This effort is envisioned as operational, not research. Current use of ORD personnel for operational support detracts from ORD's primary mission.

An important benefit would be to provide a capability within government to assess the credibility and importance of technical information obtained by responsible parties. Currently, government spends a substantial amount of money on contractor work to duplicate site analyses or cleanup technology evaluations performed by responsible parties. This often means delay in cleanup and, very often, the government contractor work provides no new or different information.

Implementation: Either EPA or Congress could implement this option. The key to successful implementation is having the Nation's best technical experts, more so in science than engineering. This means people with major experience in investigating and cleaning up certain types of sites. OTA believes that many qualified experts already work for different EPA programs, such as in some of EPA's regional offices where they have accumulated many years of experience. Others are in universities, consulting firms, and some technology development companies. Work in this program could be seen as a rotating assignment, for EPA staff and for those in universities and elsewhere. The level of effort envisioned here is about 20 to 40 professionals administering this program; total annual spending would probably be in the range of $3 million to $5 million. But about $10 million might be necessary initially for development of several expert systems.

OPTION 11: Establish Technologies Assistance Program

Groups of experts in generic technologies would be established at EPA headquarters; for example, incineration, biotechnology for soil cleanup, chemical fixation, low temperature soil stripping of organics, vacuum extraction of organics, groundwater cleanup. The groups of experts would provide operational assistance to site managers and staff by phone, personal visits, and quick reports in all phases of the program. The technology experts would be able to interpret new R&D results, as well as help design and interpret the results of site treatability tests (i.e., testing of site materials to evaluate effectiveness of a particular technology). They would stay abreast of all commercial developments and data, and provide an independent evaluation of vendor information. During design and implementation, they would also be available as consultants and trouble-shooters;

[44] The expert systems would be interactive computer software programs which should also be made available to communities, responsible parties, and the consulting engineering community.

they would also collect and analyze performance data from cleanup implementation. The experts would be the key instruments in transferring information from all government and industrial efforts to the front-line people implementing Superfund. Teams of experts could help regional site managers and staff resolve the difficult issue of what technologies or what combination of technologies could best be used at a site. This group would also provide another level of formal peer review of RODS prior to their regional approval and release.

Benefits: This option would improve the rate at which the best, most innovative, and cost-effective cleanup technologies were implemented. **It** would give the government much needed independent expertise cost-effectively, because it is impossible for site managers and staff in regional offices to be experts on a large number of very different, rapidly changing technologies. Moreover, OTA's research has shown that Superfund staff need to be less dependent on the expertise of vendors, contractors, and responsible parties. This option would help EPA conduct some of its own Feasibility Studies. Conflicts of interest which may affect key technology choices would be minimized. More consistency in Superfund implementation would also result, and the successes and failures of technologies would be quickly integrated into program implementation.

Implementation: The key to successful implementation by EPA is to assure that the highest caliber, experienced professionals are chosen for this critical task, more in engineering than science. OTA believes that many qualified experts already work for different EPA programs, such as in some of EPA's laboratories where they have accumulated many years of experience. Others are in universities, consulting fins, and some technology development companies. Work in this program could be a rotating assignment, for EPA staff and for those in universities and elsewhere. A key need is for **objective,** critical analysis and evaluation of information. In this regard, it is important that EPA personnel be totally committed to this work, as compared to current practice where some EPA experts provide technical assistance to Superfund staff on a part-time basis from their current home bases, such as in ORD. The level of effort envisioned here is about 20 to 40 professionals administering this program; total annual spending would probably in the range of $2 million to $4 million.

OPTION 12: Better Define Mission of SITE Technology Demonstration Program

This option would not change the basic premise of the SITE program; the need for the program remains. What appears necessary, however, is to make the program perform faster, be more user friendly, and be less bureaucratic. Moreover, the program needs a better focus on the demonstration of truly innovative technologies which seem too risky or uncertain for the private marketplace. This probably requires more sharing of cost and risk by the government. Too many of the technologies in the SITE program (21 out of the 30 technologies currently) have already had extensive private sector use and support. Attention would also be given to the need to say that a technology has not worked when it hasn't, and to minimize the use of SITE participation as a marketing tool, especially when SITE results do not fully support the claims of a vendor. Moreover, technology companies not in the SITE program should not be penalized by, for example, receiving less attention or support from EPA and Superfund staff. This option first means an independent evaluation of the SITE program by, for example, EPA's Science Advisory Board or the National Research Council. A short 6-month study would provide specific recommendations on how to improve the program.

Benefits: For a long-term cleanup program there are enormous benefits from the demonstration of innovative technologies which offer true breakthroughs in solving particularly difficult and important cleanup problems, and also to produce substantial and even dramatic reductions in unit cleanup costs. Incremental technological improvements are well handled by the private sector, particularly because the cleanup market is so large and competition among and within generic technologies so intense. So the mission of the SITE program **should be to push the frontiers of cleanup technology.** The benefits, however, are questionable if the program competes with private sector efforts in promoting the demonstration and diffusion of more modest incremental technical improvements. With this option, current or anticipated spending levels for the SITE program might be **decreased,** because so much of the program's activities now have little to do with cutting edge, innovative technologies.

Implementation: EPA or Congress could require the study and specify its scope and objectives. The study should make use of detailed interviews with companies that have already participated in the program, with experts in cleanup implementation who are able to evaluate the types of technologies chosen for the program, and with academic experts in the areas of technological innovation and diffusion. Special attention should also be given to how sites have been selected for the program and whether the SITE technologies met a need that could not be satisfied by any currently available commercial technology.

Improving Government Management

OPTION 13: Use Generic Site Classification

A site classification system could be established and all existing sites and each site entering the Superfund system classified according to the best applicable generic description. **A relatively small number of site classes is possible; the types would focus on the origin and nature of site contamination.** Some feasible site classes are: wood preserving, pesticide, lead battery recycling, complex industrial manufacturing facility, PCB cleanup, municipal landfill, industrial landfill, solvent contaminated well field, asbestos, mixed heavy metals, and mining waste. All Superfund records, documents, and public notices would show a site's classification on a level of importance comparable to the site's name and location (e.g., site name, location, a municipal landfill).[45]

Benefits: This is a way to simplify the Superfund program and introduce management efficiencies. It also offers an opportunity for more certainty in the operation of Superfund by reducing excessive flexibility in key decision-making. **For too long, EPA has chosen to see every cleanup site as unique. While every site, like every person, may differ from others, it is also possible to see the important commonality within certain classes of sites.** Classification becomes critical for a large and growing cleanup program; it is based on the principle that much is learned over time about certain classes of sites and that transferring this expertise prevents unnecessary, redundant, and inconsistent work. Major amounts of repetitive contractor study work (particularly in the FS) could be eliminated, speeding up cleanups and reducing study costs; major regional inconsistencies for selection of cleanup standards and technologies could be eliminated. It is feasible to have generic protocols for all program activities based on site classification. Early classification of a site could also speed up removal and interim cleanup actions.

Implementation: Congress could statutorily require EPA to devise and implement a site classification system, or Congress could itself establish site classes. There are no major implementation obstacles; all current sites should be classified as well as new, incoming

[45]This system differs from the current designation in EPA's database which is not always applied, is less definitive, and is not used to simplify workload or to gain efficiency.

sites. One class would have to be something like "No Generic Classification" for sites which cannot be accurately fit into a generic category. When a site is first discovered or identified little information may exist and it might automatically be assigned NGC. But site classification should not be a rigid decision; as information on a site increases, its classification may change. The workload to apply a classification system to existing sites is relatively small; experienced EPA staff should take no more than 2 months to classify NPL sites and perhaps 1 year for all other sites in the system.

OPTION 14: Limit Responsible Parties to Implementation of Remedies

This option involves a major change in policy. EPA has sought and achieved substantial increases in the number of site studies (RIFSs) performed by responsible parties (actually by contractors they hire). More than half of site studies are being done by responsible parties with government oversight provided chiefly through government contractors (under EPA's Technical Enforcement Support contracts). One-third of all fiscal year 1988 RODS were for sites at which responsible parties conducted RIFSs. From June 1988 to June 1989, information from EPA indicates that there was about a 50-percent increase in the fraction of RIFSs conducted by responsible parties.[46] EPA has said that it wants to give responsible parties a larger role in defining site problems and evaluating cleanup alternatives. This approach offers the benefit of reducing the need for fund-financed studies and, to the extent that studies performed by responsible parties also promotes settlements with them to perform cleanups, also the benefit of reducing the need for fund-financed cleanups.

A study on the RIFS process done for EPA concluded that "Many of the RPMs [site managers] believe that the PRPs [potentially responsible parties] often seek the least expensive, rather than the best, clean-up techniques and are willing to expend considerable amounts of money in attempts to establish justification for the less expensive clean-up procedures. "[47] An earlier EPA headquarters study that examined the concern about risk assessments being different in enforcement actions, but which did not evaluate individual risk assessments, came to several pertinent conclusions: EPA regional staff believed that there was no difference between risk assessments prepared by EPA or responsible parties; about half the EPA regions ''recognizing PRPs' biased perspective and the 'malleability' of a risk assessment. . . have their contractors prepare all risk assessments, even if' PRPs are conducting the rest of the site investigation; and because of ineffective oversight EPA headquarters ''would not necessarily know if differences between Fund and Enforcement assessments are occurring. ' '[48]

With regard to the use of innovative cleanup technology, EPA has said that 'Difficult negotiations [with potentially responsible parties] are most likely where innovative technologies are proposed for sites where containment remedies are consistent with CERCLA mandates. PRP concerns generally focus on continued liability in the event of remedy failure, implementability problems, and cost. "[49] Thus EPA recognizes the tendency for responsible parties to favor containment remedies (see Option 6 and discus-

[46] This change appears to be related to EPA's desire to meet the congressional requirement in SARA for starting 275 RIFSs by October 1989 as well as the desire to reduce the demand on fund financed studies and cleanups. Another factor often brought up is that the more studies and cleanups performed by responsible parties the less the fund itself is used, making more money available from the fund for other cleanups. But it has also been noted that there has consistently been unused fund money which offsets the Federal deficit.

[47] Research Triangle Institute, *Outreach initiative on Superfund Remedial Investigation/Feasibility Study (RI/FS)*, Summer 1988.

[48] EPA, *Evaluation of the Preparation of Risk Assessments for Enforcement Activities*, September 1987.

[49] EPA Memorandum, ''Advancing the Use of Treatment Technologies fOr Superfund Remedies, ' OSWER Directive No. 9355,0-26, February21, 1989.

sions in ch. **3).** Also, EPA seems to acknowledge that the effectiveness of protection of health and environment is not a primary concern of responsible parties, but is the responsibility of the government.

In November 1988 a senior EPA enforcement official said:

> I am getting anecdotal information from a number of regions that some work being done by PRPs on RI/FSs is of substandard quality and is not being completed in a timely manner. . . . The most sensitive portion of the PRP work and the area that EPA must pay particular attention to is the remedial alternatives and the endangerment [risk] assessment portions of the RI/FS.[50]

More recently, EPA has acknowledged public concerns about this issue and has said the following:

> According to nearly all Regional managers and staff interviewed on this topic, many PRPs try to economize and propose only the most minimal remedial action. Some variations exist, of course; this characterization certainly does not apply to all PRPs. Nonetheless, EPA's basic approach to oversight must first assume that PRPs will try to conduct RI/FSs geared to their interests alone. . . . There was broad consensus among EPA managers and staff that the Agency needs to put more effort and resources into oversight of RI/FS performed by PRPs. . . . In light of the increasing number of PRP leads to be conducted in the coming months and the general concerns raised during this study . . . the task group believes that EPA must act quickly to upgrade current oversight practices and, in particular, involve *citizens* in this process.[51]

Responsible parties play a major role in many cleanups being conducted under the jurisdiction of States; the sites are not Superfund NPL sites, although many of them might qualify. A forthcoming GAO report on State cleanups says, "When private responsible parties clean up a non-NPL site, the state role in remedy selection is normally limited to reviewing and accepting or modifying a cleanup plan proposed by the responsible party. The state does not normally evaluate other alternatives or cost-effectiveness. " OTA agrees with the GAO assessment, State cleanups are not likely to offer environmental protection comparable to that required under Superfund. This is significant because the responsible party community has an interest in moving the Federal Superfund program in the direction of this type of interaction between responsible parties and government. The current rapid increase in the number of site studies and cleanups performed by responsible parties in Superfund stresses EPA's capabilities to exercise independent control over data acquisition, analyses, and cleanup actions.

The current policy, with its emphasis on having responsible parties conduct site studies, does not promote public confidence in Superfund for several reasons:

1. there is an intrinsic, potential conflict of interest because responsible parties have strong reasons to give as high or higher priority to minimizing study and cleanup costs than to stringency of cleanup;
2. responsible parties have an advantage over community groups in the pre-ROD stages of cleanup and can have greater impact on EPA RODs;
3. the current EPA oversight process, based nearly entirely on contractors and constrained by EPA's lack of experienced personnel and high workload, lacks public accountability and provides nearly no information to affected communities (e.g., critiques of responsible party contractor work);
4. there is so much inherent flexibility in EPA's policies and requirements as well as in many statutory preferences and

[50] Bruce M. Diamond, ''Tightening Up on Enforcement, ' paper presented at Superfund '88 conference, Washington, DC, November 1988.

[51] EPA, *A Management Review of the Superfund Program,* June 1989. This study considered but did not endorse disallowing responsible parties from conducting site studies. The recommendation was for closer oversight of private party studies, but improved oversight could be more expensive than the approach of OTA's option.

requirements that it is well within legally defined boundaries to select cleanup objectives and remedies at the low end of health and environmental protection; and

5. there is statistical and site-specific evidence (see ch. 3) that key EPA decisions on cleanup objectives and remedies are sometimes less stringent for sites when settlement with responsible parties is possible and sought by EPA as compared to government-paid site studies and cleanups.

The first two factors cannot be easily changed, but the last three factors could, theoretically, be removed with substantial improvements to EPA's workforce, policies, and requirements, as well as statutory changes (as suggested in many of the options in this report). Accomplishing the latter would take time, and only their successful implementation over time might create enough improvement in the Superfund system to restore public confidence and overcome public concerns about the first two factors. That is, the intrinsic potential for conflict of interest might become unimportant if the government's set of rules for studying sites, examining cleanup alternatives, and making key cleanup decisions, as well as its own technical expertise, reduced the risk of responsible parties biasing cleanup decisions to minimize cleanup costs. And the advantage of responsible parties over communities might in time be offset by an improved Technical Assistance Grants program and improved public participation activities by EPA. **As it now stands, however, OTA concludes that this option is one of the most important in this report for the Congress to consider.** Congress might also wish to consider limiting its implementation to perhaps 5 years, **at** which time Congress could assess whether it was still needed.

Responsible parties strongly oppose this option. They believe it critically important that they have the opportunity to conduct RIFSs. Responsible parties maintain that they have technical and project management expertise, often superior to and more stable than that of the government. And sometimes they do. They also maintain that they follow EPA guidance and regulations as well as statutory preferences and requirements. But, as discussed previously, excessive flexibility blunts the significance of compliance with government rules. They point to low-quality site studies done for the government and questionable cleanup decisions—which OTA has also identified-and maintain that they can do better work or ensure better contractor work for themselves. Moreover, they maintain that EPA provides significant oversight and retains the ultimate authority to make the key cleanup decisions in RODs.[52] Overall, responsible parties believe that they are ready to accept the responsibility assigned to them by the government and that responsibility should not be limited to providing money for or doing the cleanup. Nearly everyone acknowledges that providing responsible parties the opportunity to conduct site studies helps get settlements with them to perform post-ROD design studies and remedial actions.

With this option, responsible parties would no longer conduct site investigations or feasibility studies, and there would no longer be any remedial cleanup effort under the jurisdiction of an enforcement office.[53] Until the government itself concluded what problems had to be addressed and what remedies would be used, there would be no settlements with responsible parties for cleanup implementation, or formal or informal negotiations for settlements which discussed cleanup standards or remedies as negotiable issues.

[52] OTA has observed, however, that EPA's RODS often contain verbatim excerpts from responsible party study documents and frequently depend upon the data obtained in those studies. In other cases, EPA's contractors redo work performed for responsible parties.

[53] Responsible parties also include Federal agencies and States for some Superfund sites.

A key goal of this option is to balance the participation by responsible parties prior to RODS with that of site communities. That is, this option does not preclude responsible party activity at a site prior to the ROD, but it does transfer the official RIFS activity to the government. Responsible parties would still have the right to conduct their own studies if they desired and to contribute, *as communities do,* to the EPA site study and cleanup decision process. EPA site managers could consider information provided by responsible parties and use that information in significant ways, but the government would retain the principal responsibility for site investigation and evaluation of remedies.

With this option, the government would still retain its authorities to recover the costs of site studies from responsible parties or even to obtain agreements to pay such costs.

Benefits: This option would definitely improve public confidence in Superfund. Whatever the problems in having the government conduct site studies, with this option all such work would have public accountability and visibility. It seems as if, to some degree, EPA has addressed its workforce, contractor, and funding issues by privatizing site studies. But ultimately those issues must be addressed by the government without yielding its responsibilities to responsible parties and contractors.

If the contractor workforce is available to responsible parties to conduct studies, then it is also available to the government. The large amounts of money spent on oversight of responsible party studies-which can be as great as the costs of the studies themselves-would instead be spent on conducting the studies themselves.[54] There is considerable potential to reduce a lot of redundant contractor work in the current system. In its research on site studies and RODS, OTA has not found any consistently higher level of technical quality in studies performed by or for responsible parties. Although that may have been the case at one time, the recent growth of responsible party studies has met the same problems faced by EPA because of the explosive growth of Superfund. With this option, there is an opportunity for a net reduction in all contractor studies. This in turn could remove some of the pressure on the contractor workforce which now contributes to low-quality work and high costs.

A subtle benefit of this option is associated with another use of site studies. Completely objective and comprehensive RIFSs provide the public with an invaluable source of detailed information about a site which may contribute to the public's ability to pursue legal actions under common law because of personal injury or property damage. If a responsible party conducts an RIFS, certain kinds of information may not be obtained or may not be given in public documents. For example, the following advice was given to the responsible party community in the context of managing environmental claims:

> If a company believes that it could be susceptible to third-party suits either because data exist to show effects on neighboring wells or because there is a likelihood that the contamination could affect the neighboring wells in the future, further investigation may be an undesirable strategy. Action is called for, and any actions must fit in with the other aspects involved in overall claims management.[55]

[54] Since the oversight cost is generally paid for by responsible parties as agreed to in consent decrees, there could be a saving for responsible parties if they only pay for government studies, assuming that, under this option, the government would not pay more than the current total for responsible party contractor studies plus government contractor oversight work. A recent news story described two cases with high oversight study costs: the A.Y. McDonald Manufacturing Co. of Dubuque Iowa paid $279,000 for EPA's oversight contractor which was almost as much as the company paid for the cleanup, and the John Deere Dubuque Works paid more than $1 million for an EPA contractor to confirm that the $8 00,000 cleanup was working. Norm Brewer, "Another Iowa Businessman Raps 'Ridiculous' EPA Cleanup Costs, ' *The Des* Moines *Register*, June 15, 1989.

[55] Michael J. Murphy and Richard E. Freudenberger, ''Environmental Claims Management: A Case Study of Technical Support, in *Insurance Claims for Environmental Damages* (New York, NY: Executive Enterprises Publications, 1989).

In **other** words, the responsible party's interest in minimizing cleanup costs also extends to minimizing or avoiding other costs as well.

Implementation: Considering EPA's high interest in having more responsible party studies, this option would probably not be implemented without congressional action. A new statutory provision to override current language could preclude responsible parties from conducting site studies and limit settlements to implementation of government cleanup decisions, from design studies through implementation. Cost recovery for government studies would still be encouraged. Clearly a current inducement for responsible parties to enter into voluntary or negotiated settlements with EPA is the opportunity to conduct RIFSs. Adopting this option, therefore, would make it all the more important for EPA to use the full array of strong enforcement tools provided it by statute. Moreover, if EPA provides effective participation in the pre-ROD process for responsible parties (as for communities) then the negative impact of this option on post-ROD settlements will be reduced. However, in the short term, this option would increase the need for spending significantly more fund money on RIFSs, but eventually these costs could be recovered.

A negative impact of this option on the duration of site studies and cleanups does not seem likely. OTA examined fiscal year 1988 RODS on a regional basis and found that in five regions fund sites moved faster from placement on the NPL to issuance of a ROD, and in five regions enforcement sites moved faster.[56] Nationwide, the average for enforcement sites was 4.0 years and for fund sites 3.9 years. OTA also analyzed EPA's data on RIFSs and remedial action projects in progress, which presented data on schedule performance from January 1,1987 through September 30, 1987;[57] 189 activities designated as responsible party lead averaged a delay of 1.7 quarters and 68 designated as fund-enforcement averaged 1.6 quarters, compared to an average delay of 1.1 quarters for 163 activities designated fund-financed.[58] For minimizing delays, these data indicate a potential advantage for shifting work from responsible parties to EPA.

However, the recent study *Coalition on Superfund Research Report* (September 1989) presented ' 'intriguing interim trends and conclusions' but cautioned against drawing broad national conclusions; 21 sites in Region 5 were examined, including 7 pre-SARA sites from 1984 and 1985. The study concluded that RIFSs performed by responsible parties were of equal quality to those by EPA, that sites move faster through the Superfund process when responsible parties conduct studies, and that cleanup standards are similar for the same type of sites for government financed and responsible party financed cleanups. All three conclusions are opposite to those of OTA's, which are based on examination of national data as well as a larger number of specific case studies in a number of EPA regions, all for 1987 or 1988. In the Coalition study, of the 6 sites that responsible parties performed the RIFS, 3 were from 1984 or 1985. Because Region 5 is large, the sites

[56] The most striking differences were: Region 6 where fired sites were 1 year faster; Region 7 where fund sites were 1.6 years faster; Region 10 where enforcement sites were 1 year faster. Nationwide, for enforcement sites, Regions 2 and 7 had the longest times (4.8 years) and Regions 3 and 6 the shortest times (3.4 and 3.5 years); for fund sites, Regions 1, 2,4, 8, and 10 had the longest times (4.6 to 4.8 years) and Region 6 the shortest time (2.5 years).

[57] This is a database over three times larger than FY88 RODS; 85 percent of the data covered over 450 RIFSs in progress and, therefore, these data suggest the possibility of discernible differences between fund and enforcement RODS released after FY88. EPA, ''Progress Toward Implementing Superfund: Fiscal Year 1987 Report to Congress-Appendix D Status of Active Remedial Investigations/Feasibility Studies and Remedial Actions in Progress on Sept. 30, 1987, " April 1989 [statutorily, the report was due on Jan. 1, 1988]. The data presented do not reveal delays which may have occurred prior to Jan. 1, 1987,

[58] Normally, responsible party lead activities would be placed in the enforcement category, We think that fund-enforcement activities mean that responsible parties have been identified and that the site is slated for enforcement action to subsequently obtain settlement for future work and cost recovery for work financed with the fund. Responsible party lead activities probably mean that responsible parties are conducting work agreed to as a result of a settlement and consent decree.

evaluated in the Coalition study are a small fraction of that region's output.

Overall, the key to successful implementation is improved EPA capabilities and procedures which **would assure that its site studies will be more effective, efficient, and consistent than they have been.** (A number of policy options identified in this report could assist that goal.) As noted above, implementation of this option could be for a limited time, perhaps 5 years, with the expectation that sufficient improvements in the program might make responsible party conduct of site studies less contentious.

OPTION 15: Reexamine Financing and Enforcement of Liabilities to Improve Environmental Performance

Superfund's environmental performance is affected by its financing and enforcement of statutory liabilities. To limit the amount of money for fund-financed studies and cleanups, Congress imposed very strict liabilities which would set the stage for major financing of cleanups by responsible parties. A number of strong enforcement powers were given to EPA and the Justice Department to ensure that responsible parties, if they could be identified, would pay for cleanups either before or after the fact. In large measure, the basic congressional strategy has worked, because responsible parties have probably provided several billion dollars for studies and cleanups. **OTA has not included 100 percent public financing (as for a public works program) without liabilities as an alternative to this basic congressional strategy. One of the more important reasons is that Superfund liabilities have been seen by nearly everyone as a powerful incentive to promote industrial waste reduction and improved waste management.**

But success has had several undesirable impacts: delayed studies and cleanups, added administrative and transaction costs for the government and responsible parties, and compromised environmental quality at some sites. These effects are an inevitable consequence of the natural confrontation between government goal of maximizing spending by responsible parties and responsible parties' goal of minimizing their costs. Delay and added administrative and transaction costs have also resulted from the reluctance of many responsible parties to actively participate and negotiate with the government. This, in turn, has resulted, in large measure, because EPA has not used some of the strongest enforcement powers given it by statute. That is, uncooperative responsible parties are not necessarily penalized. But some of the problem has to do with the difficulty of making a strong legal case. Thus EPAs preference for voluntary or negotiated settlements which is only one of several tactics given it by statute to implement the basic congressional strategy. Settlements have been promoted through: 1) allowing responsible parties to conduct RIFSs, and 2) implicitly or explicitly reducing the scope or extent of cleanup and selecting less permanent remedies to reduce costs at some sites.

With this option, Congress would reexamine how the mix of statutory tactics can best be used to implement the original congressional strategy (i.e., maximizing financing of cleanups by responsible parties) and obtaining stringent cleanups comparable to fund-financed ones. Principally, this means exploring: 1) using more government funds to act quickly at sites—implying increasing current special taxes or establishing new ones initially-followed by increased cost recovery; 2) using the stronger enforcement tools provided by statute to compel more responsible parties to pay for stringent cleanups; and 3) developing more effective incentives for voluntary settlements so that it is not necessary for EPA to compromise environmental goals.

For the first two tactical approaches, OTA's research has not yielded any new technical insights and congressional discussion of them will largely center on legal, financial, and

implementation issues. However, for the third tactical approach there is an idea debated, but rejected by Congress in 1986, which merits reexamination. Responsible parties have argued that giving them complete and final closure to the government's claim on them at a specific site would get more voluntary settlements and get them more expeditiously. Obtaining quick and certain closure has monetary value. The government could provide this settlement incentive: If the responsible party or parties pay a premium to the government—above the near-term estimated cost for cleanup--then the government will irreversibly close its case.[59] (EPA sometimes uses this approach today with de minimus responsible parties; i.e., those assigned a small fraction of a site's cleanup cost.) To lower its monetary risk with broad application, the government would have to have **a good** sense of what the ultimate complete cleanup might be and cost, taking into account uncertainties about site contamination, risks, cleanup objectives, and cleanup technologies. This may, however, not be feasible at all sites.

Benefits; Improving Superfund implementation requires the examination of all aspects of the program and, especially, their interactions. Giving the public the kind and amount of environmental protection it demands expeditiously is, inevitably, linked to Superfund's components relating to financing and enforcement of liabilities. Past and current tactics have provided some key financial benefits, but they have come at some environmental and monetary costs. OTA believes that there is no intrinsic conflict between the twin goals of obtaining expedient, comprehensive, and permanent environmental protection and making responsible parties pay for cleanup. The issue really is what mix of tactics best achieves both goals.

implementation: Congressional action is required. Although CERCLA already gives EPA some of the necessary statutory authority (e.g., enforcement tools and cost recovery), history has shown how contentious and difficult it is to deal with financing and enforcement of liability issues. The idea of responsible parties paying a premium to quickly reach complete and final closure at a site is actually an extension of something already implemented by EPA in a limited way. However, the release from future liability does not cover the discovery of new conditions or other extraordinary circumstances. These are not improbable events. Thus, the responsible party cannot obtain total protection from future liability. However, for complete elimination of future liability as considered in this option, Section 122(f) of the CERCLA/ SARA statute would have to be changed. A critical policy issue for implementation of the premium option is: Would the public interest be served by giving responsible parties complete and total release from future payments and liability if they pay a special one-time premium?

The answer, of course, may depend on how well the government can identify what that premium should be. In 1986 making this determination was viewed as infeasible and the idea of allowing responsible parties to pay for a complete release was rejected. OTA's examination of many cleanup decisions and the development of new information at many sites during their cleanup leads us to conclude that it would be difficult to calculate a premium but not as infeasible at most sites as it seemed in 1986. Much experience has been gained through hundreds of remedy selections, remedial de-

59 "The term 'risk premium payment' refers to a risk apportionment device similar to insurance premiums, under which the risk taken by the government for providing PRPs with a broader release from liability is offset by a payment in excess of the projected cost to complete the remedy, The premium should be sufficient to compensate EPA for taking the risks associated with contingent future costs, such as cost overruns in completing the selected remedy or future costs that may be incurred if the selected remedy is not adequately protective of human health and the environment. Robert J. Mason and Mark F. Johnson, "Structured Settlements: A New Settlement Incentive, " *Superfund* '88, proceedings of November 1988 conference, Hazardous Materials Research Institute, Silver Spring, MD.

signs, and remedial actions. A study could show the relationships between estimated costs in RODS and actual costs of implementing remedies (and some such work is underway). The distinction between current and future risks discussed above might also aid this effort. The example given in the discussion of Policy Option 1 (box l-D) is also instructive here. Although only a small amount of money would be associated with the immediate cleanup, a much larger sum would be necessary to address complete source control and groundwater cleanup in the future.

OTA believes that it is possible to estimate (with reasonable but not complete certainty) the costs of future cleanup at most sites and factor in the delay before future actions might take place. High eventual costs would be often offset by longer times before action is necessary, if at all, and low costs would usually be offset by a need to take action fairly soon. Too low a premium would result from higher than anticipated cleanup costs and/or costs that became necessary faster than anticipated; too high a premium would result from a lower than anticipated remedy cost and/or one more delayed than anticipated. (The premium situation described here is not unlike that facing insurance companies in setting life insurance premiums.)

Implementation of some of the other policy options presented in this report would help EPA estimate premiums, these include: site classification, defining permanence, using a hierarchy of cleanup methods, the site technical assistance program, and the technology technical assistance program. Uncertainty about future cleanup costs cannot be eliminated, but it can be reduced to reasonable levels for many sites and translated into risk premiums.

In terms of economic principles, there is a benefit for the government to get significant money upfront. In effect, premiums are like mini-trust funds for individual sites, covering future cleanup contingencies, and building value over time before they are needed. They are like life insurance premiums used by companies to earn money before payment is necessary. The government also might pay less for administrative and transaction costs when negotiating because a one-time premium may reduce the length and complexity of the settlement process or other, sometimes multiple, enforcement actions.

OPTION 16: Strengthen EPA Headquarters Direction and Oversight of Regional Implementation

There is little dispute that Superfund actions and program performance vary widely among EPA regions (see OTA's 1988 case study report and ch. 2). In its recent management review, EPA said that nearly 80 percent of fiscal year 1988 RODS, for example, used the agency's required nine criteria for selecting remedies. But the fact that over 20 percent of RODS did **not** use the agency's method for remedy selection indicates excessive regional autonomy. In checking the accuracy of information provided by EPA in its first report to Congress on Superfund implementation, EPA's Inspector General recently found "30 percent of removal activities and 13 percent of remedial activities claimed by the Regions were not supported by valid documentation in the Regions' files."[60] A recent study of Superfund examined this issue and concluded:

> In reality, the Administrator has little time to "manage" the Regional Administrators. As a result, they operate with considerable autonomy and, it appears, frequently without close adherence to national policy. [There is] a lack of clearly defined responsibility, authority and accountability between the Regions and Headquarters.[61]

[60] EPA, *Progress Toward implementing Superfund Fiscal Year 1987—Report to Congress,* April 1989.

[61] Clean Sites Inc., *Making Superfund Work,* January 1989.

The flexibility regions want competes with national consistency. With this option, EPA regional offices would still maintain primary implementation responsibility, but they would have less flexibility in interpreting or ignoring EPA policy and guidance. EPA headquarters would have a primary goal of national consistency for Superfund implementation. There would be routine examination of RODS and studies for inconsistent regional decisions, especially for cleanup standards and remedy selection.[62] ROD bunching at the end of the fiscal year and ROD inconsistencies for substance and format would be given special public attention. Deviations from program policy would be **identified, such as using design studies to** circumvent the need for treatability studies on alternative cleanup technologies during the pre-ROD study phase.

Benefits: This is a way to reduce excessive flexibility in program management, restore pub**lic** confidence in the program, and strengthen environmental performance. **There is no basis in law or policy for environmental protection depending on what region a Superfund site is in.** It is also a critical way to reduce unnecessarily high administrative and transaction costs for the government and the responsible party community. Reducing regional variation in the implementation of Superfund is key to having a single, truly national cleanup program. There is no inherent contradiction between the desire for central national policy and management versus the desire for regionalized implementation. **Regions could identify regional, State, and site specific conditions which merit special attention or different responses from the national norm.**

Implementation: **Regional managers and staff's are likely to resist this option. Finding a middle ground between the need for regional flexibility and central national control, however, is necessary if Superfund's performance is to be improved.** Theoretically, EPA could implement this option. But, considering the historical relationship between EPA headquarters and EPA regional offices, it may be advisable for Congress to explicitly require action by the EPA Administrator. For example, all key summary information on Superfund's performance could be required to be presented on a regional basis. The Administrator would identify significant differences among regions, the environmental impacts of those differences, and actions to address those differences and impacts. Special attention should be given to the impact of State laws and actions on regional departures from agency policies. Explicit and public evaluation of regional performance against nationwide, program objectives would also be required. Programs designed to rotate key regional people among regions to bring the poorest performing regions up to the level of the best performing regions might be required.

OPTION 17: Commit to a Permanent Superfund Program

As a matter of public policy, Sup-fund would be acknowledged to be a permanent program, requiring a national infrastructure and institutional delivery system. This means, for example, establishing: university programs to support a well-educated, stable workforce in government and the contracting industry; a continuing R&D effort; well-defined policies for short- and long-term priorities; effective inter-agency and Federal-State relationships; and central, national information systems. As a first step, Congress could consider requiring an independent study to: 1) assess whether and, if so, how current Superfund activities have been based on detailed long-term program needs and strategic objectives, and 2) identify specific policies, programs, and funding requirements to establish an effective national infrastructure for a permanent cleanup effort. The study would produce a long-range strategic plan for Super-

[62]Other program components, such as site evaluation, also need headquarters oversight and periodic assessment.

fund, identifying and discussing issues, needs, and policy options beyond the scope of this OTA study.

Benefits: Public confidence in Superfund would be improved by the government taking specific steps to ensure an effective long-term delivery system. It would help make public expectations for Superfund more realistic, and it would help the private sector in making efficient and effective contributions to the government effort.

Implementation: Congressional action is required. It could take the form of both a statutory policy statement and a series of specific program spending authorizations and appropriations. Broad public support is likely because it is in virtually everyone's interests to minimize future uncertainties.

OPTION 18: Establish an All Inclusive List of Cleanup Sites in the United States

The new list might be called the National Cleanup List and a new NCL office would be established at EPA to be a central, national clearinghouse for key information about sites for which some governmental agency had determined that cleanup was probably necessary.[63] This corresponds to the Superfund's National Priorities List. All cleanups of chemically contaminated sites would be tracked through the new NCL; Superfund sites would be a subset of the NCL and they could be designated as belonging to the National Priorities List. Twice a year, the office would issue a revised NCL document, made freely available to the public. By using a set of simple symbols, for example, the following important information could be presented for each site: what cleanup program the site was being managed in (e.g., Superfund, RCRA corrective action, a State program, a Federal agency); when the site first was recognized as requiring cleanup; what actions have been taken at the site (i.e., site investigation, emergency action, recontrol, interim or final cleanup) and when those actions were completed. Appendices in the report could provide names and telephone numbers of key government cleanup offices, and a list of sites which have received complete cleanups.

Benefits: Cleanup in America has not only grown, it has become increasingly fragmented among many different programs, making it increasingly difficult for anyone in or outside of government to have a good sense of the overall effort. This option would greatly improve public accountability. **A chief use of the NPL is to provide information to the public, but the current NPL covers only a small fraction of cleanup sites in America. This** option would inform the public about the relative contribution of Superfund compared to other cleanup programs. And from the perspective that sites in other cleanup programs may ultimately become Superfund sites because of less complete or less stringent cleanups than in Superfund, this option is important for a long-term Superfund program.

Moreover, there is relatively little information in the current NPL which really helps people understand what is going on at sites. With this option, the NCL would be become a quick-reference report card for cleanup sites. The NCL would become the key instrument for disseminating the results of a national clearinghouse for centrally collecting key facts about cleanup sites. The NCL office would also have the capability to provide important summary information to Congress and others about cleanup in America. Environmentally, there is bound to be increasing attention to *cumulative* exposures and risks; contaminated sites in different cleanup

[63] This is in contrast to a list of inventory sites; that is, sites which have been identified as possibly requiring cleanup but which *require some* assessment, inspection, and evaluation before determination of the need for cleanup. The number of inventory sites is much larger than the number of sites eventually determined to likely require cleanup. In Superfund, about 10 percent of examined inventory sites have become NPL sites. But 10 to 20 percent of the inventoried sites become the responsibility of other cleanup programs. Some estimates of the potential number of Superfund inventory sites reach hundreds of thousands of sites.

programs may be close enough to affect the same people. Determining safe levels of residual contamination in land or water may require accurate information on multiple cleanup sites as well as other sources of toxic chemicals, such as operating industries reporting information to the Toxic Release Inventory maintained by EPA under Title III of SARA.

Implementation: This **option requires statutory action by Congress, possibly including authority to obtain key information from ail cleanup programs in the nation. Implementation** of **this option would not in any way affect current statutory requirements for NPL sites. Establishing this new effort means more people and money.** But the effort would be relatively small, probably no more than 10 to 20 people could carry out this function; EPA already commits some resources to the administration of the NPL. Procedures would be established to receive information in a routine, periodic way from all cleanup programs. Total annual cost would be probably be in the range of $1 million to $2 million, including publishing and mailing NCL reports (the report could also be made available electronically). This cost would be balanced against the potential benefits of improving public information and confidence, as well as the help it could give to managers of all cleanup programs and companies in the cleanup business. A few States, such as Florida, now provide the kind of comprehensive and informative listing of sites considered in this option.

OPTION 19: Begin Examination of Moving Superfund Implementation Outside of EPA

Direct implementation of such a large-scale field activity is not, theoretically, what a regulatory agency is supposed to do. Moreover, Superfund implementation pits the environmental standard setting role of EPA against EPA's compliance with environmental standards. It is similar to asking EPA to build and operate, for example, hazardous waste landfills or incinerators. In fact, this fundamental problem helps account for the trend in EPA's management of Superfund to privatize the program as much as possible, through both the extensive use of private contractors and settlements with responsible parties. But there are other strategies to shift Superfund implementation away from EPA, leaving it to concentrate on setting cleanup standards and goals and ensuring compliance with them by all parties which perform cleanups.

Two main alternatives seem worth detailed examination, which is beyond the scope of this OTA study. First, Superfund implementation might be transferred to the States. A number of other EPA efforts have taken this route. On the plus side, the States are closest to the problem and, for the most part, want as much responsibility as they can get in implementing environmental programs, although that is usually contingent on obtaining substantial financial support from the Federal Government. On the negative side, State implementation of environmental programs has had mixed results, and the State participation in current Superfund implementation (through site specific cooperative agreements) also has not been especially successful. Moreover, although many States have significant cleanup programs of their own, there is very little detailed information to support a general conclusion that State implementation has been better than EPA's of Superfund. Still, State implementation of Superfund could be a longer term strategy, perhaps in about 10 years or more.

Second, Superfund implementation might be transferred to a new quasi-Federal agency, designed especially to carry out the national cleanup effort-perhaps including many other cleanup programs. The Federal Government has established new agencies in the past to implement a major national *technical* effort (e.g., National Aeronautics and Space Administration). Indeed, neither OTA nor others have been able to make a good case for using an existing Federal agency other than EPA for Superfund implementation, even though, in theory, several of them seem qualified. The chief problem seems to be a lack of public confidence in those existing agencies to move beyond their current missions and undertake a major hazardous waste cleanup program (e.g., the Army Corps of Engineers, the Bureau of Reclamation) or the relatively small size and limited scope of the current organization (e.g., U.S. Geological Survey). Moreover, there are unique benefits of establishing a new quasi-Federal agency. In particular, it is a way to overcome many personnel constraints, especially the cap on Federal salaries for technical professionals in short supply.

Benefits: If Superfund is accepted to be a permanent program, then there are enough theoretical benefits for shifting implementation away from EPA to warrant a serious study of the option.

lmplementation: This option requires congressional action. The frost step would be a special, independent study delivered to Congress. It would focus on the costs and benefits of specific options, paying special attention to identifying transition problems and their solutions. Such a study could be done by a major university government or public policy center with some experience in the environmental area, and could take about 2 years. Another early action could be providing grants to States which submit proposals on how they would develop their resources in order to implement the Superfund program in the way EPA regional offices now do.

PART II: Program Changes

Setting **Cleanup Priorities and Goals**

OPTION 20: Use Hazard Ranking System in More Limited Way

The HRS (in its present or revised form) would no longer be seen as yielding numbers accurate to two decimal places and scores would no longer be assigned to NPL sites for their entire history. Instead, the HRS would be used as a binary decision tool: either a site poses a significant environmental problem which may require cleanup, or it does not. Years of research and analysis of the HRS has found that it cannot reliably make fine distinctions from site to site (see ch. 2). Its appropriate use is as an aid to early site decisions based on limited information. Instead of the current cutoff score of 28.50 for placement on the NPL, which was set on nonenvironmental grounds, two scores would be used: a high score above which a site certainly merits detailed examination and possible remedial cleanup, and a low score below which there is little chance of the site having a significant environmental problem. For sites with scores between these two critical scores, a panel of experts would make a consensus professional judgment as to whether the site does or does not get placed onto the NPL, on the basis of the information prepared for the site.

Benefits: This new use of the HRS would save a lot of effort and money which now goes into the determination, review, revision, and use of scores, which, in fact, serve little purpose. For example, in the shift from proposed to final status, scores are often changed very small amounts-amounts which make little sense in terms of the accuracy of the methodology nor in terms of how the scores are used. There is no evidence that EPA regions make important decisions about sites because of their precise scores. The chief priority-setting accomplished by the NPL is to distinguish between sites on the NPL and sites not on it. Site scores, however, have not set priorities among sites on the NPL. EPA's practice of changing site rankings on the growing NPL, based on site scores, serves no useful function. The extensive quality assurance/quality control efforts by government and contractor staffs is largely misdirected to achieve a false and unnecessary precision. Moreover, the use of a single score for the entire history of an NPL site doesn't mean much technically or environmentally. The score is determined when information on the site is at its early and worst stage; the score is never changed on the basis of new and improved information, such as the eventual risk assessment, nor is it changed to reflect the environmental consequences of emergency, removal, or remedial cleanup actions at the site. To its credit, the Department of Defense updates its site scores to reflect changes in sites.

With this option, sites which may not now get on the NPL because of deficiencies in the HRS methodology would have a better chance of being placed on the NPL.

Implementation: EPA could do this on its own or Congress could direct it to make these changes through statute. There are no significant obstacles to implementation. Unnecessary work by government and contractor staff could be stopped. Some effort would be necessary to determine the two new high-low score boundaries. This could be done by EPA's Science Advisory Board, which has already done work on the HRS. This study could be done within 6 months; it should also recommend a standard form which would be filled out by the technical review panel in explaining its decision on a site.

The composition of the panel of technical review experts to make the decisions for sites with scores between the high-low boundaries should not be difficult. To make the application of the HRS efficient and timely, this group should be a permanent staff function at EPA headquarters (not a contractor activity). From three to six of EPA's most senior, experienced technical staff should be selected for this important function. The review panel should prepare its standard brief report on a site within 1 month of receiving the job; the panel should have the right to visit a site. Currently, regulatory rulemaking is used for site placement on the NPL, which carries with it many legal and procedural burdens, including challenges to HRS scores. However, this option would not require changing that procedure. Sites would be proposed on the basis of a score which exceeded the high-boundary score or the judgment of the review panel. Challenging EPA's decision would remain essentially the same as it is now.

OPTION 21: Reassess and Limit Use of Indicator Chemicals for Site Studies, Risk Assessments

The selection of indicator chemicals to study risks at sites merits more attention and public scrutiny. The purposes and technical appropriateness, in theory, of using indicator chemicals needs policy clarification. For example, the Oak Ridge National Laboratory study mentioned earlier found that 54 percent of RODS used no formal screening procedure for selection of indicator chemicals. This option would require an independent examination of current policy and procedure, and a detailed analysis of how indicator chemicals have been selected and used in critical site cleanup decisions. As a means of simplification and study cost reduction, using a short-list of representative site contaminants stands on its own merits. The problem lies in implementation of the concept, especially by relatively inexperienced people, and unintended uses of the short-list.

First, indicator chemicals used in risk assessment may not produce accurate risks because too many site contaminants are left out. The extent of this problem is linked to what concept of risk is employed. If risk assessment is centered around possible worst case individual risk, as it is currently, then using a short-list is less problematic, as long as the worst site contaminants in terms of health effects are chosen. However, if the risk concept is population risk, reflecting actual or likely total risks to a whole exposure group, then using a short-list of contaminants could greatly underestimate total estimated risk and the total benefits from risk reduction. The latter is favored by people who want to have cleanups justified by cost-benefit analysis. But using only indicator contaminants inevitably means *underestimating* total risk and total benefits (or total risk reduction) from cleanup.

A second major problem is that indicator chemicals are used for technology evaluation and implementation. But selection of indicator chemicals because of their documented health effects is not necessarily consistent with differences among site contaminants with regard to their chemical and physical properties which are critical to cleanup. Therefore, decisions regarding remedy selection, design of remedy, and—most critically—measurement of cleanup success may be seriously affected by the originally selected indicator chemicals. For example, it is quite conceivable that a cleanup could be judged to be successful on the basis of cleanup levels for indicator chemicals. But such a cleanup could leave a site contaminated with other contaminants which, in their own right, pose unacceptable levels of risk to health or-especially—environment, because environmental effects are not used on a par with health effects in the selection of indicator chemicals. Or site contaminants which are not indicator chemicals might seriously reduce the effectiveness of chosen cleanup technologies.

Benefits: More effective and consistent cleanups could be achieved, as well as fewer surprises arising in the later stages of the cleanup process that often mean increases in cleanup costs. Applying more public scrutiny as well as technical expertise early on in the selection of indicator chemicals could, in the longer term, make the entire cleanup process more efficient and effective.

Implementation: Either EPA or Congress could initiate a study which implemented this option. Such a study should be possible to complete in about 1 year by a university program with experience in chemistry, health effects, and environmental engineering. The study should include a detailed examination of sites within a few generic categories (e.g, wood preserving sites) to see if past practice has used consistent types of indicator chemicals. And the study should examine the performance of some recently completed cleanups to see the extent, if any, of problems arising because of the use of indicator chemicals.

OPTION 22: Clarify and Strengthen Cost-Effectiveness Requirement for Remedy Selection, Reject Use of Cost-Benefit Analysis

Major policy attention is necessary if we are to clarify what cost-effectiveness means, how the goal is achieved by the remedy selection process, and how it is different from cost-benefit analysis. This option embodies a policy commitment to cost-effectiveness as the way to meet national and site environmental objectives with limited resources. **The keystone of this commitment is using health and environmental criteria to decide on the extent of cleanup (risk reduction) first. Then, the lowest cost alternative able to reliably provide the selected level(s) of cleanup is selected.**[64]

This option requires a reexamination of the current framework for remedy selection, which uses nine criteria. One of these is cost—not cost-effectiveness.[65] The nine criteria have provided enormous flexibility to Superfund managers, enough to select virtually any kind of remedy and maintain that it is consistent with

[64] The method of setting cleanup objectives first and then determining the cost- effective remedy has been expressed by Congress ''The term 'cost-effective' means that in determining the appropriate level of cleanup the President first determines the appropriate level of environmental and health protection to be achieved and then selects a cost-effective means of achieving that goal. '' Conference Report to accompany H.R. 2005, Superfund Amendments and Reauthorization Act of 1986, U.S. House of Representatives, 99th Congress, 2d session, Report No. 99-962, p. 245. In the debate on the conference report, Senator Mitchell said ''An analysis of cost effectiveness begins only after a remedial action has been selected m compliance with the health and environmental protection requirements, permanent treatment requirements, and other standards, requirements, criteri a or limitations imposed under the law. Congressional Record [daily cd,], 99th Cong., 2d sess., Oct. 3, 1986, at S14913.

[65] The other eight are: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements of other statutes (' 'ARARS '); long-term effectiveness, reduction of toxicity, mobility or volume; short-tern effectiveness; implementability; State acceptance; and community acceptance.

statutory requirements and effective environmental protection. A recent study of Superfund concluded:

> **EPA has not clearly defined each** of the criteria nor how they are to be applied. , , . The Agency's current remedy-selection policy, in that it treats all the criteria equally, does not provide EPA staff, States, PRPs and concerned citizens with a framework that clarifies how tradeoffs are to be made among the different criteria in selecting a remedy.[66]

The current nine EPA criteria might be reduced to two essential steps ***after the*** precise cleanup objectives (based on existing environmental standards, risk assessment, and perhaps special cleanup standards) are determined: 1) analyzing each alternative for its ability to meet those cleanup objectives, and 2) estimating the full costs for each cleanup alternative (including **factors which are now in some of the nine** criteria, such as implementability and less than complete permanence). Then, with this option, the lowest cost alternative able to meet the cleanup objectives would be selected.

The goal of selecting a cost-effective remedy is **not the same** as cost minimization, which, in large measure, is the current practice. Nor does current practice define or use specific detailed cleanup objectives to examine cleanup alternatives and to justify the one selected.[67] When using cost-effectiveness, minimization of cost occurs after a remedy is selected, consistent with the cleanup objectives originally selected.

Superfund managers have a number of ways to minimize cleanup costs, starting with deciding as early as possible which are current risks and which are future, possible risks. Similarly, early recontrol and interim cleanup actions can reduce final cleanup costs because they prevent sites from becoming worse. Analysis of alternative technologies, including value engineering and full short- and long-term costs is also critical. More generally, costs will be minimized through: R&D and technology transfer; design optimization; pilot testing; new information about contamination or exposures which can reduce cleanup needs; competition among providers of cleanup services; and effective government procurement procedures and oversight of contractors.

Current Superfund practice has largely replaced the statutorily required cost-effectiveness approach with cost-benefit analysis. This option would explicitly reject the use of site cost-benefit analysis to justify cleanup, to set the extent of cleanup, or to select a remedy; it would prevent the changing of cleanup objectives with little public scrutiny. **As an** example of a conclusion based on cost-benefit analysis, a recent ROD said: "The selected remedy provides overall effectiveness commensurate to its costs such that it represents a reasonable value for the money."[68] EPA's proposed National Contingency Plan has similar language, which would make current practice official policy.

The chief attribute of cost-benefit analysis, and its apparent attraction, is to consider environmental protection goals as variable. The chief presumption of the approach is the ability to accurately quantify both costs and benefits, even though experience demonstrates the inability to do either. Indeed, research shows that cleanup costs have more impact on remedy selection than any other factor, even though costs are nearly always underestimated at every stage of Superfund before cleanup is actually completed. Cleanup happens or stops when costs seem appropriate relative to estimated

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[66] Clean Sites Inc., ***Making Superfund Work***, January 1989.

[67] The Oak Ridge National Laboratory study mentioned above found that only 12 percent of cleanup decisions were based on a quantitative analysis of the degree of risk reduction provided by different cleanup alternatives. Even though some form of cleanup goals were also identified, the study noted that "few sites incorporated the cleanup goals into the evaluation of alternatives. "

[68] EPA Region III, Record of Decision, Ambler Asbestos Piles site, Ambler, PA., Sept. 30.1988.

benefits. A recent analysis disclosed that changing the current statutory structure for Superfund (i.e., risk-based decisions, for the most part, followed by cost-effectiveness analysis) to the cost-benefit approach would exacerbate current problems. According to the analysis, replacing the statutory approach with cost-benefit decisionmaking would, on the negative side, reduce risk reduction and equity from high to low, public accountability from high to very low, and administrative simplicity from high to low. On the positive side, the change would increase efficiency from low to very high.[69]

Some inevitable consequences of the cost-benefit approach include the following examples:

1. not cleaning up identically contaminated sites because at one, in a rural area, there are relatively few people potentially affected and other short- or long-term environmental benefits are ignored;
2. not cleaning up a site at all because there are no quantifiable current benefits and future benefits are discounted;
3. not using available cleanup technology which offers a truly permanent remedy because it is more expensive than another one, which is based on containment of toxic waste and not its destruction;
4. cleaning up only part of a site, which accounts for most of the **risk to health,** which can be quantified, but not the part which might pose some uncertain risk to environment;
5. stopping cleanup, even though original cleanup standards have not been met, because the marginal cleanup costs are high relative to the incremental benefits obtained, leaving, contamination in groundwater or soil above the cleanup standards;
6. having very different levels of cleanup among sites for specific contaminants in soil or water.

Benefits: This is a way to reduce excessive flexibility in remedy selection and, therefore, ensure that environmental protection is not compromised in order to minimize spending by the government or responsible parties. It is also a way to ensure that all approaches to reduce the cost of a cleanup with specified environmental objectives are examined and used where appropriate. Current flexibility is reduced in order to comply with statute and to obtain national consistency. By stressing proper use of cost-effectiveness, program managers would also be required to formulate specific environmental, risk reduction cleanup goals, something that is not now commonly done.

Implementation: This option requires congressional reaffirmation of the cost-effectiveness approach to Superfund management. Explicit statutory language would give the meaning and use of cost-effectiveness as well as the preclusion of implicit or explicit cost-benefit analysis. This would likely be opposed by those valuing maximum flexibility. Support would likely come from community and public interest groups.

Lastly, the statute has provided EPA a way to reject some fund-financed cleanup alternatives simply because their costs are too high. The fund-balancing provision is based on the legitimate environmental position that a very expensive fund-financed cleanup could consume so much money that the action would preempt a substantial number of other fund-financed cleanups. However, EPA has rarely used this statutory provision to reject cleanup alternatives with relatively high costs. If Congress provided more guidance on what level of spending could trigger use of this provision, it would make it possible for EPA to move outside of the cost-effectiveness approach discussed here *in exceptional* fund-financed cleanups. However, there is now no statutory basis for rejecting high cost responsible party-financed cleanups obtained

[69] Lester B. Lave and Eric H. Males, "At Risk: The Framework for Regulating Toxic Substances," *Env.* Sri. & *Tech.*, vol. 23, No. 4, 1989.

directly through a settlement (i.e., not subsequent to a fund-financed cleanup followed by a cost recovery action).

OPTION 23: **Better Integrate Community Perspective Into Enforcement and Site Decisions**

It was the perceived lack of public confidence in Superfund implementation which motivated Congress to enact the Technical Assistance Grants program in 1986. (OTA suggested this option in its 1985 report *Super-rid Strategy.)* Since 1986, implementation of the TAG program has been slow and interpretation of statutory provisions has resulted in complex, burdensome procedures and requirements for community groups. This option would provide major policy direction for the TAG program and its integration into Superfund implementation. Another trend since 1986 has been the expanded role of responsible parties in Superfund implementation, mainly because EPA has emphasized the settlement route to enforcement. Therefore, an emerging issue is whether EPA has balanced its enforcement of the polluter pays principle with concerns about victim's rights. (Victim may be a strong word, but it is important to acknowledge that community members are at risk; they perceive themselves as actual or potential victims, either because of health or economic effects.)

The presumption of this option is that victim's rights have become overshadowed by the desire by EPA to shift cleanup spending from Superfund to responsible parties primarily through voluntary or negotiated settlements. With this option, better balance between the two concerns would be sought. For example, EPA could be required to:

1. include community representation during its settlement negotiations and provide opportunity to comment on consent decrees and other formal instruments implementing settlements or carrying out enforcement actions for anything other than payment;
2. solicit formal community comments about key cleanup decisions;
3. provide more than perfunctory responses to community comments in its RODS;
4. instruct site managers to maintain ongoing communication with community groups during the entire time a site is within the Superfund program; and
5. require responsible parties implementing cleanups to maintain ongoing communication with community groups and to notify them of any new information which reveals changes in perceived site problems and problems in the performance of the selected remedy.

Benefits: This option would help balance the role of communities and responsible parties. If the emphasis on enforcement continues, this option becomes more important in improving public confidence in Superfund.

Implementation: Congress would provide statutory direction to EPA. A major implementation concern would be whether this option would result in delays in key cleanup decisions and actions. It seems that the best way of minimizing this problem is for government site managers to inform communities that their actions may have negative impacts. After all, it is not in the community's self-interest to cause unnecessary delays. But delays in the pursuit of improved environmental protection are justifiable. A site manager who concluded that community activity was causing a loss in environmental protection has an obligation to tell the community that and to take action to mitigate that impact. Another concern would probably be that the option would interfere with enforcement objectives. But enforcement should take second place to environmental protection and to the public's confidence in the government's sincerity and ability to provide that protection. The increase in program administrative costs to implement this option are uncertain. Congressional oversight could give special attention to the effectiveness of this option and make changes if necessary.

Developing Workers and Technologies

OPTION 24: Make Site Managers Responsible for Sites From the Front-End of the Program Through Final Disposition

One person would have operational management responsibility for a site from the time it enters the Superfund system until the time it leaves it. The Superfund site manager option would apply the concept of project management in engineering or a case worker in social services. Indeed, the site manager has many engineering responsibilities and, moreover, critical responsibilities for dealing with affected communities, local officials, and responsible parties. The latter would look to the site manager as the person providing environmental services on behalf of the government. The site manager would have total responsibility for seeing that the site is handled efficiently, fairly, and consistently under law and EPA policies, and compared to other sites in the program. The site manager would draw on a broad array of experts to support his or her efforts, including experts in the areas of: technology, contracts, conflict resolution, policy, law, and health.

Benefits: Cleaning up sites is a complex process whose management could be made **more efficient by having one person responsible from beginning to end. Many human endeavors fall into the project management category and historically everyone has acknowledged the virtue of having a single point** of management responsibility to provide continuity over time. Accountability is improved by having a single overview of diverse activities carried out by many different people, including contractors and government staff. A site manager could be key in preventing unnecessary, redundant site efforts which now occur as different site activities are handled in different bureaucratic stages.

Implementation: This is a management option for EPA, but Congress could, through oversight or legislation, support or not support this approach. An obvious concern about this option is that EPA is currently having major problems retaining remedial project managers. Some people may believe that this option is infeasible because of this problem. But one of the ways to improve the status, importance, and pay for these key front-line people is to expand their role. Superfund site managers would become an elite corp of professionals; they would have the most comprehensive knowledge of the entire program, from one end to the other. People working in other parts of the program would aspire to become site managers. Having assistant site managers could provide on-the-job training under experienced EPA staff, as well as support for the site managers. The workload of site managers would be balanced by providing new site responsibility, for a site entering the system, as other sites near the end of the Superfund process.

OPTION 25: Establish Program for Certified Public Environmental Auditors

This option would require EPA to establish a new program to certify people who could attest to the quality of site and cleanup data and reports (i.e., for onsite investigation and engineering activities outside of analysis and studies which require no onsite activity). Responsible party studies and cleanups would have to use certified public environmental auditors. **Government agencies and groups receiving EPA Technical Assistance Grants would also be required to use certified public environmental auditors to the extent that the work was conducted by non-governmental contractors for onsite investigation and engineering activities.** The basis for certification would be meeting a set of criteria established by EPA after discussions with a number of organizations representing professional engineers, consulting engineers, hazardous waste professionals, and

EPA's Science Advisory Board. Such criteria would pertain to minimum cleanup experience, level of science or engineering education, and professional certification. EPA would make lists of certified individuals available to the public.

Benefits: Certification of experts would aid government oversight. This approach would improve the quality of contractor work, which seems critically needed because of the explosive growth of the industry and the rapid entry of many new companies. It would also help build public trust in contractor work for responsible parties.

Implementation: Congress could direct EPA to establish a certification program expeditiously. Certification could be implemented effectively through a concerted effort by EPA with the help of other groups in perhaps 1 year. Comments and ideas should be solicited from about a dozen engineering, professional, and trade organizations. Out of this activity would come a set of criteria and procedures for certification. Within EPA, certification could be managed by the procurement and contracts management office. Recertification could be every 5 years. To offset the cost to the government of administering this option, certification and recertification would require a fee, which would be paid into the trust fund in the same way that the primary fees are.

OPTION 26: **Strengthen Effort to Offset Current Limitations of the Government and Contractor Workforce**

The rapid expansion of Superfund created the conditions for workforce problems. It is axiomatic that the more inexperienced the workforce, the greater the need for strong management. In the case of Superfund, the situation was exacerbated by the enormous amount of money spent on contractors, resulting in a steady loss of government workers, keeping the government workforce inexperienced. And the growth of spending on contractors (from Superfund and other cleanup programs) has forced companies to hire more and more inexperienced people, despite siphoning away government workers. If Superfund implementation is to improve for the long term, then the government must give high priority to identifying weaknesses in the workforce and ways to offset them. With this option, EPA would have a permanent activity within its Superfund office to improve the performance of the national cleanup workforce. For example, continuing education and training, intensive technical assistance, improved administrative support, expanded use of electronic support (e.g., databases, expert systems), and more opportunity to attend technical conferences. Moreover, EPA could establish special programs with contractors, State programs, universities, research laboratories, other Federal agencies, professional and trade associations, and responsible parties to meet the objectives of this option. A special position would be established under the director of the Superfund office to carry out these responsibilities.

Benefits: For long-term success, the Superfund program must provide assurance to the public that the government is doing everything possible to make the cleanup workforce first rate.

Implementation: EPA could implement this option, but congressional support for increased spending seems necessary. Annual spending for this effort might be in the $5 million to $10 million range, which is small compared to cleanup costs.

OPTION 27: Establish a Bureau of Mines Superfund Support Program

Many Superfund sites are contaminated with toxic metals, such as lead, arsenic, and chromium. Achieving a permanent remedy for such contamination means recovering and using the metal. The Bureau of Mines is the Federal Government's major source of expertise appropriate to accomplishing this goal. The Bureau has already performed some important work at a few sites for some regional offices, but the Superfund program has not fully optimized its use of the Bureau.[70] This option would require a long-term commitment of funds to support the Bureau's continuing involvement, particularly for developing techniques applicable to generic categories with many sites, such as lead battery sites. Moreover, some sites have a combination of organic and metal contamination, and there is an opportunity to integrate metal recovery techniques into a series of cleanup steps for contaminated soils to achieve a permanent remedy. The Bureaus Superfund support program would include R&D, site treatability and feasibility studies, site demonstrations, technical assistance to site program managers and others implementing cleanups, and possibly managing some cleanups instead of contractors.

Benefits: This would be an efficient way to greatly improve the technologies used to clean up hundreds of current and future NPL sites contaminated with toxic metals. Very little recovery of metal site contaminants is currently used to achieve permanent remedies. The government has already invested millions of dollars over many years in creating the Bureau of Mines and its technical expertise is undisputed. The Bureau also is well positioned to network with experts in the academic and industrial communities. Developing techniques to clean up sites might also provide an opportunity to develop new mining techniques. The kind of expertise the Bureau has does not exist within EPA or the technical environmental consulting community now providing major support for Superfund implementation.

lmplementation: Although EPA could implement this option, congressional action seems appropriate to establish a significant program, probably at the level of $10 million to $20 million annually initially. This is particularly important if EPA is to move beyond the current limited use of the Bureau by its regional offices toward a national program with some long-term certainty to facilitate internal development of resources by the Bureau. One concern may be that pursuit of the recovery approach for metal cleanup will be expensive compared to current approaches. First, current approaches usually consist of: 1) offsite land disposal which is not a permanent remedy; or 2) onsite containment (i.e., capping of a site) which is not a permanent remedy; or 3) chemical fixation or stabilization treatment technologies whose permanence over very long times is uncertain. Moreover, the limited work to date with recovery and recycling does not suggest exorbitant cleanup costs. To the contrary, because there are large numbers of relatively similar metal-contaminated sites, it is likely that generic cleanup techniques can be developed and applied at many sites, bringing cleanup costs down. Moreover, the sale of recovered metal could reduce cleanup costs. The recently completed cleanup of the Jibboom Junkyard Superfund site in Sacramento, California ended up costing about $400 per ton to excavate and ship lead-contaminated soil to a landfill in Utah. But a decision to use a recovery technology developed by the Bureau for a permanent remedy at the United Lead Superfund site in Ohio involves a cost of about half that land disposal rate.

OPTION 28: Establish a Superfund Support Program at the U.S. Geological Survey

The USGS is one of the most respected technical Federal agencies; it has extraordinary information and expertise about groundwater. But to date the Superfund program has made relatively little use of USGS. With this option, a formal and stronger supportive role of USGS

[70] This seems to be but one example of a general strategic choice exercised early in Superfund's history; that is, it was decided to emphasize private sector contractors for Superfund implementation and not immediately available and potential resources of Federal agencies, The one exception is the Army's Corps of Engineers at the back-end of Superfund.

for Superfimd implementation would be created. For example, USGS could:

- assist R&D efforts to identify and develop effective groundwater cleanup technology;
- provide assistance in evaluating technical information provided by responsible parties concerning groundwater problems and cleanup;
- conduct parts of or all site investigation and feasibility efforts at sites where groundwater is the major problem, or review contractor studies;
- provide independent evaluation of the performance of groundwater containment and cleanup efforts at Superfund sites; and
- perhaps manage the cleanup of some particularly complex groundwater contamination.

Benefits; This option would improve the environmental performance of Superfund by using an existing Federal resource. It also compensates for the shortage of highly experienced technical personnel in EPA and contracting fins.

Implementation: **There** is no significant obstacle to implementation. EPA, however, has not used USGS effectively, and, therefore, congressional direction to do so may be advisable. This option seems feasible and valuable because for the past several years USGS has significant y and successful y carried out technical support for the U.S. **Air** Force's site cleanup program. Moreover, it is OTA's understanding that EPA's Inspector General's office has used USGS in the past to review Superfund studies and actions. Currently, USGS is working on site investigations and feasibility studies for about 20 to 25 Air Force sites, at an annual spending level of about $10 million. This is the type of Superfund activity currently performed by contractors. The level of activity envisioned for this option is annual spending of perhaps $20 million initially. USGS was able to develop its **Air** Force effort within its existing resources and staff; it is not clear how quickly it could commit to implementing this option. But USGS has some competitive advantage, relative to EPA, in attracting first rate technical specialists. Moreover, in its Air Force work, USGS has successfully expanded its capabilities through the use of certain types of contractors (e.g., site drilling and laboratory analysis) and, most interestingly, by using the experienced staff of some other Federal agencies such as the Bureau of Reclamation. There is also probably substantial opportunity for USGS effort in the R&D area.

OPTION 29: Increase R&D Spending, With Focus on Groundwater Cleanup

A long-term national cleanup program requires a stronger R&D program to develop more effective and lower cost cleanup technologies for the most prevalent and difficult cleanup problems. This option would frost consist of an independent study, for example by the National Research Council or EPA's Science Advisory Board. The basic objective is to define the exact targets for increased R&D spending within and outside EPA. **A** national research agenda is critical for avoiding unproductive and redundant research efforts. For example, improved groundwater cleanup technology is a critical need, as is permanent cleanup of large landfills through some type of treatment technology, but without large-scale excavation. Major attention to **the** potential use of in situ biological cleanup of groundwater seems critical. Even without a study, a major increase in the outstanding groundwater program at EPA's Robert S. Kerr Environmental Research Laboratory seems critically needed. There are also needs outside of cleanup technology; for example, more and better non-intrusive and non-invasive site investigation technologies to determine hot spots of underground contamination. Moreover, if cleanup in America is a permanent effort, then much more support of *basic* research is critically necessary.

Benefits: To the extent that there is a need for a wider range of technologies to effectively run

along-term cleanup program and to find innovative ways to reduce costs, a stronger commitment to R&D stands on its own merits. Moreover, a strong R&D program which inevitably means more university activity helps address the long-term need for greater education to improve the national workforce.

Implementation: This option requires action by Congress and support by EPA and OMB. Considering the enormous future spending on the national cleanup effort, a major increase in cleanup R&D spending is in a special class. The key issue is determining how much money to spend on R&D. It seems useful and appropriate to see annual R&D spending relative to total government and private sector cleanup spending. The latter is probably in the range of $2 billion to $4 billion currently by all parties. **Spending say 5 percent on R&D suggests a target of $200 million annually; this seems necessary because the national cleanup effort is still in its infancy, and because there is a critical need to reduce costs and come up with new, effective solutions. This figure is probably about three times larger than current public spending on R&D related to cleanup of chemically contaminated sites.** In particular, a several-fold increase in annual spending for EPA's Robert S. Kerr laboratory and for the Superfund Basic Research and Training Grants Program of the National Institute of Environmental Health Services would probably yield an enormous payoff in the years ahead. Together, current annual spending on these two programs is less than what is often spent on a single major site cleanup. Another important target for increased funding is the University Hazardous Substance Research Centers established by Congress in 1986.

Improving Government Management

OPTION 30: Combine Preliminary Assessment, Site Inspection, HRS Scoring, and Remedial Investigation Phases Into Single Site Evaluation Program

Three technical activities now make up the preremedial part of the Superfund program: preliminary assessment, site inspection, and HRS scoring. The Remedial Investigation is now part of the remedial program. This option would combine all four EPA staff activities into one organizational unit at the headquarters and regional levels. The premise of this option is that understanding the hazards posed by a site is a continuing learning experience based on getting more and better information about a site over time. All four activities constitute site evaluation. Use of the four current individual activities could be retained with this option, but they would be parts of a unified process and a single bureaucratic operation.

Benefits: Improved program efficiency and probably improved environmental performance would result from this organizational streamlining. Currently separate, often redundant activities would be combined in a simpler operation. Bureaucratic disconnects would be eliminated. Moreover, the front-end of Superfund would, through this consolidation, become more visible and important. Currently, relatively junior people perform the earliest, but, in a critical sense, the efforts with the largest long-term impacts. More senior and experienced technical people would be more likely to be attracted to these activities because of the greater scope of responsibility.

This option is particularly important in overcoming the currently popular view that cleaning up sites is a straightforward engineering job. In fact, however, the ' 'specifications' for cleanup are not fixed quantities, easily determined at one particular time. As complexity of contamination (e.g., types, amounts, and distribution) and natural site conditions (e.g., geology, hydrology, soil parameters, etc.) increases, site evaluation increasingly takes on the character of an evolving investigation instead of a one-time event producing correct answers. With complex sites, new information leads to new probes about the site and its problems. Moreover, as site complexity increases, more discrete types of actions are taken at the site (e.g., emergency, removal, interim or operable unit actions, groundwater cleanup, soil cleanup, final remedial cleanup) and when these are implemented new information often arises which leads to unforeseen needs for new and different site investigation.

Finally, separating site investigation from current feasibility study activity could offer benefits. The feasibility study is supposed to take information about the site and its problems and determine possible cleanup solutions. This **is a very** different technical activity than site investigation. In fact, site investigation is fundamentally a *scientific* endeavor, seeking knowledge to define the problem (i.e., the cleanup specifications)-the demand side of cleanup. A feasibility study in conjunction with cleanup actions themselves, is fundamentally an *engineering* operation, in which a solution to the problem is conceived, designed, and constructed-the supply side of cleanup in which **cost** is explicitly factored into remedy selection. By keeping the activities separate—but with effective, continuing communication between the two-the integrity **of the two** different functions could be better maintained. This is in contrast to the current situation, where sometimes the definition of the cleanup problem and cleanup goals are compromised to fit what engineers (working for the government or responsible parties) say is feasible, desirable, effective, or low cost. In other **words, by separating site investigation from the remediation function, environmental needs will drive engineering solutions instead of the other way around.**

Implementation: This is a management improvement that could be implemented by EPA. However, current separate bureaucratic activities and different contracts pose a serious implementation problem. Unification of separate activities is never easy. However, from a long-term perspective, the ultimate benefits of bringing together essentially the same technical activities may be worth overcoming bureaucratic obstacles in the near term. Congressional action might be necessary to overcome bureaucratic inertia.

OPTION 31: Combine Removal and Remedial Programs Into Single Site Cleanup Program

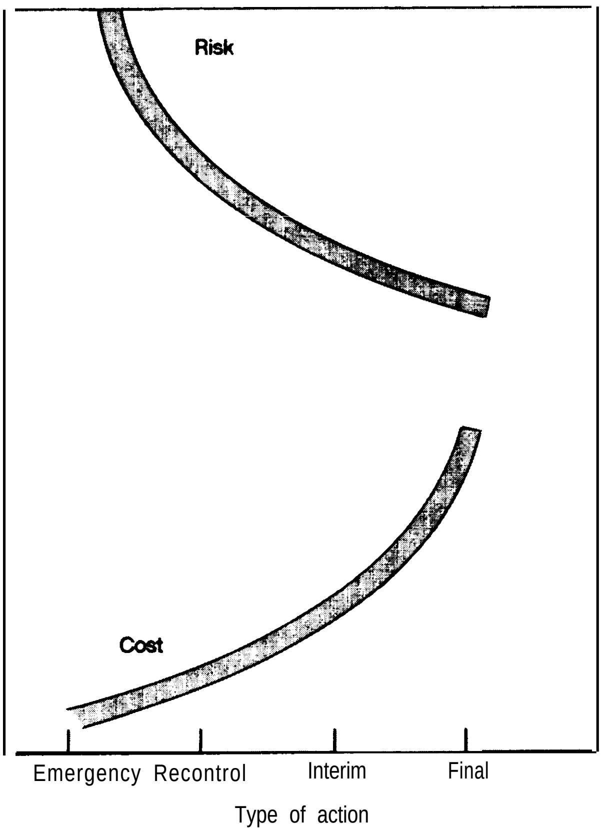
This option would recognize and institutionalize the relationship over time of different types of cleanup actions. The sharp distinction between emergency/removal actions and remedial actions would cease. Instead, Superfund management would recognize a continuum of cleanup actions over time: emergency, recontrol, interim (currently called operable unit), and final.

Total risk reduction decreases over time (see figure 1-2) as extent and cost of studies and actions increase over time. In other words, **in moving from emergency response to final remedy, the marginal costs on average increase, producing less environmental benefit per dollar over time. This progression of cost motivates aiming for initial cleanup actions at as many sites as possible, instead of aiming for final cleanups at relatively few sites.** Postponement of the final remedy (as with Option 1) is a way to optimize the entire Superfund system.

This option provides an explicit definition to each of these four types of cleanup action:

- Emergency response is self-evident: an immediate, urgent, and certain threat is addressed and is more important than procedure or policy preferences regarding analysis of the problem (Site Investigation) or selection and implementation of remedy. Emergency responses in this option would be essentially the same as emergency responses are now and applicable to non-NPL sites.
- Recontrol stresses preventing the spread of contamination into the environment aside

Figure I-2—Approxlmate **Reductions In Risk** and Coat **for Dlfferent Types of Cleanup Actions**



SOURCE: Office of Technology Assessment, 1989

from addressing risks.[71] Recontrol also means addressing near-term risks to health or environment because of current, certain exposures to hazardous material. Studies should be minimal for recontrol actions. Decontrolling a site may mean **actively maintaining** effectiveness through expedient engineering or institutional controls. That is, a service or continuing activity may be required to implement the action, such as monitoring, maintenance, and periodic repair. Recontrol measures usually: 1) impose physical or institutional barriers between the contamination and its environment, such as a cap on contaminated soil or buried waste, a slurry wall between buried waste and groundwater, above-ground storage of hazardous waste or contaminated soil, groundwater extraction wells which prevent a plume of contamination from spreading, fencing to prevent human exposure to contaminated soil, restrictions on use of contaminated groundwater, provision of new supply of water, relocation of **homes etc.; or 2)** use treatment technologies which leave residual contamination. With recontrol actions which leave hazardous material onsite, the need for a permanent remedy eventually is acknowledged. The proclivity to send hazardous waste to a landfill in the current removal program would be replaced by a policy to either store waste temporarily or send it to a treatment facility. Recontrol actions would be applicable to non-NPL sites, as with current removal actions.

- An interim remedial action achieves a partial remedy by addressing current risks to health or environment, leaving either future, uncertain risks to address or current risks for which no current technology offers a permanently effective remedy. That is, in contrast to recent.rol actions, there would be a preference for permanently effective technologies. Part of a site's problem may be addressed through an interim action, such as a soil or groundwater cleanup, or surface soil cleanup but

[71] Although there is some similarity between recontrol and removal (in the current program), this option could lead to a much larger use of recontrol. Removal actions do not stress recontrolling sites when spreading contamination does not pose immediate risks. For example, EPA said ''States generally are going to have to be responsible for non-time-critical removals where there is not an immediate danger but the site is deteriorating in a way such that something needs to be done over the next year or two. " In general, EPA has acknowledged that its conduct of the removal program stresses limiting removal actions by defering actions to responsible parties and State or local government agencies, and non-NPL sites have the lowest priority. It is not clear that EPA provides significant oversight of actions taken by other parties. Limiting spending on the removal program has dictated the scope and number of actions. (Karen Burgan et al., "Setting Removal Program Priorities,'' *Superfund* '88, proceedings of November 1988 conference, Hazardous Materials Research Institute, Silver Spring, MD,)

not subsurface soil cleanup; several interim actions at a site may be necessary.

- A final remedial action would address all remaining current or future risks through technology which irreversibly renders hazardous site material nonhazardous. Delisting of a site from the NPL would only occur after completion and confirmation of a permanent final remedy.

Transfer of a site from Class I to Class II, as described in Option 1, could occur after emergency, recontrol or interim actions.

Organizationally, EPA would combine all cleanup activities into one unit, Site Cleanup, because all are fundamentally engineering solutions to a contamination problem, employing similar methods and technologies. Use of removal and operable unit terminology, which has not conveyed useful notions to the public, would cease. With this option EPA would formally be required to issue Records of Decision for every site cleanup action, except that an emergency action would not be held up for its ROD. For emergency actions a post-action ROD would be acceptable to establish a public record of what occurred. Currently, RODS are only issued for remedial actions, including operable units.

Benefits: This option would provide a technically rational framework for a range of complex site actions. Some current practices which seem to circumvent statutory requirements would be eliminated, such as performing remedial cleanups as removal actions. There has been confusion about the nature and purpose of removal actions. Neither public opinion or public policy supports removal in a literal sense, whereby toxic waste or contaminated material is removed from a site to a landfill, for example. The first choice is removal to a treatment or storage **facility,** although sometimes landfilling may be necessary. With this option, recontrol actions would be integrated into the full remediation of a site; currently, removal actions are not necessarily matched well with remedial actions.

Another benefit might be reduced studies, because recontrol and interim actions should not require extensive studies as are now being done for nearly all remedial actions and some larger removal actions. Public understanding of the true, complex nature of site cleanup would be improved and, hence, public confidence in the program could improve. The requirement that EPA issue RODS for every cleanup action would also improve public accountability and public confidence. Currently, there is virtually no accessible information to the general public or Congress which provides substantive information on what emergency or removal actions have consisted of, accomplished, or cost. All RODS should reference earlier RODS at the site in order to help people understand the history of site actions.

Implementation; This option requires statutory action. Definitions and limits for all four categories would replace current statutory distinctions for removals and remedial cleanups. An immediate issue is how current statutory provisions would apply to this framework. Therefore, there would have to be an explicit assignment of critical statutory requirements to the four types of actions. For example, current remedy selection and cleanup standards provisions, or modifications of them, might only apply to interim and permanent actions. Current spending constraints on removal actions could be applied to recontrol actions. Within EPA, there will be some resistance to this kind of conceptual and organizational change. Over time, competition has developed between the removal part of the program and the remedial part. Problems with existing contracting mechanisms would not be affected too much. Contractor services for emergency responses remain a unique kind of need. However, current distinctions between contract support for removal v. remedial actions would cease.

OPTION 32: Reexamine Current Statutorily Required Program Performance Schedules

Congress established a number of program performance schedules in 1986. However, in setting performance goals for the program, unintended impacts, such as eliminating or reducing environmental criteria for key decisions have occurred. EPA has said ''Achieving targets can mean trade-offs with achieving environmental results. Targets are numerical goals that do not measure quality, timeliness or risk reduction.''[72] A recent study of Superfund said ''Time pressures sometimes reduce opportunities to involve all the affected parties (including the community) early in the remedy-selection process to promote consensus.''[73] OTA agrees with these views. With this option, either the performance schedules would be dropped or they would be supplemented by explicitly directing EPA to assure that compliance was obtained without environmental compromises.

Benefits: Subtle but negative impacts on environmental performance would be eliminated by removing pressures on EPA to meet timetables which have little to do with effective cleanup. Mandated schedules direct EPA's attention away from satisfying requirements on cleanup objectives and remedy selection.

Implementation: Congressional action is required. This option requires rethinking the benefits of imposing performance schedules against the negative impacts they have on environmental performance. **EPA is facing almost a Catch-22 situation: either it compromises environmental goals to comply with schedules or it maintains environmental standards and fails to comply.** Either way, the agency draws public criticism. For the most part, EPA has done the former. But because of the complexity of the Superfund program, it has received relatively little criticism thus far for most of its environmental compromises, such as restricting the inflow of sites into Superfund. But such compromises are bound to have significant negative effects in the longer term.

OPTION 33: For Records of Decision, Require a Statement of Inconsistency for Selected Remedy

All RODS would be required to have a separate section for a statement of inconsistency, or a statement that none has been found necessary. This statement would force a routine consideration by site managers and their superiors of any significant inconsistencies between the cleanup action, particularly its cleanup standards and remedy selection, and statutory or EPA policy requirements, as well as with general practices (e.g., a deviance from a generally standard type of remedy selection for a generic type of site, or a postponement of a treatability study until after the ROD).[74] The inconsistencies would have to be identified and the **environmental** justification of them fully presented. Use of a new, innovative technology or a technology demonstration would be described and explained.

Benefit: This option would improve public accountability and, hence, public confidence in Superfund. It would reduce current inter-site and EPA regional inconsistencies. It would provide an incentive for effective use by Superfund staff of technical assistance resources and information transfer programs. EPA headquarters control of regional efforts would be enhanced. Congressional oversight would be improved.

[72] Environmental Protection Agency, *A Management Review of the Superfund Program,* June 1989, pp. 1-6.

[73] Clean Sites Inc. *Making Superfund Work,* January 1989.

[74] OTA has been told that such statements are sometimes a part of the administrative record or backup information to a ROD,

Implementation: Either EPA or Congress could implement this option. More effort would be required in ROD preparation by regional offices and another responsibility is placed on site managers, increasing administrative costs. But the cost seems marginally small both in an absolute sense and relative to potential benefits.

OPTION 34: Reduce Need for Formal Regulatory Compliance for Onsite Cleanups

In meeting the goals of simplification and speeding up cleanups it seems appropriate to eliminate regulatory requirements for permits—**not** health or environmental effects based standards-if their environmental objectives can be met more simply. The objective is to eliminate intensive time, labor, and paperwork requirements for regulatory compliance. On the assumption that a government agency wants to satisfy the functional requirements of environmental regulations, and that the need for expeditious cleanups has intrinsic environmental imperatives, elimination of formal, regulatory compliance is unlikely to jeopardize environmental goals. This option would go beyond the current statutory provision that eliminates formal compliance with Federal permitting requirements for onsite cleanups. With this option, all Federal, State, and local regulatory requirements for obtaining a license or permit to operate, or substantiating compliance with a regulatory requirement through documentation, would automatically be waived. The only requirement would be that EPA would have to publicly identify which requirements it was not planning to formally comply with and how it was achieving the same environmental objectives of the regulations. This would be done in a separate section of the Record of Decision.

Benefits: Cleanups would be speeded up and administrative costs reduced substantially.

Implementation: Congressional action is required. As a form of Federal preemption, this option poses certain traditional issues. However, many regulatory requirements would still pertain to Superfund cleanups, including, for example, all health or environmental effect based standards for acceptable levels of contamination in environmental media, regulatory definitions of hazardous wastes and substances, and regulatory bans against land disposal. Successful implementation without sacrificing environmental protection is contingent on the motives and capabilities of key Superfund staff, principally site managers. As long as only government personnel are entrusted with the power to bypass formal regulatory compliance, as compared to contractors or responsible parties, the risks of compromising environmental protection can be minimized. It might be useful, nevertheless, to also provide through statute the legal right of any governmental authority with regulatory powers or member of the public to petition the EPA Administrator within say 30 days after a ROD is issued for reconsideration because of some basis for believing that the intended noncompliance would likely lead to adverse environmental consequences (noncompliance because of emergency responses would not fall under this provision). OTA recognizes that some State agencies and regulations **have** been critical to achieving improved cleanups and this option is not meant to reduce the positive influence of stringent State programs.

OPTION 35: Establish a Formal Evaluation Program for Completed Site Cleanups and Long-Term Ones in Progress

There is a critical need for *independent* evaluation of the environmental and economic performance of Superfund actions. With this option, an ongoing performance evaluation effort would be established outside of EPA. Some sampling of sites in generic classes would yield critically needed information on how well technologies are performing in the field in an absolute sense and relative to estimates and projections made by the government or responsible parties. It is important to discover the extent to which technologies are succeeding and failing, and the extent to which originally chosen cleanup objectives or requirements identified in RODS and consent decrees are being met or not met.

For example, for the Pepper's Steel & Alloys site in Florida, for which the responsible party was successful in gaining EPA approval for a first time, large-scale application of new technology, the cleanup has recently been completed. However, the responsible party, which now markets the cleanup technology, has requested EPA to do more than delist the site from the NPL because the remedy is successfully completed. It has also asked for ''unrestricted use of the affected property' and in its discussion of its implementation of groundwater monitoring has said:

> If [the presence of the constituent above the target level] is confirmed, then, if appropriate, an effort to determine the source of the constituent, or some other action consistent with the facts presented, might be undertaken.[75]

The latter is not a strong commitment for taking remedial action in the event that monitoring finds that the chemical fixation technology used at the site, contaminated in large part with PCBs, does not perform as expected. Indeed, the long term effectiveness of this technology for PCBs has been a major issue. The ROD had said:

> the action will require monitoring and institutional controls on future land use to ensure the continued effectiveness of the remedy. These activities will be considered part of the approved action.

Yet, immediately after the onsite treatment, the responsible party has reached a high level of certainty about the cleanup's effectiveness on the basis of laboratory testing and wants to remove the institutional controls on land use. Industrial use of the site, as desired, would also complicate interpretation of monitoring results with regard to responsibility for groundwater contamination.

With this option, if information was obtained which could immediately impact current decisions and program implementation, the program would issue some form of alert notice to EPA headquarters and regional offices, as well as other programs which are part of Superfund implementation (such as the efforts in Options 10, 11, 27, and 28). Otherwise, semiannual collections of site evaluations could be released to these groups and the general public.

Benefits: In a program as technically complex as Superfund and one in which there have been major problems with implementation, quality of work, and public confidence, there are benefits from having an *independent performance* review effort. Both the environmental performance and economic efficiency of Superfund would be improved, because there would be more use of the most effective technologies and less use of ineffective ones. Moreover, there would be improved information transfer through the system, improving the expertise and performance of the workforce. Public accountability would be improved. There is a particular need to build public confidence for less visible post-ROD activities, especially because of increasing implementation of remedies by responsible parties. There are also a lot of selected remedies which include institutional and engineering controls. This option would help in the implementation of the current statutory requirement for 5-year reviews when contamination remains onsite.

Implementation: Congressional action is necessary. This would be a new activity requiring additional funding. As envisioned here, the level of effort would be perhaps $5 million annually; that is, it seems feasible to examine about 25 to 50 sites annually, assuming a site evaluation cost of from $100,000 to $200,000. Although

[75] Florida Power & Light Co., *Final Report on Remedial Action—Pepper's Steel & AlJoys Superfund Site, Medley, Florida*, June 1989.

this effort would not have to be permanent, it seems useful to see it extending over the next 5 to 10 years. The most difficult implementation issue is the selection of the group to perform the independent analysis. Having a lot of experienced and expert professionals seems at odds with having true independence of the Superfund program, because nearly everyone associated with cleanup may have some involvement in Superfund. One possibility would be to create something like a Superfund Evaluation Board administered by the National Research Council; it could have a small core staff (such as recently retired, experienced government cleanup professionals) supplemented by consulting academics and others who would only examine sites for which they had no conflict of interest. Statutory direction to EPA to supply all requested information to the Board would be useful. It might also be beneficial, as with peer review of scientific journal articles, to maintain the anonymity of the professionals evaluating a site. The impact of cleanup reviews on Superfund implementation by EPA would be a priority of congressional oversight, if this option was adopted.

OPTION 36: Establish Formal Measures of the Program's Environmental Progress

Improving Superfund implementation for the long term requires developing meaningful measures of the program's environmental success. **With this option, the current practice of using bureaucratic outputs, such as numbers of studies and actions started and completed per quarter, number and dollar value of enforcement actions, numbers of different types of technologies used, and speed of passing through program stages would be replaced (or supplemented) by environmental outcomes.** There are two fundamental areas which, theoretically, could form the basis for formal measurements. First, some measure of how well professionals understand site contamination and conditions could be defined. Second, some measure of how much site cleanup has occurred over a given time could be derived; for example, whether current risks have been fully addressed, but not future risks (in terms of Option 1), and the extent of risk reduction or contaminant reduction. The goal in developing formal measures should be simplicity and a good analog is the use of technology performance standards, as, for example, the percentage of input hazardous material destroyed by an incinerator. For environmental performance at a site, therefore, we might want a comprehensive percentage to indicate how well the site is understood and a reduction percentage to indicate how much the site's contamination (or total risk) has been reduced. A special notation would indicate whether all current risks have been addressed permanently. Performance at the regional and national levels could be presented by some type of averaging of site performance figures over the appropriate population of sites.

Benefits: In the past, in other areas, approaches by EPA or others have been effective; for example, percent reductions in atmospheric or surface water pollution, or percent reductions in the amount of toxic chemicals in people's blood. If the American public can get a semiquantitative sense of the percent of the nation's contamination being destroyed, for example, its confidence in Superfund will be improved. Moreover, EPA itself needs to measure environmental results to assess its staff and regional offices.

Implementation: Congress could direct EPA to develop some formal measures of environmental performance. There are significant implementation problems. Designing specific factors to measure environmental progress is not easy. This is something that EPA's Science Advisory Board or a university might be able to help with over a 6-month period. Another problem is that the Superfund base is continually increasing, in terms of numbers of sites and information about sites moving through the system. One way to overcome this problem might be to present figures only for individual sites. For program performance it might make sense to have an annual report which based performance on what was known to EPA at the beginning of the year; another way might be to base performance on a set of NPL sites. A detailed approach is beyond the scope of this OTA study, but the potential benefits justify serious attention to this basic need. Lastly, implementing this option will be made difficult by poor quality information on sites and by the frequent lack of specific cleanup standards.

OPTION 37: Address Conflicts of Interest Associated With Technology Selection

The selection of cleanup technologies in RODS is a primary determinant of future spending and, therefore, affects the economic interests of many responsible parties, cleanup companies, and technology developers. The chief potential problem is a selection of remedy which does not assure the best environmental results. Secondarily, decisions which are influenced by specific commercial interests interfere with market competition and can impede the introduction of newer technologies. For example, some of the major engineering firms working as Superfund or responsible party contractors own specific cleanup technologies. And a number of large corporations who are responsible parties at many Superfund sites have gone into the cleanup business, often by developing a particular new technology.[76] Therefore, there is a need for explicit attention to the potential for conflicts of interest which may affect critical cleanup decisions (see OTA's 1989 report on contractor use and a GAO report[77]). With this option, RODS would be required to have a statement that certified that all parties who have been involved in the execution of site studies or who have provided significant information on the site or its potential cleanup have been examined for conflicts of interest. A finding of no conflicts or of business interests which exist but which have not affected the site's decisions would be required.

Benefits: There would be more assurance that the best cleanup technologies for effective and minimal cost cleanups have been selected. Competition among cleanup technologies, particularly newer ones, would be safeguarded. The influence of responsible parties on remedy selection which compromise environmental protection would be reduced.

Implementation: EPA could implement this option. This option requires more staff activity, places another responsibility on site managers, and increases administrative costs. However, these additional requirements seem to be outweighed by the potential benefits. This option is likely to engender strong opposition from some firms and people.

OPTION 38: Reauthorize Superfund for 10 Years

Consistent with Superfund being a long-term program, the period of the second reauthorization would be increased from 5 to 10 years. This, of course, does not preempt congressional action, should the need arise, for changing statutory provisions.

Benefits: Considering both the past, difficult history of Superfund and the possibility, as envisioned in this report, of making fundamental as well as incremental changes in the program, providing stability and certainty appears highly desirable. This option would make program management and implementation by

[76] For example, the chemical fixation technology selected for the cleanup of the Pepper's Steel & Alloys site in Florida was one developed *and now* commercialize by the responsible party; EPA staff expressed some concerns about using the technology for cleanup of PCBs. For the cleanup of a number of PCB sites in Indiana, the government selected a novel but unproven type of incineration, which the responsible party could also develop commercially; there have been many objections to using this technology and cleanup has been delayed.

[77] GAO, *Superfund Contracts: EPA's Procedures for Preventing Conflicts of Interest Need Strengthening*, Feb. 17, 1989.

EPA easier, and it would also help everyone else, such as affected communities, public interest groups, responsible parties, and technology developers. It is significant that EPA has had great difficulty implementing SARA within 5 years; for example, there has been a substantial delay in finalizing the new National Contingency Plan to reflect statutory changes.

Implementation: Committees with legislative jurisdiction would have to act. Appropriations actions do not have to change.

Chapter 2

The Front End of Super fund: Site Discovery and Evaluation

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The Front End of Superfund: Site Discovery and Evaluation

INTRODUCTION

Before major site studies are done and long before cleanups start, uncontrolled sites spend 5 or more years in the front end of the Superfund pipeline. First someone has to discover a potential site, then others evaluate it to determine whether or not the Federal program will take action.

In this chapter OTA reviews both the site discovery and evaluation aspects of the Superfund program; how site discovery has remained the same and site evaluation changed during the first 8 years of Superfund, and the consequences for the future. OTA concludes that **Superfund's environmental mission could be measurably enhanced by the addition of a national site discovery program and the revamping of the evaluation process.** Both changes will involve spending more money at the front end of Superfund but can mean saving more money over the long run. The upfront costs of having better information sooner and making sounder environmental decisions, instead of expedient management choices, are small, compared to the cost of a few Superfund cleanups.

National Site Discovery Through Technology

Almost a decade after obvious problems like Love Canal drove the Federal Government to get actively involved in cleaning up environmental damage, we still do not really know how many sites need attention. As Russell Train, former administrator of EPA, said in 1987 in answer to the question, How serious is the problem? "Distressingly little is known, in fact, about the number of toxic waste sites and how serious a risk each site poses.

We do not know how many sites there are because there has been no comprehensive or systematic search for them. The sites that have been discovered are listed on various Federal and State inventories for which there are no listing criteria nor attempts to avoid duplications among lists.

Despite haphazard and passive site discovery, over 31,000 sites have been reported to EPA's CERCLA Information System (CERCLIS) inventory of sites that potentially require cleanup. Over the years of the program, 1,274 of these sites have been proposed for the National Priorities List (NPL); the list now includes 1,224 sites. All sites on the NPL qualify for cleanup funding under the Superfund program, except the 115 sites belonging to Federal agencies.

For some years EPA has maintained that a maximum of about 2,000 sites will ultimately be Superfund's responsibility. Those estimates have always been constrained by the choices that EPA has made about the Superfund program. OTA said in 1985 that ultimately 10,000 sites might be on the NPL. That estimate, still valid, assumed that EPA would have an active site discovery program and would apply environmental criteria to the site evaluation process. It did not take EPA's deferral of cleanups to other programs into account. Today's CERCLIS inventory and its growth rate--despite passive site discovery-imply that over 4,000 sites could be on the NPL by the year 2000.

Enough sites to keep the Superfund program challenged? Of course, but the real question ought to be: Have we found them all? OTA and many others don't think so, and data from the Superfund program shows that the worst sites are not necessarily accounted for. Both site discovery and the way sites are inventoried can be improved—and the costs of doing so contained-by the use of technology.

Active, comprehensive, and systematic site discovery could be built around a method such as historical aerial photography analysis. A national program could be supplemented by State efforts using traditional site discovery methods. With funding assistance from the Federal Government and in combination with improved preremedial site analysis, this could move the Nation quickly to finally knowing with more certainty the true size of the cleanup problem. But the history of the Superfund program so far tells us that a **comprehensive site discovery program will not occur unless Congress gives explicit direction to EPA, or some other authority, to proceed.**

[1]Russell Train, ' 'Big Questions Facing the Cleanup, " *EPA Journal*, January/February 1987, p.8.

Site Evaluation: A Management or Environmental Decision?

Most observers express great concern with one point in Superfund's site evaluation process: the on/off NPL decision, whether or not a site is on the NPL. Few, however, seem to care about what happens before that point. OTA concludes that there are many reasons to suspect that the entire site evaluation process is biased against making sound environmental decisions.

Should the Superfund program bear the burden of **determining** whether or not discovered sites are potential environmental threats, even though the program may not have the authority or resources to respond to all those threats? Or, should the Superfund program's site evaluation process be restricted to only finding potential Superfund sites? If so, how early in the process is it reasonable to make that decision? When it is made, how can the public best be notified when a site is rejected for management reasons even though it poses a threat to public health and the environment?

There is evidence that past Superfund site evaluations have produced many false negative decisions. That means that sites have been rejected when they really require cleanup. **OTA estimates that from 240 to 2,000 false negatives may exist so far.** Recent changes in the process-meant to cope with demands to work faster-are likely to aggravate this problem. Another characteristic of site evaluation is regional inconsistency; across the Nation wide differences exist in the efficiency and apparent environmental effectiveness of site evaluation.

SITE DISCOVERY AND INVENTORIES

This section sums up what the Nation knows and does not know about potential sites; how many sites *might* need to be cleaned up? The ad hoc nature of EPA and State searches and reporting systems is a result of EPA (and Congress) not having paid much attention to (or spent much money on) site discovery since the Superfund program began in 1981. In the interim and without knowing the full extent of the potential universe, **EPA** (and Congress) have concentrated on evaluating sites that are known.

Further, what we do know about the potential size of the national problem is confused by a multiplicity of site inventories. OTA has identified other national inventories, besides the well-known CERCLIS and NPL lists associated with the Superfund program, In addition, each State has some kind of list or lists. Today, there is no way to know the extent of overlap of these lists. This situation will be exacerbated if EPA's proposed deferral policy (see ch. 4) for Superfund sites goes into effect. Increased deferral of sites out of the Superfund program and into other programs will create dynamic lists of sites as the authority for cleanup changes and sites are moved back and forth among programs. Accountability at the national level will become more difficult. Some sites deferred to other programs will essentially disappear. Not only are the other cleanup programs less visible to Congress and the public than is Superfund, but few of their site inventory systems are as available. Some programs do not have formal inventories.

Why Should We *Want to Know?*

The major, longstanding bureaucratic argument against site discovery has been that we know enough without it to keep us busy for years. But this argument ignores the environmental mission of the Superfund program. And it perpetuates the crisis atmosphere around Superfund. Without a strategy to decide which sites get attention first, newly discovered sites that engender a lot of publicity tend to push existing work aside.

The number of sites potentially requiring any kind of cleanup defines the magnitude of the national problem, its ultimate cost and length. The number of sites *actually* needing cleanup will always be less than any inventory of known *potential* sites, such as CERCLIS. But, all potential sites consume national resources because they all require some type of evaluation to separate out duplicate and obviously nonhazardous sites from hazardous sites requiring some kind of attention.

From a policy perspective, knowledge of the outside bounds of site cleanup determines the necessary scope and, therefore, acceptable pace and financial impact of a national program. Unrealistically low estimates of potential sites lead to underestimates of sites requiring cleanup and low estimates of resource needs. If a site is a problem today, it will probably be a worse problem tomorrow. **Ignoring potential sites only saves resources in the short term and decreases protection of human health and the environment.** Overestimates of the size of the national problem that overwhelm systems and resources result in an unnecessarily slow pace of cleanup.

A relatively small number of potentiai sites may mean that limited funds can be used quickly to clean up the universe of sites, but a small number devalues the importance of a priority system for determining which sites get attention sooner. The larger the number of potential sites becomes, more care must be taken in assigning priorities to sites and managing limited funds. Issues of environmental protection and cost-effectiveness become more difficult to balance; thoughtful development of a long-term strategy becomes critical.

What Have We Done So Far?

In 1982, the General Accounting Office (GAO) stated that ''a national hazardous waste site inventory does not exist. "[2] In 1985, GAO stated, "A complete inventory of hazardous waste sites does not exist. And, in late 1987, GAO said, "While still not fully understood, the extent of the nation's potential hazardous waste problem appears to be much larger than is indicated by EPA's inventory of sites.

These statements are not surprising since an EPA official stated in 1981 that a comprehensive search for sites needing cleanup was "against EPA policy. ''5 This attitude was still policy in 1985 when the then director of the Superfund program said:

> There is no national policy that says go out and aggressively look at sites. I'm not sure, if we had such a policy, that we would have more to deal with then we currently do, however. The national inventory (not the NPL) has grown about 3000 sites a year. It is growing faster than we have the resources to assess and inspect those that come to our attention, I'm not sure, frankly, what more we could do. Or how one would go about actively investigating for the presence of new sites ...6

Congressional Direction and Funding

Congress has been largely silent on site discovery. In CERCLA, little attention is paid to site discovery except to say that the NCP shall include ''methods for discovering and investigating facilities. "[7] GAO and **OTA analyses** at the time of Superfund reauthorization concluded that the 'methods' being used by EPA were not producing comprehensive information. But site discovery was not art issue during reauthorization and nothing was added in the Superfund Amendments and Reauthorization Act of 1986 (SARA) to prompt more action from EPA.

Sufficient site discovery funding levels have been *authorized* under the Resource Conservation and Recovery Act (RCRA) since 1980 but Congress has only *appropriated the* funds once,[8] When the authorized level was $20 million, Congress appropriated $10 million for fiscal year 1983 for State site inventory programs. Subsequently, Congress raised the authorized level to $25 million per year for fiscal years 1985 through 1988. None of that money was ever appropriated. If it had been appropriated *and* directed toward site discovery, the question of how large the potential universe is might have been answered by now.

The fiscal year 1983 funds were actually drawn from the Superfund trust fund. They were earmarked

[2] U.S. General Accounting Office, ''Environmental Protection Agency's Progress in Implementing the Superfund Program, ' GAO/CED-82-91.

[3] U.S. General Accounting Office, *EPA's Inventory of Potential Hazardous Wastes Sites Is Incomplete,* GAO/RCED/-85-75 (Gaithersburg, MD: U.S. General Accounting Office, Mar. 26, 1985).

[4] U.S. General Accounting Office, *Superfund: Extent of Nation's Potential Hazardous Waste Problem Still Unknown,* GAO/RCED/-88-44 (Gaithersburg, MD: U.S. General Accounting Office, December 1987).

[5] Morgan Kinghorn, then EPA Comptroller, as noted in telephone log of Vem Webb, then director, Environmental Photographic Interpretation Center, Aug. 25, 1981.

[6] William N. Hedeman, Jr., as quoted in ''Superfund Chief Outlines Strategy on Hazardous Waste cleanups,' *Chemical & Engineering News,* June 3, 1985, p. 17.

[7] CERCLA Section 105(1).

[8] RCRA Section 3012, Hazardous Waste Site Inventory

for site discovery *and* evaluation. Congress referred to that appropriation as a "one time event. '

There was no followup accounting by EPA (or examination by Congress) to ascertain how useful the funding was for site discovery purposes. However, EPA has said that activities were funded ". . . in the following order of priority: preliminary assessments, site inspections, responsible party searches, **discovery,** and site inspection follow-up" [emphasis added].[10] Given such low priority, little of the $10 million was likely spent on site discovery.

EPA and Site Discovery

EPA has never requested funds from Congress for site discovery. EPA has no site discovery program, has no budget for site discovery, and does not allow States to spend Superfund monies for site discovery. Instead, EPA has relied on varied State-funded efforts and a few regional investigations to identify potential sites.

Traditionally, EPA officials give two reasons why the program devotes no effort to site discovery. First, there is no need for a site discovery program because the extent of the problem is known; the worst sites have been found already. Second, the Superfund program has enough to do just evaluating the known sites. Discovering more would simply choke the system.

EPA has implied that some kind of a site discovery program once existed. In 1984, EPA told Congress that it had shifted the emphasis in the Superfund program away from site discovery. 'These changes reflect EPA's belief that many of the sites posing more serious problems have been identified and EPA resources should increasingly focus on further assessment and inspection of these sites. ''[11] **Today, EPA's policy is the same even though it has abandoned the idea that the extent of the problem is known. GAO** reported in 1987:

> EPA officials now recognize that many more hazardous waste sites may exist, [but] they believe a higher priority is to meet the deadlines imposed by SARA for assessing and evaluating those sites already included in the CERCLIS inventory .12

In other words, **resources and SARA schedules are determining the size of the inventory rather than the inventory size establishing the funding level.** This management, rather than environmental, perspective of the CERCLIS inventory ignores the higher future costs (both resources and public health and environmental damage) of not fully understanding the extent of the problem today. Moreover, limiting the size of the inventory and the NPL diminishes the need to develop a strategy for distinguishing between near- and long-term remedial actions.

EPA reported on the extent of site discovery to Congress in 1984 with a list of site discovery methods in use: [13]

1. required reporting under CERCLA Section 103 of known sites (following enactment of CERCLA) or subsequent releases;
2. government investigation under CERCLA response authority;
3. reporting by permit holders under other statutes when required;
4. inventory efforts (i.e., RCRA Section 3012) or random observations and reports; and
5. ''other sources,'' including formal analysis of various industries.

EPA said the one-time reporting requirement of Section 103 (#1 above) had been a major source of initial site discoveries. Since then, EPA said it was

[9] House of Representatives, Conference Report [appropriations for HUD and Independent Agencies for fiscal year 1983], H.Rep. 97-891, Sept. 29, 1982.

[10] U.S. Environmental protection Agency, ''The Effectiveness of the Superfund Program, CERCLA Section 301(4(1)(A) Study,'' December 1984, p. 1-14. According to Frank Wolle, who was then with EPA's Environmental Photographic Interpretation Center, the funds were actually used to redo RCRA inventories conducted in 1976 and 1980 that were considered to be invalid. Thus, the monies were not spent on gathering any new information.

[11] Ibid., p. 1-13.

[12] U.S. General Accounting Office, *Superfund: Extent of the Nation's Potential Hazardous Waste Problem Still Unknown*, op. cit., footnote 4, p. 28. In a rare public statement, an EPA official from Region 2 lamented on national TV in July 1989 that just as we think we know where all the sites are another one becomes known.

[13] U.S. Environmental Protection Agency, ''The Effectiveness of the Superfund Program, CERCLA Section 301(a)(l)(A) Study,' op. cit., footnote 10. These "methods" are the same as those listed by EPA in the National Contingency Plan.

relying on inventory efforts (#4) and other sources (#5) for discovery. For the future, EPA said it was:

> .,. currently developing a method to systematically evaluate various industries to determine categories of waste generators which are more likely to involve hazardous release problems that require Superfund action. 14

The new method may have been developed, but industries have not been systematically evaluated by EPA since 1984. OTA could locate only one industry study: "U.S. Production of Manufactured Gases: Assessment of Past Disposal Practices, " completed in 1988.

EPA did contract with Booz-Allen & Hamilton to conduct a study on site discovery. The results are contained in a 1987 draft report, which begins:

> To date, discovery and identification of releases or threatened releases of hazardous waste have been reported to the EPA through a wide variety of uncoordinated channels . . . The magnitude of the hazardous waste problem on a national level remains unknown and EPA is unable to forecast the resources required to understand and mediate this problem. An active site discovery program is needed to better forecast future EPA resources and schedules in which Superfund's overall objectives may be met. [15]

The study remains in draft form; the need expressed in it for an ''active site discovery program' is not EPA policy and does not reflect official EPA thinking. Two followup studies mentioned in the report-to develop management options and guidance for a site discovery program-were not done. Followup work was confined to reviewing discovery techniques and drafting some guidance.

The Aborted 200 Cities Plan

There were some technical people in EPA in the early days of the Superfund program who saw value in site discovery. EPA's Environmental Photographic Interpretation Center (EPIC) had a comprehensive site discovery program-the 200 Cities Hazardous Waste Site Discovery Plan-underway in 1980. It lasted barely a year; in August 1981, EPA's comptroller told the laboratory to cancel the project because "we already have more sites than there is money for so we do not need more.[16] EPIC asked the Superfund program in March 1982 to support its $850,000 request for funding the project. According to the director of EPIC, the Superfund program director told him that there was not to be a 200 Cities project.

There was some initial support for the EPIC project within EPA's Office of Research and Development (ORD). EPIC had $161,500 in fiscal year 1981 for a pilot program and received guidelines from ORD for an expanded program in June 1981. The guideline document called for the 200 city search to be completed and 50 sites analyzed by 1985. An accelerated program was also outlined in which 100 of the most serious sites found would receive detailed analysis. Total funding through fiscal year 1986 was estimated at $6.4 million for discovery and site analysis. Of the four city inventories selected for the pilot project, two were finished.

The 200 Cities plan was based on EPIC's experiences since 1973 in developing the use of historical aerial photography for environmental purposes. By the late 1970s, it was an established technique for site characterization. One intent of the initial 200 Cities pilot project was to demonstrate the practicality of using the technique to conduct a *site discovery* program and to determine if the criteria for selecting the 200 cities were valid (see box 2-A). Figure 2-1 shows how a series of aerial photographs, the basis for HAP analysis, can uncover past disposal practices no longer visible.

State Site Discovery

State site discovery efforts are funded by States. States have become, by default, fully responsible for collecting national data. But EPA does not allow States to use Cooperative Agreement (CA) money for site discovery, because CERCLA Section 104b confines its planning authority to only *site-specific* actions. Thus, since site discovery actions-by their very nature--cannot be site specific, EPA reasons that States cannot use CA funds for site discovery

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14 Ibid., p. 1-8.

15 U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''CERCLA Site Discovery Program Evaluation, " draft prepared by Booz, Allen & Hamilton, Inc., Mar. 5, 1987, p. 1. EPA told OTA that the report never went from draft to final form because of resource constraints in the preremedial program.

16 Morgan Kinghorn, then EPA comptroller, as noted in telephone log of Vern Webb, then EPIC director, Aug. 25, 1981.

Box 2-A Historical Aerial Photography and Site Discovery

Site discovery using historical aerial photographs allows a trained analyst to peel back layers of construction and vegetation in a particular area that have occurred over time and hide past practices and to review those practices. This process of looking back in time uncovers sites where wastes have been dumped. The technique cannot confirm that hazardous constituents are present at a site. Instead, a probability of their presence is inferred from activities observed or if the site has remained scarred over a long period of time and does not support vegetation.

Historical Aerial Views of the United States

The United States has been extensively photographed from the air since at least the 1920s and especially after 1938. The photographs have been taken primarily for mapmaking and soil survey purposes. After World War II, aerial photography increased with the availability of surplus military reconnaissance equipment and pilots and crewman trained in the technique during the war. For maps, a series of overlapping photographs are taken of the terrain as an aircraft progresses along a straight flight path. The photographs are taken from a height of 12,000 feet and each one covers an area 11.5 square miles. Viewed through a stereoscopic microscope, a three-dimensional view of the terrain is obtained. Towns and cities undergoing the greatest development and expansion have been the most recoded areas, generally on a three-to-five-year cycle.

The collection of historical aerial photography (HAP) is now stored in five government archives: the National Archives in Washington, DC; the Earth Resources Observation System in Sioux Falls, South Dakota; the USDA's Agricultural Conservation and Stabilization Service in Salt Lake City, Utah; the National Atmospheric and Oceanic Administration in Rockville, Maryland; and the Tennessee Wiley Authority's Mapping Services Branch in Chattanooga, Tennessee. Additional photos and index services are sold through commercial firms. In the past, some commercial negatives have been destroyed to reclaim the silver value. For instance, during the speculation of silver by the Hunt brothers in the late 1970s, the value of the silver in film rose ten-fold and millions of feet of commercial photographic records were lost. An unknown amount of aerial photographic film was destroyed as well.

The use of historical aerial photography for purposes other than mapmaking is not new. In the past, it has been used to:

- analyze coastline erosion or change over time;
- note changes in watersheds following darn construction;
- collect evidence for litigation involving land change, such as wetlands; and locate historical landmarks, such as Civil War fortifications.

When EPA's Environmental Photographic Interpretation Center (EPIC) was established in 1973 part of its charter was to develop techniques and methods for the extraction of environmental information from the historical aerial photographic libraries of other Federal agencies. At the time, many people considered historical aerial photography to be of no value in addressing environmental problems. Instead, the prevalent belief was that aerial photographs could be used to record current environmenal events such as oil spills, fires, and agricultural practices rather than uncover practices of the past. Work at EPIC has proven the value of HAP analysis as a site discovery technique.

Using Historical Aerial Photography for Site Discovery

The process of using aerial photographs to locate unknown hazardous waste disposal sites involves: 1) selecting an area of high probability; 2) acquiring a historical series of aerial photographs of the area; 3) analyzing the time series of photographs for indicators of hazardous waste activities; and 4) for any area where indicators are four@ following up the analysis with ground investigations to ascertain whether hazardous substances are present.

Areas of High Probability-For the 200 Cities project at EPIC, a number of criteria were used to select areas with the highest potential of having abandoned hazardous wastes. Criteria included: 1) knowledge of where hazardous waste had been generated through manufacturing, 2) knowledge of traditional waste disposal areas, 3) consideration of transportation methods and corridors between the 1930s and 1960s, and 4) cancer incidence rates. Four cities (one each in EPA Regions 1,2,3, and 4) were selected for the pilot project: Worcester, Massachusetts; Buffalo, New York; Charleston, West Virginia; and Chattanooga, Tennessee. They were chosen because of their population density, concentration of chemical manufacturers or users, and health data.

Selection of Photographs-A time series of photographs, usually in 4-to-5-year increments, is selected and printed **from negative transparencies.** A **current aerial photograph may have to be taken.**

Analysis of Photo Series--A photo analyst, using a backlighted table and magnifying stereo optics, scans each **transparency for indicators of hazardous waste activities,** such as ground scars, indiscriminate dumping, waste ponds, landfills, quarries, ground stains, junk yards, etc. By viewing successive years of photographs, an analyst can see changes that have occured over time and are no longer visible on the surface.

Ground Investigations--Like all discovery methods, once a suspect site is located through photo analysis, the site must be investigated on the ground. For instance, all sites placed in the CERCLIS inventory must undergo **a** Preliminary Assessment to determine if there is any evidence of an environmental problem and to assure that the site reported is not a duplicate of another one in CERCLIS. In the case of sites discovered through HAP, the same process must occur. However, HAP sites also provide information not available through other discovery methods, such as the exact location and extent of the possible contamination.

purposes. But EPA has not invoked this interpretation to explain its own lack of attention to site discovery, and there is no reason to believe that, if EPA allowed States to use CA funds for site discovery, anyone—including Congress-would be concerned.

EPA also does not allow States to use Core Program Cooperative Agreement (CPCA) funds—money that is explicitly *not* site specific-for site discovery. In this case, EPA reasoned:

> Site discovery is not eligible for funding at this time. It is OERR's [Office of Emergency and Remedial Response] opinion that all sites presently listed in CERCLIS should be addressed prior to any funding for site discovery under the CPCA.[17]

This decision by EPA was made despite admitting, in the same memorandum, that CPCAs are a result of congressional "intent to increase the scope of Cooperative Agreements. ' '[18] The congressional SARA Conference Report mentions "site inventory and assessment efforts" as a class of activity that may be included in these expanded Cooperative Agreements.[19]

The consequence of delegating site discovery and funding to States is that there are 50 different site discovery programs. According to the 1987 Booz-Allen/ EPA study:

> [State] discovery efforts have not been consistent. They range from minimal efforts with little interest for change to an active state effort based on state "Superfund" legislation, which may result in site lists larger than CERCLIS.[20]

Eighteen out of fifty States surveyed by Booz-Allen claimed to have an active, as opposed to a passive, program. Booz-Allen's review of the site **discovery** methods used by States, however, shows that passive methods predominate. Citizen complaints topped the list of methods (47 States) with referrals from other programs second (38 States). Third on the list (22 States) was some kind of survey review (e.g., a records search), which, of the three most used methods, is the only active one. Other active methods (e.g., aerial photography, property transfer regulations, and special studies) were used by less than a quarter of the States.

Comprehensive, Active Site Discovery

The existing structure for site discovery and listing of sites that may need cleanup is largely a disconnected maze. Various authorities (Federal and State) seek out sites. The degree of effort and comprehensiveness each applies to the task varies widely; each approach lies along a spectrum from passive to somewhat aggressive. Once discovered, knowledge about potential sites is handled in many

[17] U.S. Environmental Protection Agency, "Final Guidance on State Core Program Funding Cooperative Agreements,'' Directive 9375.2-01, Dec. 18, 1987, transmittal memorandum p. 3.

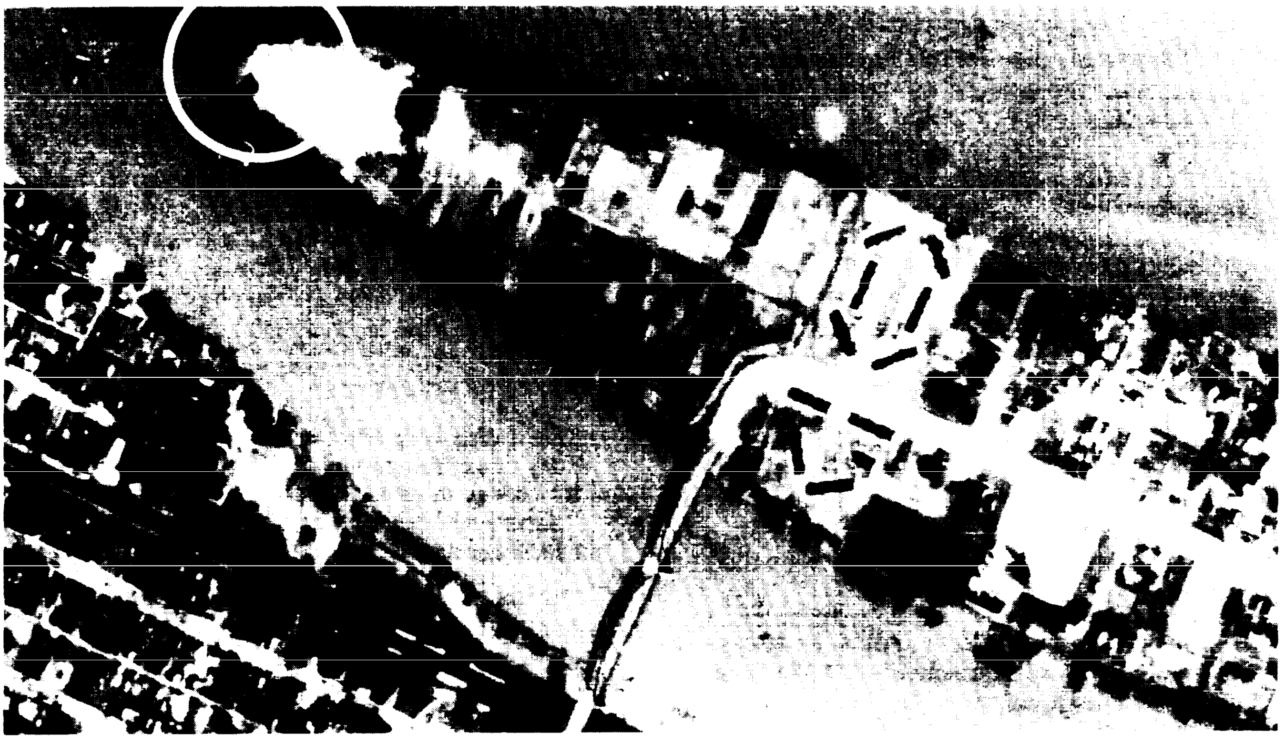
[18] Ibid., p. 1.

[19] House of Representative, Conference Report [on amendments to CERCLA], H.R. Rep. 99-962, p. 195.

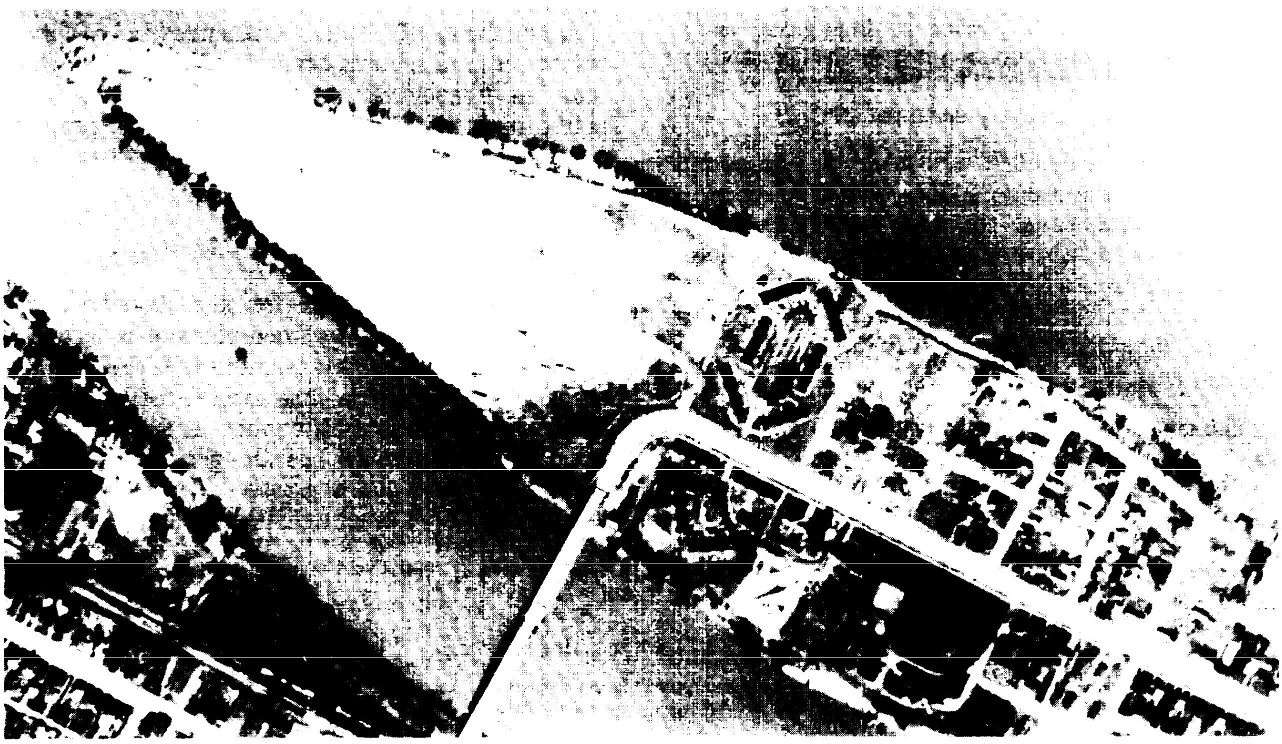
[20] U.S. Env'ironmental Protection Agency, ''CERCLA Site Discovery Program Evaluation, " op. cit., footnote 15, p. 26. OTA found in a review of many Stale programs' annual reports that site discovery efforts were rarely mentioned. The topic, thus, appears to be of little interest at the State level.

20-011 0 - 89 - 3 : QL 3

Figure 2-l--Land Disposal In the 19509 Hidden **by Land Use In the 1970s**



1948



1952

These three photographs are from a larger series of historical aerial photographs of one end of Neville Island in the Ohio River near Pittsburgh, PA. A number of chemical plants are located at the opposite end of the island. Across from t he island are industrial plants. A 1938 photograph (not included) shows that before the war the island was a large farm. Over time, land use on the island changed to a mix of residential, light and heavy industrial, and recreation.

Even viewing the photographs without the aid of a stereoscopic microscope, as is done in HAP analysis, it is possible to see activity taking place overtime t hat eventually created a need for a cleanup. In the first photograph-taken in April 1948--victory gradens from WWII still remain the dominate feature, although at the tip of the island (circled area) t he gardens have been destroyed and t he surface appears disrupted. It may indicate the beginning of land disposal. In the second photograph—April 1952—farming here has ceased and this portion of the island has become a disposal **site** for solid and liquid wastes.

By October 1973 (the third photograph), however, visual evidence of dumping has almost disappeared. Vegetation has returned to most of the area, although in the circled area **(where liquid dumping** has taken place) the soil does not support much vegetation. By 1979 the area had been donated to the local community for a park. Cabins, roads, trails, and a parking lot further obscured past waste disposal practices.

1973

ways, from entering the information into a database in a timely manner to letting the information sit in a file drawer for years. Communication among all these discovery and inventory systems ranges from nonexistent to formal handoffs. Thus, sites discovered in one system but judged not eligible may be officially turned over to another authority or may be simply ignored, even though some cleanup may appear necessary.

Often site discovery methods do not respect regulatory or legal boundaries. Historical aerial photography (HAP), for instance, discovers sites on evidence of land use over time. HAP does not necessarily distinguish between underground tanks that store a nonhazardous or hazardous material. HAP does not distinguish between a RCRA hazardous waste and a CERCLA hazardous substance. HAP also does not tell whether the private or public sector is responsible for creating a problem or whether or not the owner of the property has had a RCRA permit or not. It does, instead, provide some *environmental* evidence of a problem.

The undiscriminating nature of many site discovery methods suggests that it is better to think of site discovery not as the responsibility of Superfund or RCRA or some other program but as a national responsibility. A national site discovery program, whether solely a Federal function or in cooperation with States, could produce inventories of potential sites to feed into a variety of cleanup programs.

A comprehensive, active site discovery program will, of course, cost money. But, as discussed above, such a program can be cost-effective in the long run, and the costs seem small compared to what is routinely spent to study and clean up individual sites. From among a variety of methods used in the past to discover sites, some could be part of an active program, and existing technology can be adopted to minimize the immediate program costs. OTA has estimated, for instance, that resurrecting and re-targeting the 200 Cities plan today would cost about $100 million over a 5-year period. The cost includes detailed analysis of an estimated 7,500 found sites—part of the work now done by EPA during the preliminary assessment (PA) phase of site evaluation.

Once sites are discovered, the information found needs to be aggregated to make the necessary followup efficient and to avoid duplication by EPA and others. One solution is to develop a nationally consistent listing system or compatible ones that can be used by all cleanup authorities (see later discussion). Once sites have been evaluated as needing some cleanup, OTA has suggested (see ch. 1, option 18) that a national cleanup list be maintained.

Technical Options for Comprehensive Searches

In heavily populated areas, it may be true that obvious uncontrolled sites have been found. People have smelled them or seen them leaking.[21] To discover those sites not yet emitting odors or liquids, techniques can be applied that sweep large geographic areas and collect information about what may be occurring under the surface. Such ways include using knowledge about contaminated ground and surface waters as indicators and peeling back layers of earth through historical aerial photo analysis.[22] California has conducted studies in two counties using the contaminated water technique. EPA and others have used historical aerial photo analysis. OTA has chosen to review the latter for its potential as a cornerstone for a national site discovery program.

HAPPI: A Historical Aerial Photography Program Initiative

Despite the halt of the original EPIC pilot project to initiate the proposed 200 Cities plan in 1981, EPA and others have used historical aerial photography (HAP) to discover, verify, and characterize hazardous waste sites. The technique has not been used comprehensively for site discovery, however, Instead, various government authorities (i.e., the U.S. Army, some EPA regions, and some State governments) have used the method on an occasional basis or for special projects.

[21] Or, have followed up some intuition. This happened in Arlington, VA, in 1989 when a piece of industrial property was being reviewed fOr sale to the U.S. Navy. Testing based on suspicion proved that PCBs had been disposed on the land, presumably by a metal recycling firm that had leased the property.

[22] Remote sensing b, satellite is often thought of as another way, however, the technique has shortcomings such as poor resolution and the inability to view subsurface conditions.

OTA has evaluated some of the projects and found that most evidence suggests the technique, when properly applied, is a very useful tool. Because of past inattention and lack of follow up evaluation, a new pilot program is advisable, especially one that carries sites through at least a PA type of evaluation. Ultimately, the best use for HAP would probably be in examining areas with the highest probability of having abandoned hazardous wastes since cost prohibits and logic denies a blanket examination of the entire country. HAP is one of the few methods of site discovery that can systematically analyze a given area for unknown and abandoned sites. One analyst says, ''Historical aerial photographs may be the only source of reliable information for identifying active and inactive landfills. ' '[23] Another expert calls HAP the most ''impersonally recorded document available' for conducting inventories.[24]

Other methods tend to be biased and limited by the information used for discovery. For instance, surveys are limited by the accuracy and completeness of responses, historical document searches are limited by how well records were kept and have been maintained, and property transfer regulations are limited by the types of property (usually existing commercial or industrial) included in the regulations and only are triggered if property is sold.

Historical aerial photography analysis is limited by the extent of the availability of historical photographs and trained analysts. As long as the existing archives of aerial photographs are preserved and maintained, there does not appear to be any shortage of photographs. Trained analysts are another matter; in the initial stages of a major government program, demand could outstrip supply.

If the pilot phase had been completed before the 200 Cities plan had been canceled, a wealth of data would be available today to analyze its potential in full. Since the termination of the 200 Cities plan, EPIC has used aerial photography analysis almost exclusively (about 90 percent of its work) for site characterization for EPA's RCRA and Superfund programs. Still, site discovery work has not been totally abandoned, and OTA has based its analysis on available information. We have included in our analysis: 1) existing results from the 200 Cities project; 2) the U.S. Army's Toxics and Hazardous Materials Agency work under the Facilities Restoration Program; 3) a Monroe County, New York, project; 4) a Memphis, Tennessee, emergency response project; 5) an EPIC inventory of Love Canal, New York; and 6) several inventories conducted for EPA Regions 2, 3 and 4. Brief summaries of the projects are presented in box 2-B.

These projects show that the HAP method locates sites found through other discovery methods and adds sites to existing inventories generated through other methods. In other words, HAP **could replace many commonly used site discovery methods.** There is no information available to determine whether the HAP method generates any more or fewer false positive sites (sites that do not need to be cleaned up) than any other site discovery method. This void exists because followup on HAP has seldom been done, or, if done, records have not been kept, so that determinations of false positive rates cannot be made. Similarly, no records have been kept on the false positive rates of other methods.

Although information is available on the cost of various HAP projects, there is little cost data available on conducting site discovery through other methods, Cost comparisons should be made on the basis of the costs of discovering true hazardous waste sites. There is, however, no information available on the costs of discovering true hazardous waste sites through HAP or any other means.

Another aspect of site discovery is the time required to complete a project. A State of California project using traditional methods took 33 months to search for sites in two agricultural counties; 9 sites were located. The time and cost of the U.S. Army searches of military installations depend on the size of the installation; some have been ongoing since the early 1980s. In comparison, the duration of the 10 HAP Re-Look projects reviewed by OTA were all less than a year,

Pros and Cons of HAP—No one questions HAP's viability as a site discovery technique. Its lack of use is a consequence of site discovery being

[23] Thomas L. Erb et al., "Analysis of Landfills With Historic Airphotos, " *Photogrammetric Engineering and Remote Sensing, vol. 47, No. 9,* September 1981, p. 1364.

[24] Frank R. Wolle, formerly with EPA's Environmental Photographic Interpretation Center, personal conversation, January 1988.

Box 2-B-Historical Aerial Photography (HAP)-Project Summaries

EPA Region 3:84 sites Added to CERCLIS; Other projects Await Screening

Two of the four inventories planned by the 200 Cities pilot project were done. The HAP inventory of Buffalo, New York has not had a followup to verify the results. The inventory of Charleston, West Virginia was released to EPA Region 3 in 1983 but was not used until the Bhopal, India, chemical release incident in 1984 heightened concern about a similar plant near Charleston. Field teams then checked the 74 areas identified in the report, many of which had multiple sites. As a result of the followup, 84 sites were added to the 56 Buffalo sites already in the CERCLIS inventory. Acceding to Region 3, about 25 percent of the HAP sites required an Site Inspection (SI) and four sites may receive a listing SI. In other words, 5 percent of the 84 sites may end up on the NPL.

The value of the inventory convinced Region 3 officials to fund two more inventories (southwestern Pennsylvania and the Elizabeth River watershed). Because of resource constraints, the new inventories were not finished by EPIC until 1987. As of April 1989, Region 3 had not done the followup on the southwestern Pennsylvania inventory because it has a lower priority than getting normal preremedial work accomplished.[1]

The Elizabeth River inventory covering 1937 through 1985 turned up 650 potential problem areas. Over half were eliminated as potential Superfund sites; the scope of the inventory had been purposefully broad, including such areas as grain storage systems, gas and petroleum storage facilities, and other pollution sources that do not qualify for the program. Almost 300 potential Superfund sites have, as of April 1989, not been added to CERCLIS because the necessary field investigations have been delayed due to funding priorities.

U.S. Army Re-Look Project: HAP Equals and Betters Other Site Discovery Methods

The U.S. Army's site discovery program has evaluated hundreds of Army installations using HAP as well as methods such as exhaustive record searches and interviews with current and former employees. The Army considers its search and interview methods possible of yielding a 90 percent discovery rate because of its penchant for recordkeeping and a stable workforce.

In a program called Re-Look, the Army asked EPIC to verify the site discovery program's accuracy using HAP. In a random sample of 10 (one-third) of the Re-Look projects, HAP added 25 new sites to the Army's inventory. HAP was particularly useful in finding errors in the previous searches at large installations; at some small installations HAP found all the known sites (i.e., had an equal discovery rate). At three large installations, 23 previously unknown sites were discovered. Eleven sites were later confirmed as hazardous waste sites; others were placed in a lower priority for additional screening.

Monroe County: HAP Project Added 33 Sites to Existing Inventory

In Monroe County, New York, record searches, interviews of residents, and an advertising campaign requesting citizen reports had produced a list of 10 landfills for a RCRA inventory. In a 1981 project to test HAP as a site discovery method, nine of the 10 reported landfills were identified and 33 additional sites were found. The one landfill not found by HAP was an incorrect entry in the inventory.

Of the 42 sites, the HAP process classified 12 sites as dumps or landfills, 19 as possible dumps or landfills, and 11 as unspecified sites. After followup interviews and field inspections, 22 sites were confirmed as dumps or landfills, 11 were classified as possible dumps or landfills, and six remained unspecified. Three sites were eliminated from the inventory because they contained clean fill.

Region 4: Eight Percent of HAP Sites with Sampling Hazardous

A HAP project, initiated for emergency response planning, discovered 350 potential sites in and around Memphis, Tennessee, in 1980. Field investigation of the sites was limited to visual observations samples at 44 sites were subsequently taken, and 29 sites were found to pose some degree of hazard.

Despite some prescreening, all 350 sites were entered into CERCLIS, at least doubling the number of Tennessee sites in the inventory at that time. Since all PAs have been done for sites entered into CERCLIS prior to October 1986, PAs have been done on all the HAP sites. This set of data of sites with PAs could be used to compare the false negative/positive rate of the HAP process v. other discovery methods. Unfortunately, once in

CERCLIS the HAP sites cannot be distinguished from all other entries. And Region 4 has misplaced the EPIC map sheets with overlays so that it is not possible to separately **identify the HAP sites.**

Love Canal, New York: HAP Confirms Known Sites and *Adds 55* More Sites

As a part of the **EPA** investigation at **Love** Canal in 1980, HAP was used to verify 107 sites identified by a task force. EPIC located and confirmed 46 of the 107 sites as potential hazardous waste sites. In addition, *55* sites were discovered that the task **force has missed. Of the61 task force sites that HAP did not confirm, some were were inside buildings and thus invisible. Others HAP confirmed as negative findings by the task force.** For instance, **for one very large disposal area in the task force inventory, HAP could not find any sign from 1938 to the present that any dumping had occured.**

Regions 2 and 4: HAP Inventories Not Used

EPA Regions 2 and 4 have engaged EPIC to do nine inventories since 1981. However, no followup work has been done in the regions, so it is not possible to ascertain the accuracy of the HAP analysis. The inventories have **not been used as sources of potential sites.**

Three inventories done for Region 2 found 1,341 potential sites. **A removal action was** later taken on one site when buried drums-identified by HAP but ignored—were uncovered during subsequent housing construction. Instead of using the inventories as intended, the region considers them as a source of supplemental information on sites discovered by other means. (The New York State cleanup program, which has a site discovery project, was not aware of the availability of the inventories until OTA happened to **contact** a *State* official asking questions about its status.)

EPIC HAP analysis for Region *4* located 2,076 potential hazardous waste sites, of which 873 are sites containing liquids. OTA could not locate anyone in Region *4 with* any knowledge **of how the** inventories have been used or whether any followup has been conducted

[1]**Regional performance is assessed** on **whether or** not **targets** (i.e., numbers of **PAs** and **SIs) are met. Doing the followup on an** EPIC **inventory,** despite its **potential environmental significance, would not count. Targets are set based on** numbers of situ **already** in the **CERCLIS inventory.**

a low priority in the Superfund program and being of little concern to Congress or public interest groups.

Most of those who have used HAP to assist in site discovery work see its value; no one disputes its ability to comprehensively and efficiently survey an area and uncover valuable environmental information. The major argument against its use is its drain on resources; finding hundreds of *potential* sites in a given area means that hundreds of sites have to be checked out. But the same argument is used against active site discovery, in general. **Hundreds of potential sites will need hundreds of assessments today but assessments today can save millions of dollars tomorrow if finding truly hazardous sites sooner rather than later means that the cost of cleaning them up is minimized.** Identifying hazardous sites faster also means that protection of human health and the environment is enhanced.

The following statement is representative of several that OTA received from EPA and other officials who have used HAP. The same kind of statement could be made about any site discovery method:

> The major drawback is that historical analysis [is] only a screen tool. A completed, historical aerial photography study does not define potential CERCLA hazardous waste sites exclusively. As a result, a significant amount of follow-up work is necessary to define the true number of potential CERCLA hazardous waste sites. This additional work includes screening out obvious non-CERCLA sites, file search, mapping, cross-referencing other environmental data bases, and offsite reconnaissances. These subsequent activities are both time and resource intensive.[25]

Like all other discovery methods, the HAP method locates potential sites that may or may not be true hazardous waste sites. HAP and other methods

[25]Stephen Wassersug, director, Hazardous Waste Management Division, EPA Region 3, letter to OTA, February 1988.

will discover sites regardless of their appropriate cleanup authority. Because of the comprehensive sweep of an area that is possible using HAP and the resultant large numbers of discovered potential sites, its use may require that more resources be devoted in the field to verify sites than would be necessary with other methods. One analyst has estimated that competing the **200 Cities** project could add another 30,000 potential sites to CERCLIS, doubling the inventory. It took EPA, under current policies, 7 years to complete the PAs for 24,185 sites, a task that was accomplished only because Congress mandated **EPA to** do so by January 1988.

It is important to note that thousands of HAP discovered sites would not be added to the CERCLIS inventory overnight. They would be added over 5 to 10 years. **Under the current passive site discovery program, the inventory grows at a rate of 2,000 sites per year. An active site discovery program, using HAP and other methods, could at least double the rate of growth.** Thus, EPA could require twice as many resources as are currently devoted to preremedial work (about $50 million per year) to keep up with the discovery rate. However, some of this need for additional resources could be offset by adopting a more efficient site evaluation process (see later discussion and app. 2A).

Other drawbacks of HAP mentioned to OTA include:

- "6 . . . it is only cost effective in highly industrial areas or areas where many sites are clustered together. '[26]
- "EPA has no dedicated resources to verify critical information such as street addresses for many of these sites. ' '[27]

The first problem is resolved by carefully selecting the areas in which to use HAP, such as was done under the 200 Cities proposal. The second problem of identification is one aspect of ground proofing unique to HAP. HAP discovered sites are identified by map coordinates; sites are listed in CERCLIS by street address (and assigned code number). Today off-the-shelf commercial computer programs are available that will match coordinates (latitude/ longitude) with street addresses.[28]

Beyond its site discovery capabilities, HAP can provide additional valuable information, not available from other site discovery methods, that is pertinent in later stages of site cleanup analysis. Some of this information is available directly from the site discovery work, other information can be provided with additional photo analysis. For instance, U.S. Army documents say that, even in cases where HAP projects did not locate additional sites, "the study was very useful in confirming the existence and a real extent of various potential sites identified in the initial assessment report."[29]

One expert has classified the information about a landfill derivable from HAP as: 1) existence (i.e., the location, extent, and possible nature of a landfill), 2) general or detailed temporal land use and land cover information, and 3) physical environmental aspects (i.e., the geology, soils, and surface and subsurface drainage). The expert says,

> In general, [HAP] can provide the most efficient, complete source of information regarding the physical environment, particularly, in the absence of soil survey or surficial geology reports.[30]

The original EPIC inventory done for EPA Region 3 (as part of the aborted 200 Cities project) was later used for other projects in the Charleston, West Virginia, area. For the Kanawha Valley Integrated Environmental Management Project, the study provided spatial relationships of potential and actual hazardous waste sites and of production facilities to populated areas. In another study on concentrations of dioxin in fish, the inventory provided valuable information for developing a sampling plan of river sediments by pinpointing areas of high potential sources of contamination.

26Barbara Metzger, EPA Region 2, letter to OTA, January 1988.

27Narindar M. Kumar, EPA Region 4, letter to OTA, May 1988.

'Mapping Information Systems Corp. (MAPINFO) offers one that covers 330 metropolitan areas.

29U.S. Army Toxic and Hazardous Materials Agency, "Update of the Initial Installation Assessment of Green River Launch Complex, UT, " Nov. 12, 1987.

30Erb et al., op. cit., footnote 23.

Inventories, Lists, and Estimates

Once sites are discovered, the information needs to be put somewhere. The Superfund CERCLIS inventory is perceived as *the* national list, but it is not. The CERCLIS inventory is, more accurately, the Superfund *remedial* list. There is also the Emergency Response Notification System (ERNS), the Federal Facilities Hazardous Waste Compliance Docket, and various inventories associated with other Federal cleanup programs, such as RCRA corrective action. In addition, most States have some type of inventory; many have multiple lists. All of these inventories or lists have been created independently of one another and few are compatible with CERCLIS.

Sometimes a site is included in more than one inventory. For example, there are Leaking Underground Storage Tank (LUST), RCRA, and Federal facility sites in CERCLIS. But, not *all* RCRA, LUST, and Federal facility sites are in CERCLIS. While all known potential Federal sites are included in the Federal docket, EPA does not have, as yet, an operational RCRA correction action database and has no plans to create a national LUST inventory.

National Lists

CERCLIS was originally created by combining three separate databases (13,392 sites) in 1982 and a group of sites reported by States in 1983 that brought the total to over 15,000 sites .31 This list now grows at a steady rate of about 2,000 sites per year (see figure 1-1 in ch. 1) despite the lack of an active national discovery program or any consistency on how and when reporting occurs.

To be evaluated by the Federal Superfund program, a site is supposed to be placed in CERCLIS.[32] Actual site entry into CERCLIS is the responsibility of EPA regional offices. But, how the information flows to that point is dependent on who discovers the information and how it is reported. **There is no national criteria or guidance on the timeliness of entering a site into CERCLIS or if any prescreening should take place. The** Booz-Allen/EPA report on site discovery identified a number of States (e.g., California, Florida, Wisconsin, Ohio, West Virginia, and New Jersey) that prescreen sites prior to turning them over to EPA for placement in CERCLIS.

GAO investigations of just five States in 1985 showed that 837 sites on State lists were not in CERCLIS. By 1988, a followup report confirmed that 494 of those 837 were still not in CERCLIS.[33] States do not report all potential sites for various reasons, Some States claim that not reporting sites to CERCLIS gives them an edge in negotiating to get potentially responsible parties to clean up sites. Sometimes States do not report sites they feel will never qualify for the NPL, Florida, according to the Booz-Allen/EPA report, ''only adds sites to CERCLIS if the State believes that the site will require [a Site Inspection]."[34] California, according to the same report, only submits those sites ''it wants to address through a CERCLA cooperative agreement. '[35]

Lack of listing guidance has backfired in a way probably not intended by Congress when it mandated (through SARA in 1986) schedules for the preremedial process. EPA subsequently added a policy that all sites must have a PA within a year of entry into CERCLIS. The nature of CERCLIS as a list of all reported potential sites is changing. Sites are now sometimes held outside of CERCLIS until regions have some confidence that resources are available for a PA within a year. An example is the EPA decision to move some 3,000 potential RCRA corrective action sites through the Superfund PA/SI process. Since this move requires the entry of thousands of sites into CERCLIS, the sites are being

31CERCLIS was called ERRIS until the mid- 1980s. In the last few years, CERCLIS has become much more than simply an inventory of potential Superfund sites. It is now THE database of the Superfund program and contains the data for tracking NPL and non-NPL sites through the program.

32Conventional wisdom is that a site *has* to & in CERCLIS to move into the Superfund program. This is not necessarily true. [n 1984 EPA identified 19 California sites that had been submitted directly for HRS evaluation without having been placed in CERCLIS. [U.S. Environmental Protection Agency, "Extent of the Hazardous Release Problem and Future Funding Needs, CERCLA Section 301(a)(l)(C) Study, " December 1984, p 4-.?,) Also, in an analysis of the time it took to move a set of sites from discovery to proposal for the NPL in June 1988, OTA could not find about a dozen of the NPL sites in CERCLIS.

33U. s. General Accounting Office, *EPA's Inventory of Potential Hazardous Waste Sites Is Incomplete*, op. cit., footnote 3; and *Superfund Extent of Nation's Potential Hazardous Waste Problem Still Unknown,* op. cit., footnote 12.

34U.S. Environmental Protection Agency, ''CERCLA Site Discovery Program Evaluation, ' op. cit., footnote 15, p. 5.

35Ibid., p. 10.

phased in to relieve the pressure caused by the one-year policy. Thus, RCRA sites are being prescreened prior to entry; high priority sites were scheduled to be entered in fiscal year 1989 and medium and low priority sites in fiscal years 1990 and 1991.36 This cautious approach to CERCLIS entry appears to duplicate workload; one outcome of the PA done once a site is in CERCLIS is to give sites priority labels. In another example, an inventory of potential sites was discovered through historical aerial photography and given to EPA Region 3 in 1987. As of April 1989, the data was still being held outside of CERCLIS until it can be prescreened prior to entry. Again, the bureaucratic reason is to avoid creating a workload for which there are no resources within the required one-year timeline.

Holding sites outside of CERCLIS has several effects. From a management perspective, it helps meet SARA targets and conserves existing resources. If, however, the preremedial program has more work than it can handle, which is justified environmentally, another approach is for EPA to ask Congress for an increase in funding. Otherwise, the practice of circumventing congressional intent of speedy PAs serves to avoid rather than solve potential problems. The practice devalues CERCLIS as a timely inventory and source of knowledge of the national extent of the problem. **Delays in entry will artificially cause the growth of CERCLIS to decline, falsely implying that site discovery has peaked.**

Other Lists or Estimates

CERCLIS is the largest single Federal inventory, but it is not the only source of potential Superfund sites. Other Federal and State inventories, lists, or estimates include:

- ***Federal Facilities Hazardous Waste Compliance Docket. The*** docket lists Federal facilities or sites that may require cleanup. Reporting is required under CERCLA every 6 months. Reporting is on a facilities basis (except for sites belonging to the Department of the Interior (DOI)); each listed facility may have one, a few, or hundreds of sites. The Department of Defense's (DOD's) Rocky Mountain Arsenal, for instance, has 165 sites, As of November 1988, the last update, the docket contains 1,170 facilities; 115 sites are on the NPL.
- ***GAO Review of Civilian Agencies.*** This September 1986 report reviewed agency data and identified 1,882 potential sites (excluding some 7,000 sites believed to be DOD's responsibility). The study implies that over half of the civilian agency sites (about 1,000) will need some cleanup.[37]
- ***Individual Agency Estimates.*** Federal agencies are required to report to Congress annually (under CERCLA) on the status of their cleanup programs. Data from those reports is more recent than the GAO report data. In fiscal year 1988 reports DOD listed 8,139 sites; DOE, 1,700 sites; and DOI 254.
- ***RCRA Corrective Action.*** A formal national inventory does not yet exist. There may be anywhere from 2,000 to 5,000 RCRA sites requiring some kind of cleanup; differing estimates depend on the counting scheme. A 1989 EPA document accounts for 5,081 known RCRA facilities. Using a 1987 GAO estimate, at least one unit in 52 percent of the facilities, or 2,626 facilities, will need remediation. In November 1988, EPA estimated that 29 percent of 80,000 units in RCRA facilities, or 23,066 units, will need to be cleaned up. A unit (called a Solid Waste Management Unit in regulatory jargon) can range from a small tank to a large landfill. Another EPA document says that close to 5,000 *closing* RCRA facilities are potential sites. None of the above accounts for the thousands of municipal landfills that may require cleanup and for which there is no national listing.
- ***Mining Sites. The DOI'S*** Abandoned Mine Lands Remediation Program has not inventoried noncoal mines needing cleanup. GAO estimated in 1987 that there could be 22,339 hazardous waste sites at mines and processing facilities, over 90 percent of them located at

[36] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''Annual Report, Fiscal Year 1988. ' EPA/68-01-7X9, November 1989, p. 31. The sites scheduled for entry and PAs in fiscal year 1989 had not been entered by July 1989.

[37] U.S. General Accounting Office, *Superfund Civilian* Federal Agencies *Slow* to *Clean up Hazardous* Wrote, *GA O/RCED-87-153* (Gaithersburg, MD: U.S. General Accounting Office, July 1987).

closed or abandoned mines.[38] Of the 24 sites in the Uranium Mill Tailings remediation program, 22 have yet to be cleaned up.

- *Leaking* ***Underground Storage Tanks. The*** estimated number of potential leaking underground storage tanks ranges from 300,000 to 400,000. Discovery and development of inventories has been left to State programs. (When writing Underground Storage Tank regulations, EPA rejected a suggestion that active discovery be required.)
- ***Asbestos Abatement.*** EPA has estimated that over 44,000 public schools contain asbestos that may need attention. Between 300,000 and 700,000 public and commercial buildings have asbestos that may have to be removed. This hazardous material gets deposited primarily in municipal landfills (see ch. 4).
- State *Lists.* Many States have inventories; usually a State list (or lists) contains more sites than the number of that State's sites in CERCLIS. The results of an Association of State and Territorial Solid Waste Management Officials (ASTSWMO) survey taken in July 1986 reported a total of 31,910 confirmed and suspected sites in 45 States and Puerto Rico.[39] This number compares with 24,544 sites listed in CERCLIS, as of October 1986, for those same States and Puerto Rico. If the same State/CERCLIS ratio holds today, States have over 40,000 sites inventoried. State inventories vary widely in content (types of sites listed), in knowledge level on sites (confirmed or only suspected problems), and whether or not they include sites that are also in CERCLIS.

It does not have to be this way. New Jersey has recognized that because of multiple and incompatible lists, "the actual number of sites requiring remediation [by the State] is unknown."[40] As part of a new strategy to coordinate various State cleanup programs, a computer database-a Comprehensive Site List—has been established. Data input will be done by and be accessible to individual programs. The central database replaces individual program inventories that caused overlap or duplicate counting and collection of data.

SITE EVALUATION

Site evaluation in the Superfund program starts with a preliminary assessment (PA) and doesn't really end until a remedial investigation/feasibility study (RIFS) has been completed. (But, to some extent, site evaluation continues through remedial design and implementation, especially for complex sites,) This section reviews the conduct, status, and outcomes of *preremedial* Superfund site evaluations; the PA and site inspection (SI) stages and the use of the Hazard Ranking System (HRS) to score sites for the NPL on/off decision. Along the way from a PA to scoring, the majority of sites in CERCLIS get rejected; only 10 percent make the NPL. Those few sites, however, are not the only ones that pose threats to public health and the environment. They are also not necessarily the worst sites .41 OTA has estimated that from 240 to 2,000 sites may have missed being placed on the NFL because of false decisions made during preremedial screening.

Environmental Fulcrum Shift

The goal of preremedial site evaluation has always been—and still is—to ultimately decide which sites belong in the Superfund program. Over time, early decisionmaking has shifted from an environmental bias ("Does the site need cleanup'?' to a management bias ('Will the site qualify for the NPL?"). A site no longer moves beyond the *first* screening step unless a case can be made that it may warrant Federal attention (i.e., has a probable HRS score of at least 28.50). A PA no longer simply determines whether or not a site is a threat or not.

The shift, part of the narrowing of Superfund discussed in chapter 4, has occurred quietly without any public discussion. There **has been little public notice of the shift because the public doesn't pay much attention to preremedial activities and because public statements by EPA imply that**

38 Ibid., p. 16.

39 Association of State and Territorial Solid Waste Management Officials, "State Programs for Hazardous Waste Site Assessments and Remedial Actions," June 1987, p. 1.

40 New Jersey Department of Environmental Protection, "Case Management Strategy Manual," draft, May 1989.

41 The term *worst sites* is rarely defined. It can mean a complicated site, a site that is expensive to clean up, or one that poses high risks to the surrounding community. It could also mean a site that poses current risks as opposed to a site that only poses potential future risks.

nothing has changed. The shift may have been occurring before SARA was passed in 1986 but was certainly enhanced by congressionally mandated activity levels for site evaluation.

The management bias means that the Superfund program has fewer sites to deal with not only during the preremedial process but in all following stages of Superfund. The shift saves money for the Superfund program and makes it easier for EPA to meet targets mandated by SARA. In 1988, EPA stated:

> A key management initiative in fiscal year 1987 was a strategy designed to expedite the pre-remedial process by focusing attention **on early decisions** to ensure that fewer low priority sites reach the resource-intensive stages of the pre-remedial process [emphasis added] .42

The environmental consequence is that, as the kinds and numbers of sites rejected early by EPA grows, increasing numbers of those sites probably truly need attention. The earlier they are rejected, the less anyone will know about them. If ignored, the future costs of cleaning up those that do need cleanup will probably be greater than they would be today and, in the interim, protection of public health and the environment has been reduced.

The Superfund site evaluation process is what the health care field calls screening. Screening generates two kinds of correct (true) and incorrect (false) outcomes. True positive and true negative decisions are the desired information. But, there is always a probability of making false positive and false negative decisions. For Superfund and in a strict environmental sense, false *positive* sites are those that do not pose a threat but are judged to be threats. False *negative* sites are sites that are a threat but are judged not to be.[43] EPA worries more about whether a site is judged a problem, when it is not, than whether a site is judged not a problem, when it is. False positives mean that money is spent unnecessarily in site analysis. False negatives may cause harm to human health and the environment until sites eventually resurface for attention, and then cleanup costs will be higher. False negatives also can downplay the extent of the cleanup problem to Congress and the public by underestimating the number of sites requiring cleanup.

Screening in Superfund is done in a series: PA, SI, HRS scoring, RIFS. Series processes tend to generate more false negatives than false positives (see app. 2A). Despite this inherent bias in the Superfund process, EPA assumes that false negative outcomes are minimal. EPA **has never assessed the 8-year universe of rejects from its process to determine how well it performs, environmentally.** On the other hand, EPA has spent time and effort to assure the lowest possible numbers of false positive outcomes.

A Better Environmental Priorities Initiative

EPA's Environmental Priorities Initiative (EPI) is a minor adjustment in the Superfund site evaluation process, It is a good example of a move by EPA to integrate two cleanup programs (see ch. 4). EPI does not appear to have the environmental significance that its name implies or EPA claims, however. But, a broader initiative with true environmental focus could have.

As it now stands, EPI partially integrates the RCRA and Superfund programs by evaluating under the existing Superfund preremedial system those sites covered by either program. At a point during the SI stage, a management decision is made about whether Superfund or RCRA has responsibility for a site.

In combination with a national site discovery program, this kind of integration could encompass all cleanup programs. To regain art environmental focus, the PA would need to be returned to its original threat/no threat role and sites would be kept in the system until a case could be made that a threat *does not* exist. At the decision point, sequential decisions would be made: Is it a threat or not? If not, a site would be tagged no further action (NFA). If yes, which program has the authority to act? Then, a formal notification would send the site to the proper authority *and the* appropriate indication would be entered into the CERCLIS database so that tracking would be feasible.

42 U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Superfund Advisory," Winter 1988, p. 1.

43 If the intent is to find NPL sites, then false negatives are sites that qualify for the NPL but have been rejected.

Just where the environmental/management decision point should be assigned is a key element of a better EPI. What may be required is to throw out the PA/SI concept, to view site evaluation as a continuum rather than two distinct steps. Instead of a system that says that at a specific point sufficient information is always available to make a binary decision, a better system could be built around the principle that *when enough information is available* a decision will be made. Unlike the current Superfund evaluation process, this system would require the development and use of experts as decision-makers.

State programs, if they had sufficient resources to do so, might be inclined to make better judgments about whether a site is a threat or not. States, unlike EPA, have no one to defer sites to. If a site is a problem and does not qualify for the Superfund program, the State itself will eventually clean it up.

The Changing PA

It is primarily at the PA stage and to some degree at the SI stage where the environment-to-management shift has occurred in the Superfund program. The change has crept in with changes in the definition of a PA and its outcome and with the use of the HRS to prescore a site. That a change has occurred is obvious by the change in the language used to tag a site that is rejected during the preremedial process (see box 2-C). No longer does a PA simply say whether or not a problem potentially exists, leaving it up to the more extensive information of the SI stage to make a judgment about NPL qualification. The PA now concludes whether or not a site may qualify for the NPL. **With little change in the information available, EPA has cast the PA in a new role for which it is inappropriate.**

According to the 1982 National Contingency Plan (NCP), the PA originally was a method for the *removal program* to assess whether: 1) no threat was present at a site, 2) a threat required immediate attention, or 2) a potential threat should be turned over to the remedial program. This concept is similar to that in the medical field where a process called *triage* separates patients into three categories: no attention, immediate attention, and later attention.

Box 2-C—From NFA to NFRAP

Concurrent with the changes in the PA have been changes in the nomenclature for sites rejected by the preremedial process. The original no further action **(NFA) was changed** around *1986* to no further remedial action planned (NFRAP).

An NFA had an environmental meaning: no threat was present at the site. The current NFRAP is more a policy statement and can mean, according to **a 1988 EPA documental**

1. **sites** that never received CERCLA hazardous **substances;**
2. sites where the CERCLA hazardous substances are clearly not releasing, and have no potential to release, into the environment and *no removal action is* required;
3. sites where EPA is not legally authorized to respond to the release; and
4. sites with no reasonable potential to score 28.5 or higher upon application of the current HRS at the end of an SI.

EPA further explained in another 1988 document: "Note that the NFRAP designation does not mean that there are no environmental hazards at the site. There may be hazards but these hazards may not be of sufficient magnitude for NPL listing purposes."[2] A 1989 EPA document is more succinct; it defines NFRAP as "those sites with no reasonable potential to score above the HRS cutoff. "[3]

[1]U.S. Evironmental protection Agency, Office of Solid Waste and Emergency Response, "Preliminary Assessment Guidance, Fiscal Year 1988," directive 9345.0-01, January 1988.

[2]U.S. Environmental protection Agency, Office of Solid Waste and Emergency Response, "Pre-Remedial Strategy for Implementing SARA," directive 9345.2-01, Feb. 12, 1988, p. 5.

[3]U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Regional Pre-remedial Program Objectives for FY 89 and First Quarter of FY 90," directive 9345.242, Mar. 10, 1989, p. 3.

By 1985, the PA had become the province of the remedial program, but the triage concept remained. That year **the** NCP listed three purposes of a PA: 1) to eliminate nonthreatening sites from further consideration [no attention], 2) to determine any potential need for removal action [immediate attention], and 3) to establish priorities among sites requiring Site Inspections (SIs) [later attention].[44]

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As late as April 1987, the PA still retained the triage concept. EPA stated in a training manual then in use:

> A PA is not intended to give a full or complete picture of a site and its associated problems. A PA is by design, a relatively quick, low-cost review of relevant available data to determine whether the site potentially poses a problem and, if so, what type of follow-up work should be undertaken to further assess the site.[45]

And, in public documents, EPA said that an SI proceeded ''if a preliminary assessment turns up evidence that a site may pose a threat . . .' '[46]

Thus, the official use of the PA has been to determine whether a site needs emergency attention, whether it should move on to the second screening step (an SI), or whether it is dropped from further consideration because the site does not pose a problem. In a 1984 report to Congress, EPA defined sites rejected by the PA—no further action sites—as sites that ''pose no threat to public health or the environment, and thus warrant no further investigation or remediation. '[47] Examples of such sites are sites reported to the CERCLIS that do not actually exist, have already been identified under a different name, and demonstrably contain no hazardous substances. Dropping such narrowly defined types of sites early is environmentally appropriate and cost-effective.

Under December 1988 proposed rules for the NCP, the PA appears to be unchanged, except that, in the preamble and a section called ''Point of Clarification, ' EPA is explicit about the entire preremedial process being one to determine whether or not sites ''warrant remedial action, " The phrase ''warrant remedial action' clearly means whether or not a site qualifies for the NPL, whether it will attain an HRS score of 28.50 or greater and will not be deferred to another authority (e.g., is not a RCRA site). No longer is a *potential* threat sufficient cause to keep a site in the evaluation process. Only if a site shows evidence of a *significant* threat may it move to the SI stage of site evaluation, according to the proposed NCP.

Today's PA (and SI) appear to be the result of studies such as one done for EPA in 1987 by Ecology & Environment, Inc. The study, "Workload and Resource Requirements for Preliminary Assessments, Site Inspections, and Hazard Ranking System Evaluations Under SARA," was funded by EPA after SARA mandated EPA to meet specific target dates and objectives.[48] This document, like other similar EPA documents, does not discuss or mention the possible environmental effects of changing the preremedial process.

At the time that such internal EPA documents were changing the concept of the PA, public statements were projecting the original environmental image of a PA (and SI). EPA told Congress in 1988 that the information collected for a PA:

> . . . is then evaluated to determine whether the site has handled hazardous substances and if those substances have the **potential** to affect human health or the environment . . . If a PA indicates that there may be a release of hazardous substances that may threaten human health or the environment, EPA then recommends a site inspection (SI) to better understand the problem. On completion of the SI, if the site still poses a **potential** threat, it is scored . , . [emphasis added] .49

Compare the above "potential to affect human health or the environment' determination that keeps a site in the screening system with a March 1989 directive to EPA regional offices that says, at the end of a PA (and a screening SI), sites ' 'with no reasonable potential to score above the HRS cutoff will be rejected from the system.[50]

[45] U.S. Environmental Protection Agency, Hazardous Site Evaluation Division, ''sup-f~d PA/SI Training Course,' ' Section 1.1, undated but used *in* training sessions on Apr. 22-24, 1987.

[46] '' Steps in Cleaning Up a Superfund Site, " *EPA Journal*, January/February 1987, p. 17.

[47] U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, ''The Effectiveness of the Superfund Program—CERCLA Section 301(a)(l)(A) Study, " December 1984, p. 1-9.

[48] See SARA Sections 105 and 116.

49 U.S. Environmental protection Agency, '' Superfund Advisory, ' op. cit., footnote 42, pp. 5-6.

[50] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''Regional Pm-remedial program Objectives for Fiscal Year 1989 and First Quarter of FY90,'' directive 9345.2-02, Mar. 10, 1989, p. 3,

HRS Prescoring

The Hazard Ranking System (HRS) was designed to score a site with data collected from the SI stage of the preremedial process; the score is used to make the on/off NPL site decision. Even this documented, quality assured set of information does not (and was never intended to) fully characterize a site and the risks it poses. That occurs later during a Remedial Investigation (RI).

Now, EPA has moved the HRS up to the PA stage. The HRS is being used to *prescore* (or, estimate the HRS score for) a site when most of the available information comes from existing records. There is no site sampling done for a PA. EPA has defined two types of prescores. A *preliminary* HRS score is a minimum value; missing data is assigned a zero. A *projected* score is a possible score with missing data estimated by the evaluator. The PA guidance document says that the prescore will "be used to assign a priority to the site for an SI or to eliminate the site from CERCLA remedial activity. "[51] **Clearly, the PA has changed from being a threat/no threat decision to being a method to eliminate sites as early as possible from the Superfund program.**

To make the ruling of *significant threat* to move a site from a PA to an SI, agencies conducting the PA have been told, through the proposed NCP, that they ''may use a combination of a preliminary HRS score and best professional judgment. The latter tool—professional judgment—is, however, only to be a supplement ''to the preliminary score in making decisions about whether or not to proceed to the next phase of evaluation. "[52] EPA's *Preliminary Assessment Guidance Fiscal Year 1988* requires the use of preliminary and projected HRS scores as a basis for site decisions. **Thus, the NCP proposal is not only codifying the use of prescoring but appears to be making it more difficult than does the guidance to move a site forward.**

Adding a quantitative measure and, perhaps, professional judgment to the PA evaluation appears to be a step toward objectivity. And, EPA is designing a computer program to standardize and reduce the workload. However, the numerical outcome of the HRS--even when used after an SI—is based on subjective decisions, and because the information available at the PA stage is the poorest, the HRS prescore is most uncertain. Since the PA relies on existing information, evidence of contamination may not be uncovered without sampling, which does not occur until an SIq.[53] Confirming this, a memorandum from two EPA officials said: ''Often it is difficult at the PA stage to recommend no further action without field visits and sampling. '[54] PA data collections and evaluations are done by entry-level employees, adding uncertainty both in the application of the HRS and the use of professional judgment.

Another point is that getting HRS scores high enough to qualify for the NPL is sometimes an art. It is not an uncommon practice to recalculate HRS scores repeatedly until a sufficiently high score is obtained so that a decision can be made to proceed with formal scoring.[55] One regional official told OTA that it is "always possible" to get the crew to go back to the site and get more information to raise the score. This is an overstatement because scores from repeated attempts would eventually approach a ceiling. However, the practice points out that the

51 U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, *Preliminary Assessment Guidance Fiscal Year 1988*, Directive *9345.0-01*, January 1988, p. 14.

52 53 Federal *Register* 51394, Dec. 21, 1988, p. 51413.

53 Sampling is not always done for an SI either. An EPA Inspector General report cited several instances where sampling did not occur In one audit of State work that had not received adequate Region oversight, the [G sad, ''The most common deficiency was the failure m perform the necessary sampling during the S1 process. [U.S. Environmental Protection Agency, "Capping Report on EPA, Office of the Inspector General Audits of Superfund Cooperative Agreements for Fiscal Years 1985 through 1987, " Mar. 29, 1988.] Also an EPA contractor study found that sampling was not done and no pre-existing analytical data was available for 22 percent of 212 sites that had received SIs. [U.S. Environmental Protection Agency, "preliminary Assessment and Site Inspection Program Quality Assurance Review, " draft, Sept. 11, 1987.]

54 U.S. Environmental Protection Agency, ''Guidance on Preliminary Assessments and Site Inspections Under CERCLA, '. draft. no date, sent to the all EPA Regions on Sept. 8, 1987, by Gene Lucero (Office of Waste programs Enforcement) and Henry Longest (Office of Emergency and Remedial Response), p. 10. In the past, site visits were not an official part of a PA. Now, they *might* occur. Under the proposed NCP: "A PA shall . *include* an off-site reconnaissance as appropriate. A PA may include an on-site reconnaissance where appropriate. [53 Federal Register 51502, Dec. 21, 1988.]

55 An EPA Inspector General report dated March 1988 documents several examples. State program officials also gave OTA numerous examples of multiple sampling to finally obtain the necessary data. For instance, William De Vine, Louisiana Department of Environmental Quality, said that air was sampled numerous times at the Dutchtown site m Louisiana before a release could be documented.

aggressiveness with which information is collected and the comprehensiveness of the information affects the ultimate HRS score. Using an HRS prescore *before* most of the information is collected can prematurely bias the ultimate fate of a site.

This is not to say that prescoring does not have value during a PA. As a tool, it can help focus future data collection and sampling efforts. For example, if prescoring indicates that no information is known about contaminant migration paths, the SI can be designed to look specifically for them. EPA's contractor in Region 5 has been using prescoring expressly for this purpose since mid-1984. Prescoring can also be used as an indicator of environmental threat to help decide which sites with PAs should get SIs first,

What prescoring cannot do is make a definitive determination of the possible environmental threat of a site nor does it necessarily forecast a site's ability to make the NPL. A preliminary score, as a minimum score, can tell whether a site appears to be a significant threat, if the information is valid. **In an environmentally biased system, the default option would be to always move sites forward unless a case can be made that a site is not a threat.** That decision would require an HRS prescore that is *maximized* and still shows no threat.[56]

Focusing so narrowly and early in the process on only the data needed for HRS scoring also detracts from a positive step EPA may be trying to take and that OTA has suggested as a policy option. That is, to link the site evaluation process with the RI to avoid the current duplication of effort that occurs as sites move from the preremedial to the remedial phase of evaluation.

Two SIs and a Deferral Point

EPA now has two SIs: a screening SI (SSI) and a listing SI (LSI). The goal is to flush out Superfund false positive sites that have managed to get beyond the PA stage (i.e., have received a high or medium priority rating when in fact they will not qualify for a Superfund remedial action). From EPA's management perspective, there is no point in spending resources on collecting more data for these sites. If they need to be cleaned up, Superfund won't be doing it.

Introducing a new screening stage does provide an opportunity to find false positive sites that have gotten through the previous stage and to prevent them from moving to a more expensive stage. It also means that additional false *negative* decisions will be made because all screening stages make both types of false decisions. Under the old one-SI system, all sites that made it through the PA stage got a full SI, lessening the chances of making false negative decisions.

Now, under an SSI all sites get a ''refined" I-IRS prescore. In conducting an SSI, the ''rigorous ILSI] data quality objectives (DQOs)" do not have to be met.[57] Thus, like during the PA, the incompleteness of the data for the prescore may bias the outcome. Not having to adhere to DQOs, however, saves resources. Based primarily on the new prescore, sites with SSIs will either be rejected (get an NFRAP designation), be recommended for an LSI, or get deferred to another authority. EPA says that deferral at this point ''indicates that the site has the potential to score above the cutoff score for NPL listing but the release could be more effectively addressed by another statute or authority. "[58] For now, this is a CERCLA/RCRA decision point. However, it is designed to accommodate more extensive deferrals, if a comprehensive deferral policy is implemented (see ch. 4).

What Are the Outcomes?

Over the last few years, the budgets for site evaluation have increased some. For fiscal year 1990, EPA has requested almost $47 million to pay

[56] In one of a series of papers prepared for the Massachusetts Contingency Plan, the question of proper bias was discussed as: ''. whether the Department should assume, when little information is available, that a substantial hazard exists *or* whether it should designate a site as a priority disposal site only when available information indicates a substantial hazardous exists. [''Site Classification System, *Massachusetts Contingency Plan*, Discussion Papers, December 1987.] Note that not included is the Superfund program concept that when little information exists a site can be classified as not hazardous.

[57] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''Pre-Remedial Strategy for Implementing SARA," Directive 9345.2-01, Feb. 12, 1988, p. 8.

[58] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''Regional Pre-remedial Program Objectives for FY 89 and First Quarter of FY 90, " Directive 9345,2-02, Mar. 10, 1989, p. 5.

contractors for PAs, SIs, and HRS scoring work; in fiscal year 1987, $34 million was appropriated.[59] Still, the annual cost of site evaluation is comparable to cleaning up one large site, and taking sites from a PA to the NPL consumes only about 3 percent of the annual Superfund budget. And, the budget increases for preremedial work may not be keeping pace with an increasing effort required.[60]

At the regional offices, the internal EPA workforce in terms of numbers of full-time equivalents (FTEs) is very small. It has decreased from a high of 47 FTEs in fiscal year 1988 to 41 FTEs in fiscal years 1989 and 1990.[61] The near leveling of PA/SI funding and decrease in staffing may reflect EPA's goal to change the process to reduce the overall workload, i.e., evaluate fewer sites.

Site evaluation is not done by EPA staff. Staff supervise the work of Field Investigation Team (FIT) contractors and State government agencies, whose employees or contractors do site evaluations. EPA's FIT contracts have been held throughout the history of the program by two firms: Ecology & Environment, Inc., and NUS Corp. The current contracts run for 5 years from November 1986 to October 1991 and are valued at $154 million and $130 million, respectively.

Like the other portions of the Superfund program, the accomplishments of site evaluation are recorded as numbers of PAs, SIs, and NPL listings completed per fiscal year. These numbers are not only used to show the progress of the program to the outside world but also internally as regional performance measures. Table 2-1 shows the numbers from fiscal years 1980 through 1988.

Additionally, since SARA imposed mandatory activity levels in 1986, EPA's performance has been judged on whether or not those schedules are met. The first requirement, that PAs be completed for all sites in CERCLIS as of the date of enactment of SARA, was met on schedule by January 1988. Within that same year, however, EPA had stated that the other deadlines—all necessary SIs and HRS scores by January 1989 and October 1990-respectively, could not be met. Actually, EPA Regions 6 and 10 did complete the SIs on all their pre-SARA sites by the deadline. Those two regions had only 6 percent of the total backlog. Thus, 94 percent of the SIs were not done as required by SARA.

Congress also placed continuing pressure by saying EPA should complete all necessary HRS scores within 4 years for sites entered into CERCLIS after SARA was enacted. EPA told the House Appropriations Committee in early 1987, that it would be able to meet that goal.[62] Historically, EPA told the committee, to go from CERCLIS entry through HRS scoring may take as little as 2 years or as long as 5 years. The conclusion from an OTA analysis differs. OTA reviewed all 229 sites proposed for the NPL on June 24, 1988. The *average* time from discovery date to proposal was 5.5 years. For 54 percent of the sites it took 6 to 10 years. While for 20 percent of the sites it took 3 years to complete the process, an equal number took 8 years.

The new PA/SSI/LSI/HRS scoring screening will be more time-consuming than the old PA/SI/HRS scoring screening was. To shorten the time it takes to move a site through the process, EPA could reduce the time a site sits between stages.[63]

***The Persistent SI* Backlog—Meeting** the initial SI and HRS deadlines has been impossible due to a persistent backlog of sites awaiting SIs and an apparent unwillingness or inability on EPA's part to fund SIs at the level needed to resolve the backlog. Even if full funding were available, a question remains as to whether or not the technical expertise

59The fiscal year 1990 request is $1 million more than the estimated budget for fiscal year 1989.

60Minnesota claims that EPA's preremedial process has changed over the past several years and has become more time-consuming The effect for Minnesota is a reduction in the *number* of sites identified for placement on the NPL. [''Minnesota Pollution Control Agency's Report on the Use of the Environmental Response, Compensation and Compliance Fund During Fiscal Year 1988," November 1988, p. 4.]

61In comparison, at EPA headquarters the Site Evaluation Division of the Office of Emergency and Remedial Response (OERR) has over 30 professional positions in three branches.

62''A Report to the Committee on Appropriations, U.S. House of Representatives, on the Status of the Environmental Protection Agency's Superfund program," March 1988, Appendix I, p. 31.

63According to EPA data, the actual amount of time to do the work to complete a PA, SI, and HRS Scoring has averaged about 4 months. Thus, a site that made it through the process in the average 5.5 years sits around m the pipeline for over 5 years.

Table 2-1—Pre-Remedlal Program Accomplishments (numbers of sites)

Fiscal year:	1980	1981	1982	1983	1984	1985	1986	1987	1988
Sites in CERCLIS	8,000	10,500	13,386	16,309	18,884	22,621	25,194	27,571	29,987
PA completions'									
Fiscal year total	2,204	1,072	1,209	1,809	4,447	5,181	4,262	4,001	2,953
Cummulative total	2,204	3,276	4,485	6,294	10,741	15,922	20,184	24,185	26,913
Fraction of CERCLIS with PAs	0.276	0.312	0.335	0.386	0.569	0.704	0.801	0.877	0.897
SI completions'									
Fiscal year total	613	428	566	642	1,308	1,618	1,267	1,343	1,258
Cumulative total	613	1,041	1,607	2,249	3,557	5,175	6,442	7,785	9,048
Fraction of SIs required	0.348	0.397	0.448	0.447	0.414	0.406	0.399	0.402	0.562
Number of SIs requiredb	1,761	2,622	3,587	5,031	8,592	12,746	16,145	19,366	16,100
SI backlog[b]	1.148	1,581	1,980	2,782	5,035	7,571	9,703	11,581	7,052
Percent of sites with PAs that require SIsb c	80	80	80	80	80	80	80	80	60

aAll sites in CERCLIS must have PA; Sites with NFA after PA do not get an SI
bCalculated by OTA from EPA data in rows above
cOne explanation fort ha same, constant percent over 7 years and a reduced percent for FY88 is that the EPA numbers for SIs were generated using 80 percent FY80-87 and 60 percent in FY88.

SOURCE: Office of Technology Assessment, 1989; using EPA data.

would be available, as well.[64] The situation is compounded by the fact that EPA is already over one year behind the SARA date of April 1988 in finishing the development of the new HRS.[65] The scope of the HRS determines the data collection needs for the SI, and although sites scored prior to the availability of the new HRS do not have to be rescored using the new HRS, there will have to be a phase-in period.

Since the CERCLIS list grows at a rate of about 2,000 sites per year, EPA must complete about 2,000 PAs per year to comply with its own policy of completing PAs within one year of CERCLIS entry.[66] EPA's performance, budgets, and projections clearly show that it can complete those PAs. Historically, the program has rejected 20 percent of the sites for which PAs are completed, Thus, 80 percent of all PAs have needed SIs. To keep up, EPA should have been doing about 1,600 SIs (80 percent of 2,000) per year. Only in 1985 has this happened (see table 2-l).

So far, the program has cumulatively completed 56 percent of the SIs necessary. That rate jumped from 40 percent at the end of 1987 because of a PA reassessment conducted in 1988 during which some 3,000 sites were reclassified as not requiring SIs (see later discussion).[67] Before the reassessment, EPA had over 11,500 sites awaiting SIs; that is, almost 4,000 *more sites* awaiting SIs than had been completed in the previous **8 years** of the program!

Now, there may be over 7,000 sites in the SI backlog. And, it may start growing again because EPA's projections for SIs do not appear to take the backlog into account. For fiscal years 1989 and 1990, EPA expects to complete 1,325 SIs each year.[68] At that rate, if 1,600 SIs are required a year, EPA will be adding 275 sites to the backlog each year. If EPA is estimating that only 66 percent of sites with PAs will require SIs, the backlog will persist at the current level. Even if only 50 percent of the incoming sites per year require SIs, only 325 of the backlogged SIs could be done each year.[69] At

64The FIT contractor in Region 5 estimated in 1987 that an additional 200 technical staff (tripling their staff level at that time) would be needed to get the SIs required by SARA done in time. [Ecology & Environment, Inc., ''Analysis of and Solutions to Problems Related to the Completion of the SARA Mandated Site Inspection Goal, " Jan. 26, 1987.]

65Rules were proposed December 1988; final rules are expected in February 1990.

66Congress, through SARA, has required EPA to complete a PA petition (a citizen's request for a PA) within one year. EPA has made that one-yew rule a policy for *all* PAs.

67As table 2-1 shows, the reassessment also reduced the cumulative percentage of sites requiring SIs from 80 to 60 percent of PAs completed

68U.S. Environmental Protection Agency, ''Justification of Appropriations Estimates for Committee on Appropriations, Fiscal Year 1990, " Other, internal EPA documents show the fiscal year 1990 S1 target to be 1,250 sites.

69EPA's workload report calculated that 1,211 SIs would have to be done each year to meet SARA's requirement of 5 years. This assumes that only 60 percent of the sites with PAs—instead of the historical 80 percent-would need SIs.

that rate, it would take 21 years to eliminate the backlog.

The reality is that to eliminate the SI backlog in, say, 5 years while handling the normal flow of required SIs from the PA stage, EPA needs sufficient resources to complete about 3,000 SIs per year. Assuming that no cost efficiencies could be found in conducting SIs, doubling the number of SIs per year amounts to a doubling of the current SI funding level to over $70 million per year for 5 years.

If Not By Adding Resources, How?—Not having asked for or been given budget levels and staffing to rapidly reduce the SI backlog, EPA is trying to manage away the problem of a mismatch between the numbers of sites to evaluate and schedules imposed by Congress.[70] EPA says it has developed a strategy that "reduces the overall pre-remedial workload while increasing resources available for the highest priority sites."[71] The PA/SI process outlined in the proposed NCP is the result of this strategy. Figure 2-2 is OTA's version of the new flow for site evaluations.

The necessary program changes are, according to EPA's preremedial strategy document, to:

1. More effectively screening out sites that do not require SI through improved PA procedures.
2. Adjusting the way we conduct SIs so that we are more efficient in applying resources appropriately.
3. Increasing the resources available to do PAs, SIs, and HRS scoring packages .72

The first change, ''improved PA procedures, ' has been made by changing the criteria for rejecting sites at the PA stage, and the second change, ''adjusting . . . SIs,'' means splitting the SI into two stages. While the third change, ''increasing. . . resources," implies increased budgets (and they have been increased), according to the preremedial strategy document, EPA planned to reduce FIT contractors' overhead by 10 percent and to ''exercise future FIT [contractor levels of effort] options now' to increase available funds up to 25 percent, nationally .73 Funds were also to be made available by discouraging the use of FIT resources for non-preremedial work.

The EPA analysis assumed that the current levels of effort allowed for the PAs and SIs were appropriate and that if new work was added, the levels of effort would have to be increased.[74] However, added workload because of increased pace does not necessarily require increased resources. Efficiencies might have been found by evaluating the validity of the established levels of effort for PAs and SIs. One State official has disputed EPA's assumption of a need for increased levels of effort. A bureau chief in Iowa's Department of Natural Resources claims that his staff can complete PAs in about 40 (instead of 100) hours and SIs in 240 (instead of 400) hours. And, EPA could have searched for cost efficiencies by reconsidering the PA/SI process itself. But that option might have been foreclosed by SARA, which by establishing schedules effectively codified the existing process.

One tactic EPA has employed is a one-shot attempt at reducing the level of need for SIs. **To cut down the SI backlog, EPA had the regions retroactively apply the new PA-to-SI rules to sites that had already received PAs.** Many of those sites had been evaluated in the days when the PA decision was a threat/no threat decision. In 1987, EPA identified over 8,000 sites awaiting SIs and in a serious of documents, asked or required the regions

70According to the House Appropriations Committee report cited earlier, in one fiscal year EPA's request fOr increased funding was denied by the Office of Management and Budget.

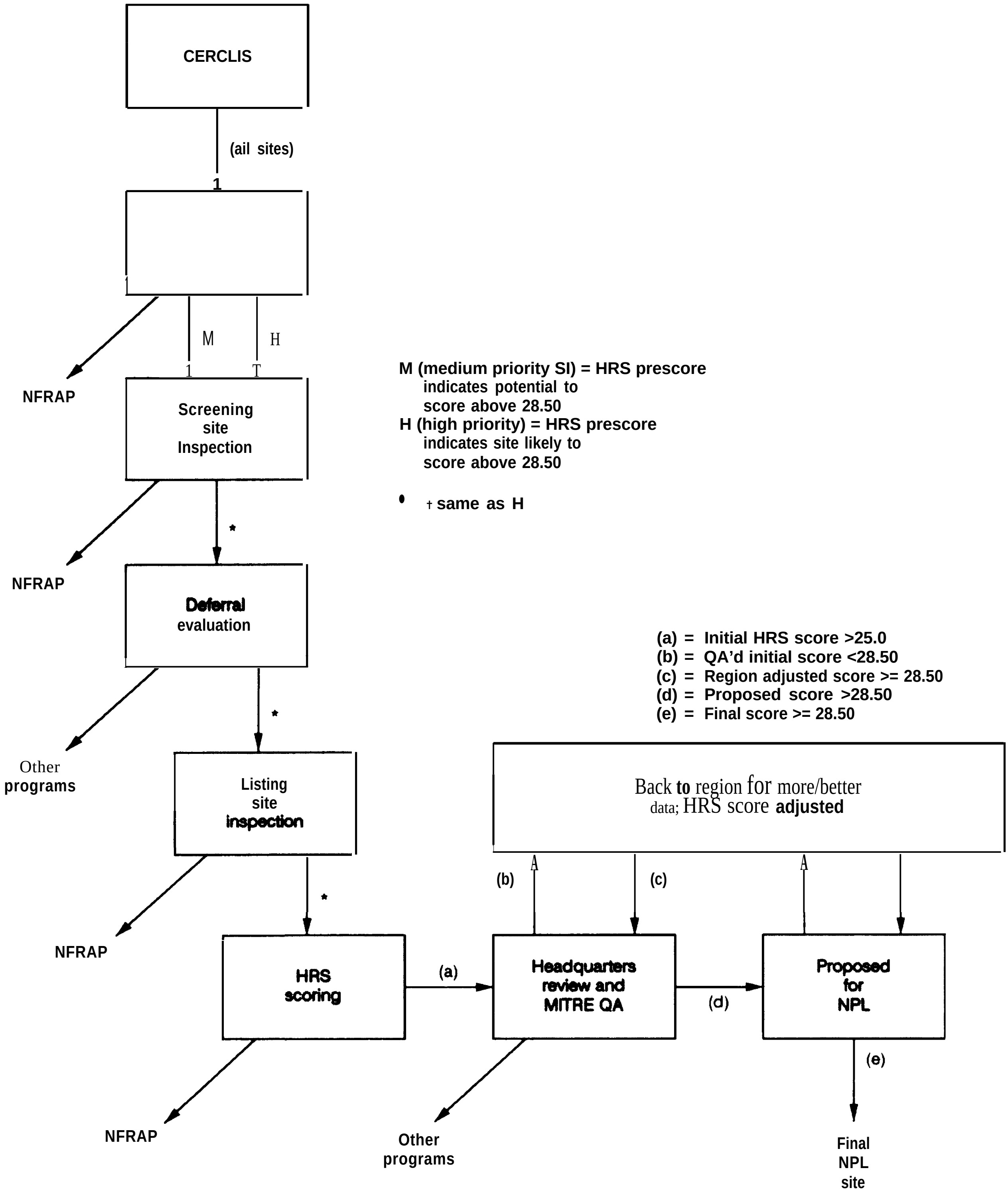
71U.S. Environmental Protection Agency, ''Pre-Remedial Strategy for Implementing SARA, " op. cit., footnote 57, p. 3.

72Ibid., p. 3.

73This Option was suggested by EPA's contract study on workload needs. Although it appears in the EPA's later preremedial strategy document, it was apparently initially rejected by EPA bemuse ''a shortage of experienced staff exists. [Ecology & Environment, inc., ''Workload and Resource Requirements for Preliminary Assessments, Site Inspections, and Hazard Ranking System Evaluations Under SARA, prepared for EPA, October 1987, p. 21.]

74It is clear from comparing the Ecology & Environment report for EPA with the preremedial strategy document that EPA relied heavily on the contractor's conclusions to make decisions about how to find the resources with the current program to increase the workload

Figure 2-2-Revised EPA Preremedial Process



NFRAP (no further remedial action planned) = sites with no reasonable potential to score above 28.50

SOURCE: Office of Technology Assesment, 1989.

to reevaluate these sites.[75] In August 1987, for instance, EPA said:

> A new criterion applies to this re-evaluation. Those sites which do not have a reasonable chance for scoring high enough to be listed should be rated as ' 'no further action This differs from the past tendency to designate ''no further action' only if there was no hazard potential. The remaining sites should be designated as "medium' or "high' priority based on their preliminary **HRS** score.[76]

In a later document, EPA said that although the 8,000 sites already had been given low, medium, and high priority ratings, they must be reassessed "against the new criteria' and given NFRAP, medium priority, or high priority .77 Regions were given the option of simply reclassifying low priority sites as NFRAP sites without any reassessment.

The reassessment was highlighted in the OSWER *Annual Report, Fiscal Year 1988* as having been necessary to ''more accurately assess the future SI workload. Out of approximately 5,000 low priority PAs re-evaluated, it was determined, said EPA, ''that no further action was necessary at approximately 3,000 sites, ' saving ''substantial resources for use at more serious sites. '[78] **What this means is that the *Superfund program* is no longer responsible for 3,000 sites. While the Superfund program may have saved 1.4 million hours of contractor time by avoiding SIs, someone else (State programs, probably) will have to spend a portion of that time and the money to discover which sites are problems.**[79]

False Negatives and Regional Comparability

With SARA, EPA was forced to review the site evaluation process. As discussed above, the reviews have all focused on how to match increased workload needs with available resources. There has been no assessment of the environmental effects of the process or how a speeded up program might affect environmental outcomes, In particular, EPA has not asked the question: How many false negative decisions are we generating?

In any screening process, some false positive and false negative decisions are unavoidable but mechanisms can be built in to minimize these errors. (See OTA's comparison of the Superfund screening process to a health care model in appendix 2A.) The EPA process in use today is biased toward finding false positives rather than false negatives for two reasons, First, false positives in any serial screening process stay in the universe being evaluated, providing further chances to find them. But false negatives are shunted out of the universe being evaluated and join true negative sites in a universe that receives little, if any, attention. Second, EPA tries to minimize false positives to save unnecessary costs to the trust fund.

No one knows the real frequency of false decisions because EPA has not kept records. But EPA apparently assumes that false *positives* exist at a level that needs to be reduced. One contractor report for EPA looked at the feasibility of spending more resources during SIs to reduce the number of false positives; the issue of false negatives was not raised.[80] In the 1987 workload report (see above), false negatives were mentioned once:

75There is an obvious discrepancy that we have not been able to resolve between EPA's 1987 backlog number of 8,000 sites and OTA's earlier calculation, based on EPA data (see table *2-1)* of over 11300 sites, as of the end of fiscal year 1987. To add to the discrepancy, EPA workload report, dated *October* 1987, said that there were 13,719 sites in CERCLIS awaiting SIs. And a 1989 EPA document says there were 7,150 backlogged SIs as of October 1988. Since this date is after the PA reassessment was completed and 3,000 sites had been eliminated, it implies that 10,150 sites, rather than 8,000 sites awaited SIs.

76U.S. Environmental Protection Agency, ''Attached Draft Pre-Remedial Strategy for Implementing SARA, ' memorandum from Stephen A. Lingle, director, Hazardous Site Evaluation Division, to Superfund Branch Chiefs, Regions I-X, Aug. 14, 1987.

77U.S. Environmental protection Agency, ''Pre-Remedial Strategy for Implementing SARA, " op. cit., footnote 57, p. 5.

78U.S. Environmental protection Agency, "Office of Solid Waste and Emergency Response, Annual Report, Fiscal Year 1988, " EPA/68-01-7256, November 1988, p. 9.

79EPA's workload report in 1987 estimated that it would take 20 hours to reassess a site PA versus 500 hours to perform an S1 for a site. Thus, if these estimates are valid. Superfund spent 100,000 hours on 5,000 reassessments and qualified 2,000 sites for SIs (which will take l million hours to do) instead of spending 2.5 million hours on SIs for all 5,000 sites. [Ecology & Environment, Inc., "Workload and Resource Requirements *for Preliminary Assessments,* Site Inspections, and Hazard Ranking System Evaluations Under SARA, ' op. cit., footnote 72, p. 19.1

80Stuart Haus (MITRE Corp.), ''~~ysls of the Impact on Superfund Program Costs of Increased Expenditures for Site inspections, draft, Oct. 28, 1986.

> It is **assumed** that the EPA Regional offices tend to err on the side of caution, and that the incidence of false-negatives is rare [emphasis added] .81

Later, in response to congressional questioning, EPA agreed that there was a statistical possibility of false negative decisions but, reiterated that they were minimized by a' 'conservative approach' to making NFA decisions. EPA further minimized the impact of errors by stating that sites are not precluded from "reentering our system if new information indicates a mistake was made" earlier.[82] This ignores the possible added costs of getting a site under control later rather than sooner.

What Is the Rate of False Negatives?

Many people working in EPA and State programs can provide anecdotal information about false negatives. OTA's comparison of a common screening model used in the health care field and Superfund's site evaluation process shows the inevitability of false decisions (see app. 2A). And, OTA's analysis of the changes in the preremedial process raises questions about the potential for making more false decisions.

While there have been no records kept on false negatives in Superfund, OTA has found some information about false negatives in EPA contractor studies. Using these studies and other information, OTA has estimated that between 240 and 2,000 false negative decisions may have been made so far (see box 2-D).

Evidence ***From*** Studies-In a paper assessing how Region 5 could meet the SARA SI goal by January 1989, EPA's FIT contractor tested the assumption that a PA conclusion is predictive of a site's ultimate HRS score.[83] The point of the exercise was not to calculate false decisions but to make a case for changing the way SI workloads were assigned. The PA conclusions (low, medium, high priorities) for 308 sites were compared with each site's eventual HRS score, The correlation was poor and indicated a problem with both false positives and false negatives. Only 30 percent of the 104 sites with a high priority rating after the PA ended up with an HRS score of at least 28.50. Viewed another way, 70 percent of high priority PAs missed the NPL; the 46 percent (48 sites) that got HRS scores of zero were clearly false positives at the PA and SI stages but were eventually caught by HRS scoring.

At the other end of the spectrum, while 57 percent of the 30 low priority PAs had HRS scores of zero, 10 percent of them received HRS scores higher than the NPL cutoff of 28.50. These sites managed to make the NPL because, for some reason, they stayed in the screening process long enough to be among the 308 sites that got scored, Under the new preremedial process, HRS prescores would eliminate them from further consideration at the PA stage. The study did not consider sites that got dropped out (NFAs) before being scored.

The same contractor stated, in another study: ''False-negatives are those sites that are erroneously classified as NFA **or** low-priority sites after the PA' [emphasis added].[84] This is simply a statement of general reality in the program at the time, that low priority sites often did not move beyond the PA stage. (EPA made this practice explicit policy by eliminating the low priority category in 1988 and, as discussed above, suggested to regions that low priority PAs when reassessed could be simply designated as NFRAP sites.)

Thus, **it is not unreasonable to assume that up to 10 percent of the sites judged as NFAs, in addition to low priority sites, might have made the NPL.** With 26,913 PAs completed through fiscal year 1988 and a historical NFA rate of 20 percent, at least 538 sites (2 percent of PAs completed) may be false negatives. This estimate would be higher if data on low priority PAs were available.

There is other evidence that some NFAs might be false negatives. A Booz-Allen contract study re-

[81] Ecology & Environment, he., ''Workload and Resource Requirements for Preliminary Assessments, Site Inspections, and Hazard Ranking System Evaluations Under SARA, " op. cit., footnote 72, p. 18.

[82] House of Representatives, ''preliminary Findings of OTA Report on Superfund,' hearing before the Subcommittee on investigations and Oversight of the Committee on Public Works and Transportation, Apr. 20, 1988, p. 270.

[83] Ecology & Environment, Inc., "Analysis of and Solution to Problems Related to the Completion of the SARA Mandated Site Inspection Goal," Jan. 26, 1987. The contractor used all HRS packages that it had completed over a 15-month period for which PA priorities were available.

[84] Ecology & Environment, Inc., ''Workload and Resource Requirements for Preliminary Assessments, Site Inspections, and Hazard Ranking System Evaluations Under SARA," op. cit., footnote 72, p. 18.

Box 2-D-How *Many False Negative Decisions?*

From 240 to 2,000 false negative site decisions may have been made so far in the Superfund program. OTA used several sources of information to arrive at these estimates. Each source covers a different set of the Superfund three-stage screening process. Each provides a different estimate. The first two estimates are based on existing studies which **used actual data from the program. The third is a model; the numbers** used are similar to the number of sites that have passed through the screening process. The fourth estimate is based on known errors caught during the *quality assurance* for assigning HRS scores to potential NPL sites.

1) A study by an EPA preremedial contractor in Region 5 covered the **PA stage only.** OTA'S extrapolation from that study gives an estimate of 538 *false negative decisions,* or **2 percent of the PAs completed** through fiscal year 1988.

2) A study done for EPA by Booz-Allen & Hamilton covered both PA and SI stages. OTA's use of that study data provides an *estimate of* 2,056 *false negative decisions* for PAs and SIs completed through fiscal year 1988.

3) An OTA comparison of the preremedial process with a health care field screening model covered all three stages (through the RIFS). The model using conservative assumptions estimates that, for 10,000 sites evaluated (of which 1,200 are problems and would qualify for the NPL), 240 *false negative decisions would be* made.

4) OTA review of two different data sets of sites with SIs moving through the HRS scoring phase of evaluation reveals an 18-20 percent error rate in calculating scores (see pp. 34-36). **EPA data implies that, through fiscal year 1988, just over 7,000 sites have received NFAs after an SI. A 5 to 10 percent error rate in underestimating preliminary HRS scores for these sites would produce 350** *to 700 false negatives. This assumes the* error rate is lower or the same for these sites. Actually, the error rate could be higher since the data can be weaker and less attention may be paid to fine tuning preliminary scorns.

viewed PA and SI files in eight EPA regions to assess how well regional work-reflected headquarters guidance.[85] In each region, a random set of PA and SI files was selected for evaluation. As part of the study, Booz-Allen checked to see if NFAs were justified by data in the files. In 406 PA files, 19 percent had NFA recommendations, and Booz-Allen concluded that 28 percent of those decisions (22 out of 79) were not supported by PA file contents. Thus, 5 **percent of the PAs completed may be false negatives.** Regionally, the percentage of possible false negatives, out of PAs completed, ranged from zero to 16 percent. Out of a total of 212 SIs reviewed, 31 percent of the 49 NFAs, or 8 **percent of the SIS completed were possible false negatives.** For SIs the range of possible false negatives across the regions was larger than that for PAs; from zero to 30 percent.

If the Booz-Allen data is extrapolated to the total numbers of Superfund PA and SI decisions, estimates of the national count of possible false negatives can be made. As of the end of fiscal year 1986, the period when the Booz-Allen study ended, EPA says it had completed 20,184 PAs and 6,442 SIs. Using the Booz-Allen rates, 1,009 PAs and515 SIs could be false negatives. Between then and now, another 556 false negative decisions may have been made for a total of 2,056 sites. This does not necessarily mean that over 2,000 sites might be added to the NPL but that 2,000 problem sites may be hidden among the universe of sites rejected by the Superfund program through fiscal year 1986. Some of them may qualify for the NPL,

Anecdotal Information-Every region, every State can provide examples of false conclusions. Anecdotes, however, are only possible when sites once judged no problem become evident as problems. In other words, until they resurface, false negative sites are unknowns. Known turnarounds include:

[85] Booz-Allen & Hamilton Inc., "U.S. Environmental Protection Agency Preliminary Assessment and Site Inspection Program Quality Assurance Review," draft, Sept. 11, 1987. The study did not include Regions 4 and 9.

- The Illinois Environmental Protection Agency provided OTA with a list of 12 sites that had been tagged after the PA with a low priority or NFA designation. Two sites (one low priority and one NFA) are now on the NPL; the balance are being cleaned up under the State program.
- In Region 8, the Martin Marietta (Denver Aerospace) site had a PA/SI completed early in the Superfund program that did not involve any sampling. Contamination was later discovered when monitoring wells were required under RCRA. After a second SI was completed, the site was proposed for the NPL in 1985 with an HRS score of 46.01.
- The California State program told OTA of a San Diego site that was evaluated using existing county information and determined to be no threat. Later, when the property was sold and construction began, an old incinerator was found and a cleanup is now required.
- In a survey prompted by SARA, EPA regional staff identified a dozen sites that they felt should be on the NPL but were not because they had not qualified.

Why Regional Differences?—The wide variance in NFA rates by EPA region, reported in various EPA documents, may indicate that regions get distinctly different kinds of sites to evaluate. The wide ranges of unsupported NFAs in the Booz-Allen study, however, indicate that it is more likely that the differences are a product of varying regional and contractor staffing problems and the fact that, until January 1988 an official PA guidance document did not exist. (The SI guidance document awaits the new HRS.) The first directive covering site evaluation was issued in February 1988, 7 years *after* the program began to evaluate sites. The consequence is that where you live may determine how many sites are being ignored.

Turnover and lack of skills, as reported in OTA's *Assessing Contractor Use in Superfund*,[86] will certainly decrease the accuracy and reproducibility of PA, SI, and HRS decisions. A MITRE official, for instance, told OTA that turnover in the EPA regions severely affects their ability to assure that properly trained employees do HRS scoring packages.[87]

For the first 8 years of Superfund, EPA regions had some direction from a State participation manual issued in 1985 and in some training manuals. FIT contracts also provide some written detail on PAs and SIs. EPA did issue PA and SI forms for use by the regions that could have provided some consistency, but not all regions used the forms and revised forms have been ignored in some cases. The Booz-Allen study found that only one of eight regions used a form on all PAs, Region 9, which was not included in the Booz-Allen study, told OTA that the FIT contractor does not use a form in reporting PAs.

Issuance of the recent documents may improve the consistency across regions or it may not. Comments made to OTA by an EPA headquarters official in the Hazardous Site Evaluation Division indicated that while headquarters would prefer all regions to conduct their work in a consistent manner, EPA is unwilling to require them to do so. Guidance documents do not assure consistency unless they are followed. Assuring national consistency may require periodic evaluations of regional performance.

Where Do False Negatives Go?—False negative sites from Superfund end up in the universe of sites rejected by the site evaluation process. The universe includes NFA (now NFRAP) sites as a result of PAs and SIs; sites rejected when their official HRS scores fall below 28.50, either before being proposed for the NPL or afterwards when MITRE Corp. does the quality assurance; and sites that EPA has decided—on a policy basis-do not belong in the Superfund program.

Since an estimated 90 percent of the sites in CERCLIS don't make the NPL, the universe of rejects is now approximately 17,000 sites. OTA has calculated (see above) that the false negatives within this universe may total over 2,000 sites. Currently, there is no easy way to track the fate of these sites. In the CERCLIS database an NFA entry indicates the site decision. In the early years, when sites were rejected primarily because no environmental threat

[86] U.S. Congress, Office of Technology Assessment, *Assessing Contractor Use in Superfund*, OTA-BP-ITE-51 (Washington, DC: U.S. Government Printing Office, January 1989).

[87] MITRE is the firm that developed the HRS and holds the contract from EPA to do the quality assurance on all HRS scoring packages completed by regional offices (see later discussion).

existed, there was no need to develop any kind of a notification system other than the CERCLIS entry. But, as EPA's own statements show, today's NFRAP is not an indication of lack of hazard. Although 1988 EPA documents tell the regions that they should notify States of sites that are rejected, there has never been, nor is there anticipated to be, a formal national notification process.[88]

In the last couple of years, States have increasingly taken on more of the task of site evaluation. When States do the PAs and SIs, they know when sites are rejected and presumably assume responsibility for those sites that are problems. But, once a site is judged NFA or NFRAP by EPA, funding by Superfund effectively dries up.[89] For the sites rejected in years prior to State involvement, any State has two choices: 1) to verify all EPA decisions (i.e., search for false negatives), or 2) to assume EPA decisions are correct and focus on the more obvious problem sites—those that have moved through the preremedial process and have at least acquired an estimated HRS score.

While State cleanup resources vary widely, they are often extremely limited. Taking the first path—reevaluation-is most unlikely. Louisiana, for instance, has 297 sites that EPA has tagged as NFAs. While the State cleanup program admits that an unknown number of those sites may require some attention, there are 209 sites yet to receive evaluation. Louisiana is a State program with few resources; a 1989 report poses the question: ''where will the necessary resources be found?"[90] Initiating 209 site evaluations for which Superfund funding is available has a higher priority than reevaluating 297 NFA sites for possible false negatives. Conversely, the New Jersey State program's strategy document states that no site should be listed as NFA ''without file documentation and sampling to justify no action."[91] This is a recognition that a State does not really have the option to defer sites away to someone else.

The HRS and the NPL

The HRS score calculated for a site determines whether or not it will go on the NPL. Being *on the NPL* (a score of 28.50 or more) means that trust fund money may be spent for remedial action. Being off *the NPL* (less than 28.50) means trust fund money cannot be spent for remedial action. The NPL also has informational significance; NPL sites receive considerably more public attention than non-NPL sites. The critical on/off decision is an EPA policy enunciated in the NCP. Congress, through SARA, expressed concern about the HRS and its use by requiring EPA to examine several questionable effects of the HRS and to revise it by October 1988 (See box 2-E).

Scoring

Once a site has received an SI, the EPA region prepares an HRS scoring package. For those sites scoring at least 25.00, the package may be submitted to EPA headquarters, which turns it over to the MITRE Corp. for quality assurance (QA).[92] If verified at 28.50 or greater the site is eligible for proposal for the NPL. Sites get returned to regions if the QA determines that the score is less than 28.50 or if the information does not support the score. Sites can also get returned to regions if EPA determines that the site does not qualify for the Superfund program (i.e., is exempt by the statute or policy).

Once formally proposed for the NPL, a site is subject to public comment, which may push the score, up or down. If adjusted below 28.50, the site is removed from the proposed list. If not, sites are eventually placed on the final list.

EPA says the HRS process currently costs an average of almost $60,000 per site, including the PA

88 A 1989 EPA document says that EPA *must* notify States when a site is given an NFRAP after a PA and *should* inform States when a site is given an NFRAP after an SS1.

89 Not officially, however, since the NCP rule is that Superfund monies cannot be used for *remedial action* at non-NPL sites. That means that, legally, States could apply for funding to continue site evacuation when EPA stops doing so.

90 Louisiana Department of Environmental Quality, *Progress and Problem: Cleaning Up Louisiana's Inactive and Abandoned Hazardous Waste Sites*, A Report to the Louisiana Legislature, April 1989, p. 1.

91 Department of Environmental Protection, "New Jersey's Case Management Strategy for Hazardous Waste Programs Remedial Actions, " June 1987.

92 Review of MITRE data indicates that only 12 sites submitted for QA since 1984 had scores less than 28.50.

Box 2-E--SARA ***and the Hazard Raking System***

In The Statute:

- **Section 105 (c)(l): ".. . assure, to the maximum extent feasible, that the hazard ranking system accurately assesses the relative degree of risk to human health and the environment posed by sites and facilities subject to m-View"**
- **Section 105 (c)(2) :"... ensure that the human health risks associated with the contaminati'on or potential contamination. . . of surface water [used for recreation or potable water consumption] are appropriately assessed. . ."**
- **Also, in Section 125,** EPA was ased to revise **the HRS to "assure appropriate consideration" of specific site characteristics of facilities that generate wastes such as fly ash, bottom ash, and slag and that emit flue gases.**

In the Conference Report, Congress asked EPA to determine:

- **the "effect of establishing a threshold value of 28.5 for facilities to be included on the [NPL]," and**
- **"whether a new threshold value should be established."** [1]

l s ~ ~~ pp. m-m.

and SI.[m] EPA pays up to $4 million per year for the MITRE **QA** services. Based on the average number of sites processed each year, QA alone may cost over $12,000 per site.

At Least 28.50!

The cutoff score of 28.50 has no technical basis. It is an arbitrary number; or, as EPA calls it, a management tool.[94] The number was selected in 1982 to come as close as possible to the 'at least 400 sites" required by CERCLA for the first list.[95] In essence, then, the hazard level of the first set of sites from which the initial 418 NPL sites came serves as the basis for inclusion on the NPL of all sites that have followed. If the hazard level of that collection had been lower, then some sites subsequently rejected for the NPL would be on the NPL.

The cutoff score is often reported as 28.5 instead of its real value: 28.50. The zero plays a major role and implies a certain numerical precision even though there is no possible technical rationale for taking the number to the hundredths, or even tenths.[96] Using two decimal places means that a site with a score between 28.45 and 28.49 does not get rounded up to 28.5 and get on the NPL.

EPA is aware of the HRS score's lack of precision but has not used that information to convert the cutoff *score* to a whole number or a range. In a study prepared after SARA, EPA commented: "because of the uncertainties associated with the HRS, it is possible that a site scoring 35, for example, is more hazardous in terms of absolute risk than a site scoring 36."[97] If so, then there maybe no difference between a site at 29 and one at 28. Furthermore, EPA groups the sites on the NPL instead of listing them by HRS score ''to emphasize that minor differences in scores do not necessarily indicate significantly different levels of risk. "[98]

Once calculated, the HRS score does not serve any official function other than to make the NPL decision. EPA repeatedly states that the HRS only measures relative risk and that the score is not used as a way of making priority cleanup decisions. However, OTA showed in its 1985 report, *Superfund Strategy,* that, even if the method works, the resultant score is **not** a measure of relative risk

93 53 Federal Register 51%2, Dec. 23, 1988.

94 In a Report to Congress, EPA stated that the cutoff score was not chosen because ''. . . it represents any threshold in the significance of the risks presented by sites. " [U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Progress *Toward Implementing Superfund, Fiscal Year 1987, Report to Congress,* EPA 540/8 -89/003, April 1989, p. 27.]

95 EPA had a list sites that had been scored. Using *28.50 as the* cutoff score generated a proposed list Of418 sites.

96 Any mathematician, scientist, or engineer knows that the solution to any calculation can only carried to as many decimal places as the least accurate number for any data used in the calculation. Many numbers used in the HRS calculation are whole numbers, i.e., 3 or 5.

97 U.S. Environmental Protection Agency, ''HRS Revisions Support: SARA Studies on HRS Scores and Remedial Actions, HRS Scores and Potential Dangers, and the Effect of the 28.5 Cutoff Score," November 1987, p. 9.

98 53 Federal Register 51962, Dec. 23, 1988, p. 5 IQ&$. Each group has 50 sites; each time new sites are added to the NPL, the sites are reordered into new groups of 50.

because not all sites receive complete scores.[99] HRS scores are a combination of three possible routes of exposure--groundwater, surface water, and air. Air subscores are frequently not calculated if the two water routes or even one of them provides enough information to push a site score over 28.50.

For this report, OTA reviewed the sites submitted to MITRE for QA since 1984. Ninety-four percent of sites were submitted without air subscores and 97 percent of the sites with final HRS scores did not have air subscores. Conversely, 98 percent of the final sites *do have* groundwater subscores. Thus, the resultant HRS score says, at the most, something about the relative risks of sites due to contaminated groundwater.

It is true, however, that the HRS score does not set priorities.[100] Higher ranking **sites do** not necessarily **move through the system first or faster.** On the whole, there is no discernible relationship between a site's HRS score and, say, the start of its RIFS. It is, in fact, possible to find cases where an inverse relationship exists, such as occurred with three sites Region 7 proposed for the NPL in April 1985.

Despite its lack of technical foundation and usefulness after the fact, the cutoff score has taken on serious meaning within the context of its use. Regions, States, public interest groups, industry, and others are at times keenly interested in making sure that a particular site gets on the list or stays off. States with few resources or without an enforcement program to clean up sites on their own may prefer to have as many sites as possible on the NPL so that they only have to pay the CERCLA 10 percent match rather than the full cost of cleanup. Some States, like California, make decisions in advance about whether or not they want a site on the NPL and in the Superfund program. If not, they intentionally keep sites off the CERCLIS, which eliminates them from consideration and scoring, Having a site on the NPL projects a negative image to the public, and a company may have a strong interest in not having its property listed.[101] Communities have been known to press to keep a site off the list because of the stigma and possible negative affect on their economic welfare. Congress can intervene; through SARA the Silver Creek Tailings site in Park City, Utah, was effectively removed from the proposed list.[102]

This jostling to be on or off the NPL position adds inefficiency to and detracts from Superfund's environmental role. As discussed previously, **calculating an HRS score is not a science.** When scores are close to the cutoff, it is not uncommon for regional offices or State agencies to seek out more information to move the score above the cutoff. A Kansas State official, who was formerly with the New Jersey State program, told OTA that he got 65 sites on the NPL by *sampling judicious).*[103] There is no way to calculate the national costs of pushing sites over 28.50, because the data to do so is spread among files in 50 States and 10 regional offices. It could be significant if each entity spends extra money and time on just a few sites each year.

Because the setting of an HRS score on a site has been made a regulatory procedure, the score must be proposed for public comment. This can cause reworking of the number and has led to an official change of at least 224 site scores. Twenty-three of those sites were removed from the proposed list because their revised score was below 28.50. For 66 of the 224 (30 percent), the difference between the proposed and revised scores was less than 1 point and ranged from 0.01 to 0.99, up or down. In none of these cases did the reworked score affect the site's NPL status. Obviously, the level of effort required to rework scores varies, but EPA was unable to give

[99] U.S. Congress, Office of Technology Assessment, *Superfund Strategy,* OTA-ITE-252 (Springfield, VA: National Technical Information Service, April 1985), p. 163.

[100] In California it does: ''. . cleanup priorities are now generally established based on the HRS migration score . . .' [California State Department of Health Services, *Expenditure Plan for the Hazardous Substance Cleanup Bond Act of 1984,* revised January 1988, p. 51.] In Louisiana, priorities are based on whether or not a PRP exists. In Minnesota, sites in the cleanup pipeline have precedence over sites that have not yet started the process.

[101] Not being listed does not prohibit EPA from taking CERCLA enforcement action, however.

[102] SARA, Section 118(p) See also, ''Selection for Superfund List Puts Utah Resort in Dumps: As EPA Reconsiders, Property Values Plunge, " *Washington Post, Mar. 2,* 1987, p. A1.

[103] Or, as a New Jersey document states: ''Since the criteria for placement (HRS) was relatively undefined, NPL placement was easily accomplished. [Department of Environmental Protection, "New Jersey's Case Management Strategy for Hazardous Waste Programs Remedial Actions, " June 1987.]

OTA a rough estimate of the cost and staff time (for either EPA or MITRE).[104]

What Are the Results?

So far, almost **2,000** sites have gone through the HRS scoring QA system. As of July 1989, 1,274 sites have been proposed for the NPL. Accounting for removals and deletions from the list, the NPL stands at 1,224 proposed and final sites. Figure 2-3 shows NPL actions by EPA from fiscal year 1983 through 11 months of fiscal year 1989.

CERCLA requires EPA to update the NPL at least once a year. Since 1983 there has been at least one update a year for the proposed or final list.[105] In addition, at irregular intervals sites have been removed (from the proposed list) or deleted (from the final list). NPL removals are part of the HRS scoring process, while deletions occur after remedial actions have been completed. Deletions can also happen because the Remedial Investigation/ Feasibility Study (RIFS) shows that no remedial action is necessary.

There are a number of aspects of HRS scoring that deserve some attention. The managerial significance but questionable relevance of the cutoff score has already been discussed. Another aspect is the reworking of scores. This is driven by the cutoff score and the need to calculate THE score for a site. MITRE checks the region's work before a site is proposed and then, as discussed above, scores can be altered between proposed and final listings. When a score is revised, it is because some kind of error has occurred. It could be caused by poor math, improper use of the HRS, or inaccurate or incomplete information. While the two revision points catch those errors, examination of some data raises questions about why regional work varies so much and what the errors and the variances mean regarding sites that do not make it to the first or second revision point.

The difference between the number of sites submitted for QA (1,970) and sites proposed (1,223) through early 1989 says that almost 40 percent of the sites submitted by regions have not been proposed. Some were rejected for policy reasons. Some have not yet been verified. These two categories may represent up to half of the nonproposed sites.[106] Then, almost 400 of the submitted sites may have been rejected because of errors in the regional offices. QA determined that their scores were below 28.50 or there was not proper documentation backup. **If 20 percent of the submitted sites have errors, for how many sites that do not get submitted (i.e., judged NFRAP after an SI or PA) are errors made?** Remember that there is less documentation for and attention paid to these sites for which HRS scores are only estimated.

The fact that the 224 scores discussed earlier could be changed between proposed and final listings is indicative of the lack of precision to an HRS score. More information and reevaluated information can change an HRS score, up or down, by as little as 0.01 and as much as 31.57 points. In terms of the on/off NPL decision, all of these errors are significant since 0.01 can make the difference between 28.49 (off the NPL) and 28.50 (on the NPL). From a risk perspective, however, because 79 percent of the errors are between 0.01 and 10.0, the errors may be insignificant. Should the Superfund program be spending money looking for and adjusting site scores, especially when they have no relevance afterwards?

While the 224 changes represent a national error rate of 18 percent in proposed scores, the rate ranges from 8 to 37 percent by region. Nationally, most of the errors (54 percent) are on the plus side (i.e., the proposed score is higher than the final score), but they range from 37 to 66 percent on a regional basis.[107] Four regions have higher minus than plus

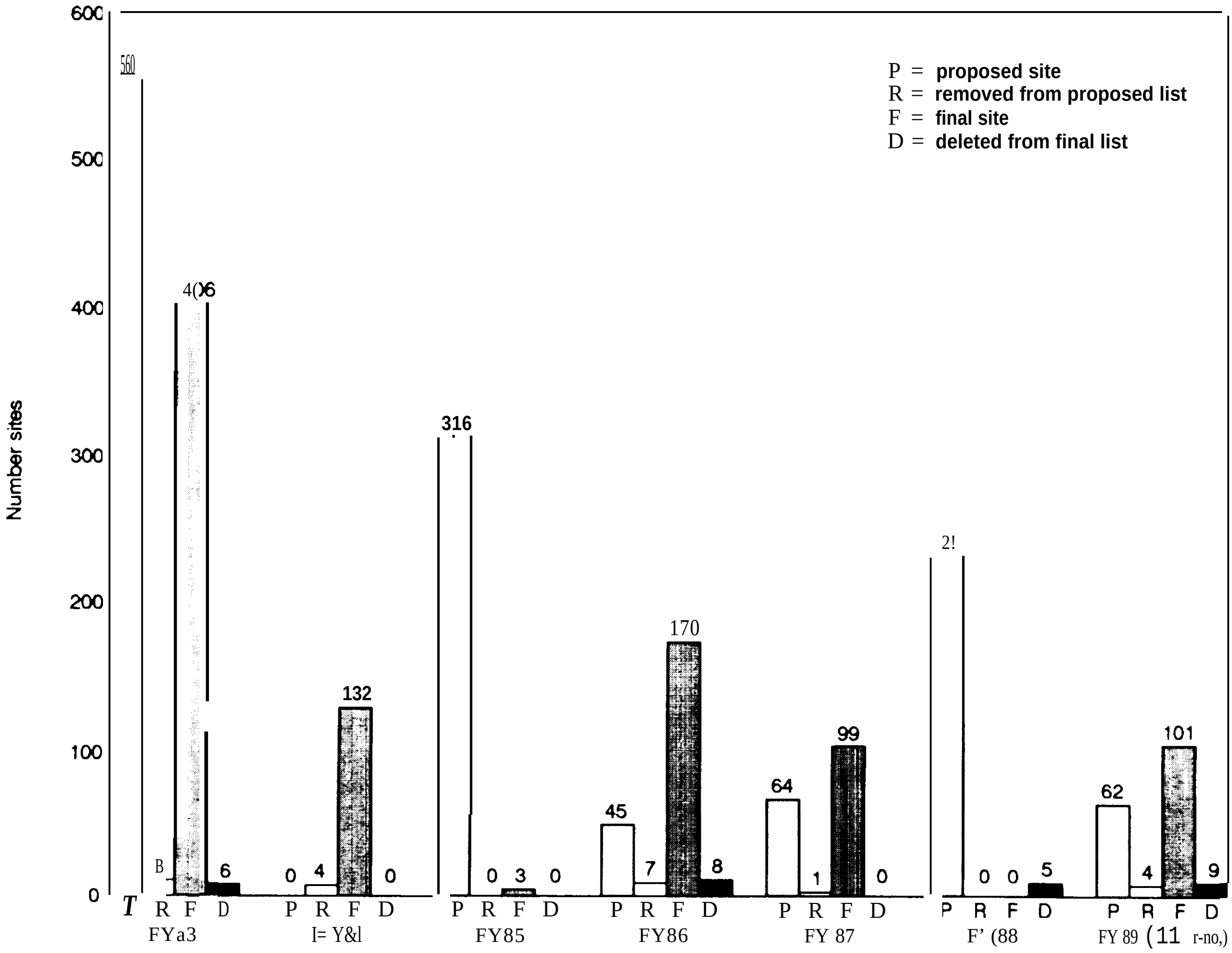
[104] EPA did provide OTA with detail on five score revisions. Obviously, the amount of time and resources necessary to respond to public comments is proportional to the complexity of the comments rather than to the eventual score change. Of *the five* scores, two were each changed 0.01 points (one went up, the other down) because of rounding errors discovered while considering comments. The other three were revised (maximum, 0.14 points) because of comments received regarding the surface water subscores.

[105] The proposed listing may be more important than a final listing. EPA does not necessarily wait until a site gains final status to start the RIFS or the search for PRPs.

[106] This is a *very* conservative estimate. For instance, less than 4 percent of the sites submitted for QA in 1988 and 1989 still wait to be proposed.

[107] This national trend for overestimating scores may be confirmed by MITRE data on all initial (ss submitted by regions for QA), proposed, and final site scores. On average, as sites move through the QA process, they systematically decline. It may be, however, that score depression is a product of the QA process, rather than regional tendencies to overestimate initial scores, especially since score depression occurs between proposed and final scores *aim*.

Figure 2-3-National Priorities List Actions, Fiscal Years 1983-89



NOTE: Shading indicates that more than one update occurred in a fiscal year.

SOURCE: Office of Technology Assessment, 1989; based on EPA data.

error rates which means they are more likely to underestimate HRS scores. Finally, **if 18 percent of proposed scores are in error, that strongly suggests a significant error rate on sites that don't make it that far.**

False Negatives and False Positives

The error rates discussed above suggest that false decisions (both positive and negative) can persist through the HRS scoring stage. EPA does not know how many false negatives scoring has created in 7 years of use but does know for sure that at least three false positives exist because three sites have been deleted from the NPL after an RIFS was completed.[108] While EPA is "concerned that lowering the [cutoff score] might substantially increase the number of [false positives] . . .," the agency has not expressed a corresponding concern about false negatives.

108 53 F-dRe@~r51962, Dec. 23, 1988, p. 519M, There may be more than three false positives. OTA reviewed all RODs issued in the program. At least nine sites have been deleted because no remedial action was recommended in the ROD.

EPA's Science Advisory Board (SAB) assumes both types of false decisions have been made and has suggested that EPA establish a review process:

> Screening models like the HRS must be simple. They do not have much resolving power and therefore, some false positives and false negatives are inevitable. Because of this limitation, HRS scorns should not be overemphasized. A process should be established either to review sites subject to scoring or to review HRS scores in an attempt to spot fake positives and negatives.[109]

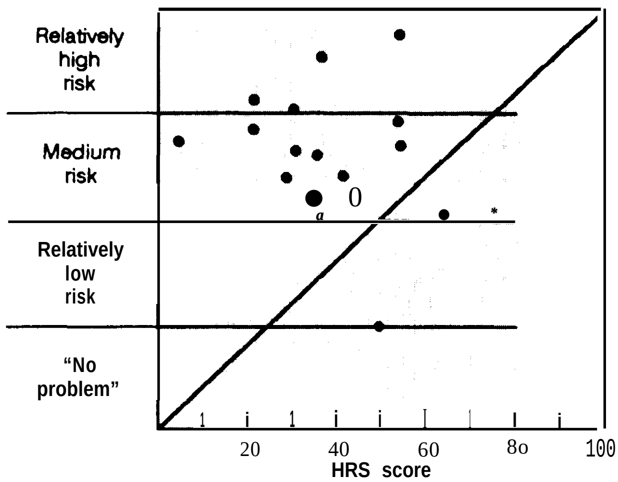
Some studies and certain aspects of the HRS point to the possibility of false decisions. In one study, EPA compared current HRS scores with potential dangers at 32 sites using a risk assessment methodology. The results showed poor correlation between the HRS score and the potential danger at a site. The study concluded:

> Based on the sites used in this study, potential false-negative results (sites that pose potentially significant risks, but receive HRS scores below the cutoff) are more common than false-positive results (sites that receive HRS scores above the cutoff, but do not pose potentially significant risks). *10

For another study, EPA's Office of Policy Planning and Evaluation (OPPE) assembled a panel of EPA experts from the various disciplines involved in site evaluation. The panel studied documentation on a set of Superfund sites, developed its own ranking methodology, and scored the sites by consensus along a spectrum from high risk to no problem.[111]

When the panel's ranking of sites is compared with the sites' HRS scores, the HRS is shown not only to be a poor predictor of risk-as judged by experts-but also to be source of many false negative decisions, As figure 2-4 shows, 6 of 18 sites (33 percent) with scores at or below the cutoff were judged by the panel as medium or high risk. Another conclusion is that the HRS underestimates risk as most of the panel's decisions placed the sites above the diagonal line that represents concurrence between the panel and the HRS.

Figure 2-4-EPA Panel's Ranking of Sites v. HRS score



SOURCE: Environmental Protection Agency.

On the NPL are three examples of the HRS as a poor predictor of risk. Under CERCLA, each State is allowed to place one site on the NPL regardless of how it scores. Three such sites, with scores of 5.49, 8.27, and 17.68, have moved through the system and received RIFSs, and RODS have been issued. In all three cases, EPA has decided that a remedial action is necessary. If the sites did not present a risk, EPA could have decided that no action was necessary and deleted them from the NPL. While the cost of cleaning up these sites ranges from $1 to $2 million and is below the average for Superfund sites, the sites are not dissimilar to many sites that qualify for the NPL on the basis of higher scores.

Two other problems with the current HRS, which may be corrected by the pending new HRS, are also creating false negatives. When there is not enough information to assign a number to a factor, a default

109U.S. Environmental Protection Agency, Office of the Administrator, Science Advisory Board, 'Review of t-be Superfund Hazard Ranking System,' ' SAB-EC-88-008, January 1988, p. 6.

110U.S. Environmental Protection Agency, ''HIM Revisions Support: SARA Studies on HRS Scores and Remedial Actions, HRS Scores and Potential Dangers, and the Effect of the 28.5 Cutoff Score," op. cit., footnote 97, p. 50.

111Applied Decision Analysis, Inc., "A Site-Ranking Panel Evaluation of the Relative Risk Posed by Twenty Superfund Sites, " draft, July 14, 1987, pp. 44-45.

value has been used.112 In 1982, EPA advised scorers to assign a default value of zero, [113] The result for toxicity is, according to an EPA scientist:

> A default value of zero would enhance the possibility of false negatives in the absence of toxicity data, while a default value of 5 would tend to enhance the possibility of false positives, A mid-range default value of 3 in the absence of appropriate toxicity information would reduce any directional bias toward either false positives or false negatives.[114]

In the proposed HRS, some default values have been adjusted. For example, a default value of 3 (a midpoint in the toxicity scale) has been proposed for a pathway's toxicity factor value when 'appropriate toxicity data for scoring does not exist for any hazardous substance relevant to that pathway .''[115]

Under the current HRS, when a site appears to have only a direct contact threat, the site will not make the NPL.[116] But, two EPA contractor studies have shown that a threat of direct contact is a major rationale for remedial action. EPA has in the past added two sites to the NPL, using provisions in CERCLA other than the HRS, when their scores were below the cutoff, because of their direct contact threat. [117] If direct contact is added as a new pathway in the proposed HRS, these kinds of sites may have a better chance of being on the NPL. However, among the universe of sites scored under the current HRS, they are false negatives. Some, but not necessarily all, may have been cleaned up by removal actions.

How Will the New HRS Change Superfund?

Many concerns had been raised about the efficacy and fairness of the HRS. Box 2-E lists the concerns expressed by Congress in SARA. A summary of major problems with the HRS from OTA's *Superfund Strategy* are included in box 2-F. Box 2-G contains a summary of recommendations made by EPA's Science Advisory Board (SBA).

Has EPA Resolved the Concerns ?-For this report, OTA could not do a comprehensive analysis of the new HRS because the new HRS does not yet exist. EPA proposed the new HRS in December 1988 but does not plan final action on the rules until February 1990 (almost 2 years beyond the promulgation date that SARA specified).[118] And, so far, EPA has not tackled a major issue—the algorithm—cited by the SAB:

> The Subcommittee places special emphasis on the algorithm issue because it is impossible to review the components of the HRS without considering how the components fit together.[119]

In the proposed rules, EPA recognized SAB's concern and said about suggested changes:

> EPA is planning to evaluate and possibly test such changes in the algorithm prior to promulgating a revised FIRS,[120]

The SAB was concerned about the algorithm because it is the basic logic of the model. The board implied that the way the current HRS was designed may have been a backwards approach. A better way, according to the SAB, is a risk assessment approach that begins with an understanding of how to list sites quantitatively if all needed information and resources were available. This risk assessment model is then transformed into a scoring system and simplified to operate at reasonable cost and with sparse information. [121]

Despite outside concern and advice, EPA has postponed consideration of the basic logic of the

112A factor in the HRS is a point at which a number is assigned based on the judgment of the person doing the scoring package. For instance, a factor could translate toxicity data mto a numerical value for calculation purposes.

11347 Federal Register 31222, July 16, 1982.

114Chris &Row, chief, EPA's Chemical Mixtures Assessment Branch, letter to Scott Parrish, acting chief, Hazard Ranking and Listing Branch, Sept. 22, 1987.

115U.S. Environmental Protection Agency, preamble to the HRS proposed rule, draft, ca. February 1988, p. 40.

116A direct contract threat means that a person could come into direct contact with toxic substances at the site.

117The sites and scores are Landsdowne Radiation site, PA (20.32) and Quail Run, MO (21.19).

118SARA Section 105(c)(1) required the new HRS to be promulgated by April 1988 and to be in effect by October 1988.

119U.S. Environmental Protection Agency, "Review of the Superfund Hazard Ranking System, " op. cit., footnote 109, p. 5.

12053 Federal Register 51%2, Dec. 23, 1988. p. 51970.

121See, U.S. Environmental Protection Agency, "Review of the Superfund Hazard Ranking System, " op. cit., footnote 109, Appendix A5.

Box 2-F—The Office of Technology Assessment's 1985 Comments on the Hazard Ranking System[1]

OTA summarized other criticisms of the HRS at that time. Problems identified were that the HRS:

- had a bias toward human exposure at the expense of the environment
- had a bias against low density populations;
- required documentation for air releases but none for water;
- scores were based on site contaminantt rather than known or potential released contaminants;
- averaged route scores creating a bias against a site with only one route score greater than zero; and
- considered only waste quantity rather than quantity and distribution.

[1] U.S. Congress, Office of Technology Assessment, *Superfund Strategy*, OTA-ITE-252 (Springfield, VA: National Technical Information Service, April 19ss).

Box 2-G-Summary of EPA's Science Advisory Board Hazard Ranking System Recommendations

When the Superfund program requested the Science Advisory Board (SAB) to review the HRS, only three specific issues were posed: types of toxicity to address and how, relevant distance from a site for air pollutants, and large volume wastes and waste concentrations. On these issues, SAB recommended that:

1. the toxicity rating scale in use be replaced by multiple measures of toxicity and exposure measures to be improved;
2. since a potential for air release seemed appropriate and possible, a scoring system weighing population exposure in concentric rings be employed; and
3. although applying the HRS to mining (large volume) sites has not treated them with systematic error, it does have the potential to do so and could be improved with the adoption of several factors.

But, the SAB subcommittee that studied the HRS chose to also address some fundamental issues. For instance, the SAB said: "Improving the algorithm could potentially do more to improve the HRS than fine-tuning individual Components."[1]

[1] U.S. Environmental Protection Agency, Science Advisory Board, "Review of the Superfund Hazard Ranking System," SAB-EC-88-008, January 1988, p. 20.

HRS. Meanwhile, the proposed HRS is replete with the "fine tuning" that the SAB thought to be less important than the algorithm. These changes apparently will result in "vast new data requirements' that also concerned SAB. **EPA says that the new HRS will cost almost $150,000 per site; that is, two and a half times ($90,000 more than) the current HRS costs.** EPA expects the new HRS to add $56 million in total costs to the program.[122]

EPA says it **"expects** that the changes will result in increased accuracy in assessing the relative degree of risks to public health and the environment **for certain sites** [emphasis added].''[123] EPA also says that "at this point, it is impossible to predict whether the revised HRS would result in more or fewer sites being included on the NPL. " Unanswered is Congress' concern that the HRS *accurately as* possible assess the relative degree of risk posed by sites.

EPA did not, according to the SAB, properly assess the current HRS prior to proceeding with changes. Also, EPA has apparently not tested the proposed HRS to assess its impact (other than cost of using it). EPA's request of the SAB was made after an advance notice of a proposed rule on the HRS had been published (April 1987) and public comments received. That is, the process of revising the HRS was well underway at the time of SAB's involvement. Thus, SAB made suggestions about how to better proceed with the next revision. On the top of its list was the need for an ''empirical retrospective evaluation of how successfully the FIRS predicts risk . . . based on an in-depth technical review."[124] What SAB had in mind was a review comparing sites' HRS scores with the knowledge gained as a result of their RIFSs. In other words,

[122] 53 Federal Register 51%2, Dec. 23, 1988, p. 52002.

[123] Ibid., p. 51966.

[124] U.S. Environmental Protection Agency, "Review of the Superfund Hazard Ranking System, " op. cit., footnote 109, p. A6-1.

EPA should ask the question "How does it err in practice?" before trying to fix it.

The copious proposed changes in the kinds of data used and how used to calculate an HRS score have been backed up with a plethora of contractor studies. But, the algorithm remains the same and there has been no analysis of the *combined affect* of the changes. The debate will continue as to whether or not the HRS can provide an appropriate or accurate measure of relative risk among sites. As the SAB said:

> Each step in this process affects the final score and, therefore, how well the HRS discriminates between sites of greater and lesser risk to human health and the environment. {x

As to the steps, EPA appears to have adopted some of the SAB's recommendations regarding toxicity, air releases, large volume sites, and waste concentrations. The proposed HRS has four instead of three pathways: surface water, groundwater, air, and onsite exposure. The new onsite (or direct contact) pathway may improve one shortcoming of the current HRS, as discussed earlier. Currently, direct contact is only used to determine whether or not a site needs a removal action.

In the HRS, current and proposed, each pathway is made up of three categories (release, waste characteristics, and targets) and each category has a number of factors. As described by the SAB:

> After a numerical value is assigned to each factor, it is multiplied by a weight to obtain a factor score. Factor scores within the same category are added. Scores for the categories are multiplied together. This procedure yields a score for the pathway. The pathways are then combined through a method called quadratic averaging. [126]

Most of the fine tuning of the HRS has involved changing factors or how to obtain the numerical value assigned. The structure of the groundwater and air migration pathways are unchanged although some of the factors of the three categories have been changed. A mobility factor has been added to both pathways to account for exposure. Potential releases are now calculated for the air pathway, and the distance to sensitive environments has been increased. The surface water pathway has been substantially expanded and now consists of four threats: drinking water, human food chain, recreational, and environmental. Under food chain, bioaccumulation and fishery use are considered for the first time.[127]

A New Cutoff?--In response to congressional concerns about the cutoff score, EPA says that a study did ''indicate that **some sites** with scores below the cutoff can also pose potential dangers to human health and the environment' [emphasis added].[128] This is in contrast to EPA's stronger statement in 1984 to Congress: **"Many** of the sites that score below the 28.5 HRS cutoff still pose some threat to human health" [emphasis added],[129]

Review of State programs yields information that "some sites' is a major understatement. In **reality, many sites with scores well below the cutoff do pose current or potential dangers.** For instance, Minnesota uses the HRS to score all sites, whether for the Superfund program or its own program. The scores for 118 sites in the State program run from 2 to 51.130 Illinois also uses the HRS to score all sites; sites with scores greater than or equal to 10 gain placement on the State Remedial Action Priority List. The list currently has sites with scores from 10 to 28.16. Further, the State acknowledges that sites with scores less than 10 may ''present immediate threats' and are handled through removal actions. [131]

EPA has proposed that the revised HRS have a cutoff that is "functionally equivalent" to 28.50 because ''EPA believes that the current cutoff score

125Ibid., p. 10.

126Ibid., p. 10.

127This new data may make it easier for marine sediment sites to gain NPL status. Until such sites are scored under the new HRS, however, it is not possible to know for sure.

12853 Federal Register 51%2, Dec. 23, 1988, p. 51966.

129U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''Extent of the Hazardous Release Problem and Future Funding Needs—CERCLA Section 301(a)(1)(C) Study," December 1984, p. 2-2.

130A Minnesota official told OTA that some of the sites with scores over 28.50 in the State program were municipal landfills and had not been submitted to EPA because at the time the policy was to reject such sites regardless of their scores.

131Illinois Environmental Protection Agency, Division of Land Pollution Control, *Cleaning* ///1/10 is, April 1988, p. 15.

has been a useful management tool" [emphasis added].[132] But, EPA has not determined the current HRS' false positive/negative rates, dealt with the algorithm, or evaluated how sites will fare under the new HRS. Thus, an equivalent cutoff maybe a useful management tool, but its environmental implications are not at all clear. Two of EPA's three suggested ways of determining equivalency are designed to produce an NPL of the same size that would be produced under the current HRS. The third way would attempt to produce the same level of quantitative risks for sites evaluated with the old and new HRS.

EPA has not grasped the nettle of the improbability of ever finding *a single point* (especially one with two decimal places) above which sites can be judged to present substantially more risk than those below. It may, however, be possible to design a more equitable system with two points (see OTA's option 20 in ch. 1).

Effects of the Delay-Congress specifically exempted EPA from having to reevaluate sites that have been listed on the NPL prior to the effective date of the new HRS, which Congress set at October 17, 1988. It may have been that the SARA schedule for revision was unrealistic, but the fact remains that the delay in issuing the new rules is causing problems in scheduling SIs. Further, while the method chosen by EPA to switch to the new HRS appears designed to save money, it may generate false positives.

SI data collection is dependent on the data needs of the HRS. The new HRS will require the collection of different information (and, perhaps, more information) than the current HRS does. This means that at some point EPA has to define and start new SI data collection. To avoid having a period during which no SIs and scoring packages are done, EPA has devised a phase-in of the new HRS. It is biased against low scoring sites and toward finding false positives.

EPA is assuming that a non-NPL site under the current HRS will be a non-NPL site under the new one but that some NPL-bound sites under the current HRS will be rejected by the new HRS. Sites that score below 25.0 during the transition will not be reevaluated. An exception is allowed for sites that have an element (e.g., direct contact pathway) that might allow them to score high enough for the NPL under the revised HRS. These exceptions ''should be infrequent" according to EPA.[133] However, sites that do score at least 25.0 (i.e., could be submitted for QA) are to be reevaluated using the new HRS. Thus, positive sites under the old HRS have to pass another screening and be judged positive under the new HRS, as well, to make the NPL.

Instead of just 2 years after SARA of current HRS evaluations, EPA will have had almost 4 years, if the new HRS is effective in February 1990. Between SARA's enactment and mid-1989, 458 more sites have entered the MITRE QA system and 355 sites have been proposed for the NPL using the existing HRS. The NPL updates in May and July 1989 would have been under the new HRS if EPA had finished it on schedule.[134] Because of the uncertainty of the effect of the new HRS, it is unknown whether more or fewer than 62 sites would have been proposed if the new HRS was used.

The NPL Grows

The NPL's annual growth and its eventual size depend on how thorough EPA is in discovering sites, maintaining inventories, and evaluating potential sites. So far, site discovery has been ad hoc, inventories incomplete and incompatible, and evaluation has been driven toward limiting the growth of Superfund. Still, the NPL continues to grow, proportionally increasing the responsibilities of Superfund.

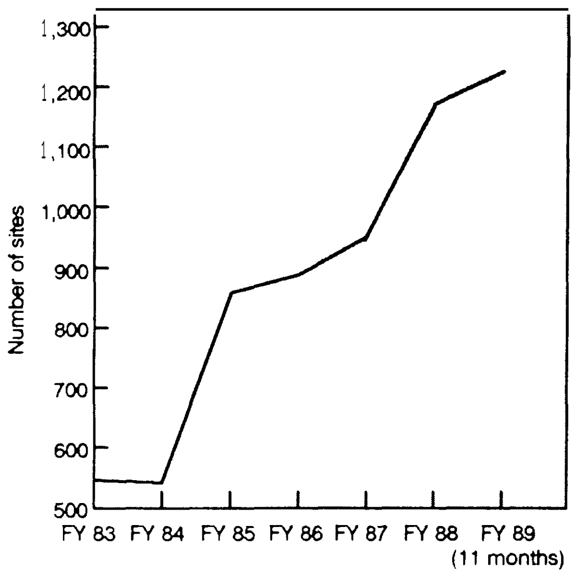
NPL growth is also affected by the rate at which EPA moves sites through the HRS scoring stage, primarily by the numbers of sites proposed (see figure 2-3). The total number of sites on the NPL at any one time is the sum of the proposed and final sites less those that have been removed or deleted, Figure 2-5 shows NPL growth from fiscal year 1983 (546 sites) through 11 months of fiscal year 1989

[132] 53 Federal Register 51%2, Dec. 23, 1988, p. 51966.

[133] U.S. Environmental Protection Agency, ''Pre-Remedial Strategy for Implementing SARA," op. cit., footnote 57, p. 6.

[134] Actually, everything is behind. The July 1989 update had been scheduled for early 1989, and a last up&uc was to happen in the summer of 1989 but, by mid-September, had not.

Figure 2-5 Growth of the National Priorities List



SOURCE: Office of Technology Assessment, 1969; baaed on EPA data.

(1,224 sites).[135] Although the growth has been uneven and sporadic, EPA has complied with the CERCLA requirement to update the list annually but did not add enough sites to meet the 1,600 to 2,000 level by January 1988 suggested by the SARA Conference report.

Another way to analyze the NPL is by the quality of the sites. EPA claims that HRS scores are a measure of relative risk among sites. EPA has also long maintained that the worst sites have been found. If so, one would expect the HRS scores to decline over time. OTA has averaged the scores of sites proposed in each fiscal year.[136] Figure 2-6 shows that the average score declined somewhat from 1983 to 1986 but from 1986 to 1989 has increased. The changes-up and down—are all within a 6-point spread that is probably insignificant for the HRS. **It is not possible to conclude-if HRS scores are a valid measure--that sites now coming through the system pose less (or more) threat than those in previous years.**

OTA also looked at the spread of HRS scores (see figure 2-6) and the distribution of scores in each fiscal year. These data suggest that the HRS scores may be approaching an equilibrium. The spread in scores (minimum to maximum score) shows a trend similar to the average scores. The spread compressed between 1983 and 1986 and then expanded between 1986 and 1988.[137] In 1989, the spread compressed again although the average is up, slightly. The distribution of scores is roughly similar for all years except the first year (1983). In 1983,44 percent of the scores were between 28.50 and 40.00. For all other years, from 60 to 73 percent of the scores were in that range. Conversely, 27 percent of the scores were greater than **50.00** in 1983; for all other years, 7 to 15 percent were greater than 50.00.

It is important to note that the changes in HRS scores averages, spread, and distribution over time do not necessarily reflect differences in the character of the sites. They can be the result of changes in policy (e.g., for a number of years EPA discouraged Regions from submitting landfill sites) or other factors. While the highest scoring sites (scores greater than 70.00) were all proposed in the first 2 years, all nine of these sites have high air subscores. As discussed earlier, 97 percent of the NPL sites processed by MITRE since 1984 have air subscores of zero. A zero air subscore may mean that air migration is not a problem or that an air score was not necessary to push a site score over 28.50.138

Estimates for the Future

Looking to the future, it appears that-if the environmental mission of the Superfund program is regained-the size of the NPL should increase substantially. OTA, GAO, and EPA data all point toward growth. **Today's CERCLIS inventory and its growth rate implies an NPL of over 4,000 sites by the year 2000. Ultimately, with a national site discovery program, minimal deferrals, and a need for secondary cleanups, over 10,000 sites could qualify for cleanup under Superfund.**

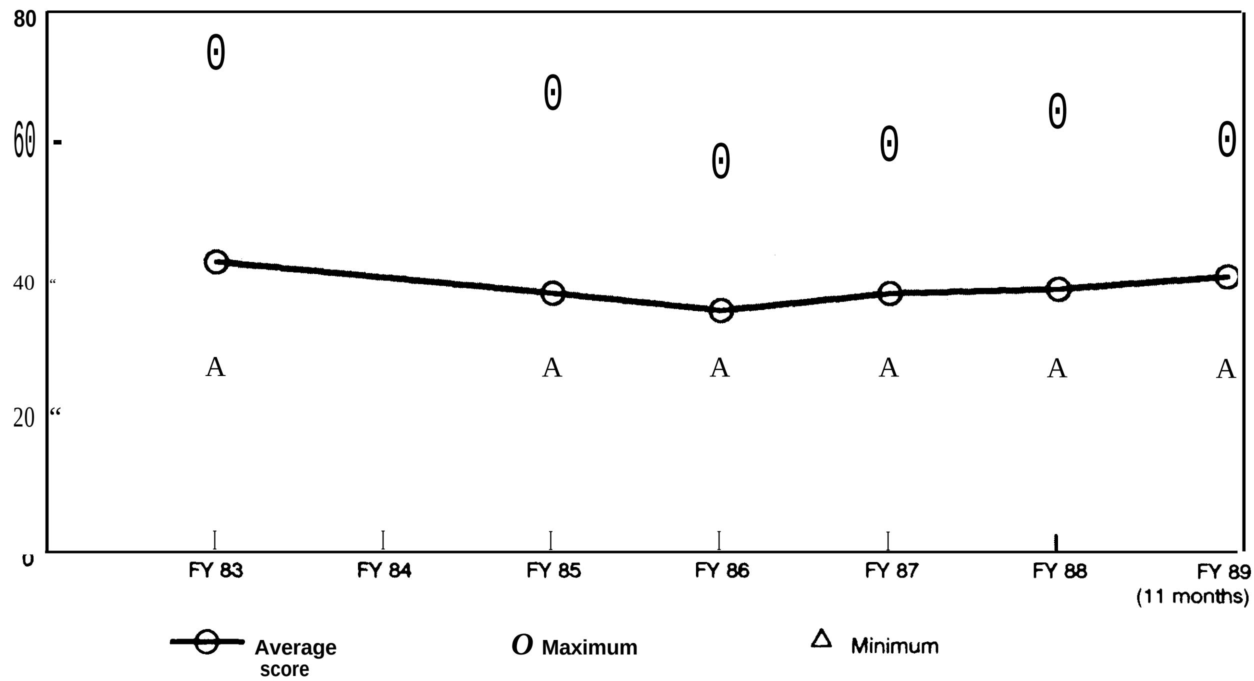
[135] Another count of the NPL is 1,251. That is, the number of sites currently on the NPL plus those that have been deleted. In the future, if the numbers of deletions per year increase, the growth rate of the NPL could appear to attenuate.

[136] The data are for 7 instead of 8 years because no sites were proposed in fiscal year 1984.

[137] The highest NPL score occurred in the first fiscal year of the NPL, 1983. Because of the cutoff score, the minimum always hovers around 28.50.

[138] Changing policies on the quality (observed or monitored) of air data needed for the HRS has affected the difficulty of obtaining air data.

Figure 2-6HRS Scores of NPL Sites (averages and minimum/maximum)



SOURCE: Office of Technology Assessment, 1989; baaed on EPA data

EPA's Projections-The Superfund program's projections do not agree with OTA's conclusions **about the future size** of the NPL. EPA makes its projections based on the choices it has made for the program. Those choices include no active site discovery, deciding that the preremedial program should make management rather than environmental decisions, and explicit or implicit deferral of clean-ups to other programs. For instance, EPA told Congress in 1988 that it was not possible to give an estimate for the future size of the NPL because "future changes in the preremedial program. . . will likely revise [the traditional] percentage" of CER-CLIS sites that make the NPL.[139]

The Superfund program estimate of the NPL has always hovered around ***2,000 sites*** despite a growing CERCLIS inventory. An assessment in 1983 projected an eventual CERCLIS inventory of 22,000 sites and an NPL of 1,400. Uncertainty about types of sites to be included in the NPL in the future produced an upper bound estimate of 2,200 sites. Today, EPA says that, with an inventory of 31,000 sites, there will be 2,100 NPL sites by the year 2000.

EPA says that about 5 percent of the *evaluated sites* end up on the NPL. How EPA arrived at *historical* average of 5 percent of evaluated sites is unclear since at the same time EPA presented data showing that the rate stood at 11 percent by 1986 and 7 percent by 1989.[140]

CERCLIS and the NPL--Using the size of CERCLIS to estimate the NPL is problematic, Not only do changing site evaluation and listing policies change historical averages but there is the pipeline effect. It can take 5 years or more for a site to move from CERCLIS entry to the NPL. Additionally, CERCLIS is not *the* master list of potential sites for the Superfund program. But, most importantly, as the Superfund program's long adherence to an NPL of about 2,000 sites shows, the size of the NPL is a product of choices made about how large the NPL *should* become. Thus, a choice of whether or not to

139House of Representatives, "Preliminary Findings of OTA Report on Superfund," op. cit., footnote 81, p. 270.

140U.S. Environmental Protection Agency, "A Management Review of the Superfund Program," June 1989, p. 1-6, conduct a site discovery program alters the size of the NPL.

OTA calculated a cumulative rate of 9 percent of CERCLIS sites making the NPL from 1983 through 1988 (using EPA data from table 2-1). OTA took the numbers of sites evaluated each year and compared it with the NPL of the following year to take into account some of the time lag between evaluation and final placement on the NPL. On a noncumulative basis, the initial rate was 22 percent in 1983 (the first NPL year) and for 1988 was 11 percent. Thus, historically-by either measure-a declining percentage of CERCLIS sites have become NPL sites, but the EPA average rate of 5 percent has not yet been encountered.[141]

OTA estimates that 10 percent of the sites on CERCLIS, or over 4,000 sites, could be on the NPL by the year 2000. The 10 percent rate assumes that the preremedial process is improved such that sites are evaluated on an environmental rather than management basis and that cleanup deferrals are minimal. Thus, if the CERCLIS could be frozen at 31,000 sites, the NPL could grow to at least 3,100 sites by the year 2000. But, a CERCLIS growing by 2,000 new sites each year will eventually contribute another 200 NPL sites per year. Taking evaluation time into account, 1,000 of those sites (or, 5 years worth) could be on the NPL by the year 2000. A national site discovery program could add several thousand more sites to the NPL.

CERCLIS may becoming an increasingly poor indicator of the potential size of the Superfund program. First, EPA plans-under the Environmental Priorities Initiative—to enter some 3,000 sites the agency clearly intends to defer to the RCRA corrective action program. That action, however, will broaden the concept of the CERCLIS inventory and move it toward being more of a national inventory. Second, as discussed earlier, the bureaucratic response to the policy to complete a site's PA within a year of its entry into CERCLIS has been to hold up site entry. The result may be a decline in the 2,000 sites per year growth rate.

Calculations based *only* on known CERCLIS/NPL data can underestimate the future size of the Superfund program (and national cleanup needs), Despite the move to add RCRA sites, CERCLIS is not a master list. But, using combinations of lists can result in overestimates. As previous discussions show, lists of potential sites abound and no cross checks have been made for double counting either among these lists or between each list and CERCLIS.

Further, when and if cleanups fail in other cleanup programs, they may become a new source of NPL sites: secondary cleanups (see ch. 4). OTA estimates that failures from other cleanup programs could add over 1,000 sites to the NPL. This estimate assumes that, while 10 percent of CERCLIS sites become NPL sites, an additional 20 to 30 percent actually require cleanup.[142] A failure rate of only 5 to 10 percent of those cleanups, could add 410 to 1,230 sites to the Superfund program.

Ultimately, An NPL of 10,000 Sites or More?— OTA's 1985 estimate of 10,000 or more Superfund sites remains valid. It assumes that the Superfund program has an improved preremedial process, active site discovery, and minimal deferrals. In terms of the national cleanup problem, the 10,000 site projection is a major underestimate (see ch. 4).

The original OTA estimate was based on a conservative analysis of only three categories of potentiai sites. It produced a total of 8,000 sites: 1) solid waste facilities (5,000 sites), 2) groundwater problems created by RCRA Subtitle C hazardous waste facilities (1,000), and 3) an improved site analysis and selection process for the NPL (2,000). EPA's own estimate at the time of a maximum 2,000 sites, which did not include the OTA categories, was added to the 8,000 figure to arrive at a total estimate of 10,000 sites.

Since 1985, when the OTA analysis was done, the OTA categories still remain as potential problems for the Superfund program:

- For **solid waste facilities** (active and closed municipal and industrial landfills and surface

[141] It is possible to obtain a cumulative rate of 3 or 4 percent by comparing the number of NPL sites in one year with the CERCLIS sites in the same year but that ignores the evaluation and time lag effect.

[142] In 1985 OTA presented State data that an estimated 40 percent of potential sites would require a cleanup. See, OTA's *Superfund Strategy*, op. cit. Also, DOD data for fiscal year 1988 shows that 30 percent of that agency's potential sites will require a cleanup.

impoundments), there has been no comprehensive study, subsequent to OTA's, to identify problem sites. In fact, municipal landfills were actively kept off the NPL (and thus not evaluated) by EPA until external pressure caused a policy reversal in August 1987. Even so, few landfills have been added to the NPL since the policy was changed. [143] A more recent, proposed policy is to defer such sites to State Subtitle D correction action programs. Proposed Federal rules for those cleanups, however, only cover new and existing landfills; closed landfills and other types of solid waste facilities would still, presumably, qualify for the Superfund program.

- Estimates for **hazardous waste RCRA Subtitle C cleanups** range from 2,000 to 5,000 sites now, but those sites are being actively deferred by EPA to the RCRA corrective action program. Since 1983, EPA has designated about 80 sites proposed for the NPL as possible RCRA corrective action sites; about a dozen have made the final list. In June 1988 EPA proposed to officially designate 30 proposed NPL sites as RCRA Subtitle C corrective action sites and 15 as NPL sites.[144] For all future sites moving through Superfund site evaluation, EPA will decide whether or not they qualify for the RCRA program. If so, they will become RCRA rather than Superfund sites. GAO estimated in 1987 that 818 sites would fail to get cleaned up under RCRA corrective action and end up in the Superfund program.
- The **selection process for the NPL** remains the same. Site analysis has actually been adjusted such that fewer, instead of more, sites should be expected to move far enough through the process to receive NPL evaluation. OTA concluded in 1985 that if EPA paid more attention to environmental factors, more sites would end up on the NPL. Congress has required EPA to revise the HRS, but those new procedures will not be effective until February 1990, or later. As the discussion on the proposed HRS has shown, whether or not the new HRS wili improve environmental decisionmaking is unknown.

OTA has identified two new categories of sites that could add work to the Superfund program: 1) newly created sites, and 2) secondary cleanups. Illegal dumping still occurs.[145] California recently cited its Transportation Department for dumping toxic and other waste materials into a pit at a maintenance yard for 10 years. The practice only ceased in May 1989. Firms that legally operate outside of the regulatory system are also creating new sites. One example is bankrupt firms that have used hazardous substances but were not required to have a RCRA permit because they did not store, treat, or dispose of hazardous wastes and, thus, received no enforcement actions while in operation. The need for secondary cleanups will occur when impermanent cleanups done by programs other than Superfund fail.

Uncertain Future--The maximum number of *potential* sites, from which eventually come CERCLIS and then NPL sites, is approaching 500,000. Ten years ago, the maximum base number was 50,000. It was estimated by an EPA contractor who concluded that from 30,000 to 50,000 hazardous substance sites existed.[146] The report was roundly criticized at the time as an inflated estimate. Then, in 1984, EPA said in its Report to Congress that systematic investigation efforts could expand the universe of problem sites and thus increase the response needs of the Superfund program. EPA estimated those "problem sites" to be between 131,000 and 379,000 from a larger universe of known sites in five categories: RCRA Subtitle C TSD facilities, municipal landfills, industrial landfills, mining waste sites, and leaking under-

143 As of May]986, 184 municipal solid waste landfills were on NPL according to the Subtitle D regulations proposed Aug. 30,1988. CERCLIS data, as of July 1988, classifies 220 NPL sites as landfills.

144 Even though the 15 sites t. remain on the NPL had been on the NPL for a number of years, EPA chose to reproposed them. They now wait again to become final sites.

145 Data from the removal program shows an increase in 1987 over 1986 in removal actions at illegal dump sites. [U.S. Environmental Protection Agency, *Progress Toward Implementing Superfund Fiscal Year 1987, Report to Congress,* op. cit., footnote 94.] Also, New York City Environmental Police unit has a 22-member force working fulltime to seek out illegal dumps. ["Toxic Avengers, " *Discover*, August 1989.]

146 Fred C. Hart, Inc., "Preliminary Assessment of Cleanup Costs for National Hazardous Waste Problem, " Feb. 19, 1979, as cited in EPA's "Extent of the Hazardous Release Problem and Future Funding Needs, CERCLA (301)(a)(l)(C) Study, ' op. cit., footnote 32, p. 1-2.

ground storage tanks.[147] EPA did not estimate how many of these sites would eventually require cleanup; only that ''some subset would require more intensive investigation, and a subset of those could require removal or remedial response by Superfund.[148]

In 1987, using EPA data, GAO recalculated the number of potential sites and arrived at a new range of 130,000 to 425,000. This group includes: RCRA Subtitle C and D facilities, mining waste sites, underground leaking storage tanks (non-petroleum), pesticide-contaminated sites, Federal facilities, radioactive releases, underground injection wells, town gas facilities, and wood preserving plants.[149] Again, no estimate was attempted of how many of these sites would actually require any cleanup. They are, however, classes of sites which currently are handled by the Superfund program. The estimate does not include classes of sites that are the exclusive purview of other cleanup programs, such as LUSTS with petroleum. Federal agency sites are included on the list. Although the Superfund trust fund is not used to pay for those cleanups, EPA incurs related costs due to its responsibility for oversight of Federal agency cleanups. 150

OTA has updated two categories of the 1987 GAO estimates for a new upper bound of at least 439,000 potential sites. GAO's estimate for LUSTS containing hazardous substances was 10,820 in 1987; using 1988 data from the Office of USTS that estimate should be about 20,000 tanks. Federal facilities now contain over 10,000 known sites, instead of the 5.800 estimated by GAO.

If 10 percent of these *potential* sites do require cleanup, the Superfund program could be facing a total NPL of from 13,000 to 43,900 sites. If only 5 percent, then from 6,500 to 21,950 sites. These are not necessarily the worst case national scenarios because they do not account for any sites currently resigned to other cleanup programs-such as LUST—some of which could eventually become Superfund sites (see ch. 4).

Comments on the RCRA corrective action program by the General Accounting Office in a 1989 discussion paper make clear why sites in other programs may eventually have to be redone by the Superfund program:

> Preliminary indications are that over half of the 5,000 operating hazardous waste facilities are leaking and causing contamination . . the pace of cleanups has been slow. in part because there is no overall strategy to deal with the problem . . . the agency has not been able to devote sufficient resources towards its corrective action program . . . remedy selection has often been conflicting and inconsistent, with no clear criteria for selecting a remedy that is most protective of human health and/or the environment . . . The longer these problems persist and remain unresolved, the greater the likelihood that operators will be unable to take corrective action and that the facilities will become Superfund sites.[151]

[147] U.S. Environmental Protection Agency, "Extent of the Hazardous Release Problem and Future Funding Needs: CERCLA Section 301(a)(1)(C) Study," op. cit., footnote 32, p. 5-3.

[148] Ibid., p. 5-2.

[149] GAO only included those RCRA Subtitle C facilities they felt would end up in the Superfund, rather than RCRA corrective action program.

[150] In a response to questions posed by the House Committee on Public Works and Transportation, EPA stated in 1988 that the maximum number of Potential sites m the 1987 GAO study should be 84,000. EPA argued that the count for three categories should be decreased not because the sites might not be contaminated but bezause-bureaucratically -+hey should not be listed m CERCLIS. EPA subtracted RCRA Subtitle D facilities on the basis of a Superfund policy that had been rejected by EPA in 1987. EPA objected to GAO's count of Federal *sites* rather than *facilities* because the NPL lists Federal facilities. However, Federal agencies inventory numbers of potential sites not facilities, EPA eliminated the bulk of injection wells counted by GAO because they are "non-hazardous by definition.'' GAO justified the inclusion of these wells because of evidence that Class 5 wells have a low to high probability of being contaminated. [''Prcllmlnag Findings of OTA Report on Superfund.' op. cit., footnote 81, p. 269.]

[151] U.S. Congress, General Accounting Office, ''Major Enviromental Issues: 1991- 1994," discussion papers, September 1989.

APPENDIX 2A
A HEALTH CARE MODEL FOR SUPERFUND SCREENING

Introduction

Because the Superfund program does not collect the proper data, OTA cannot make a definitive analysis of the environmental effectiveness of its screening process. Analogies are possible, however, with the health care field where screening tests are routinely used to detect the presence of illness (e.g., mammography for breast cancer) or risk factors (e.g., high cholesterol levels) that may require treatment. The efficacy of medical screening tests receives a lot of attention and making improvements is often high priority research. In addition, cutoffs are set with explicit consideration of the costs of missing cases and of incorrectly labelling a healthy person as diseased. The Superfund program, which justifies cleanup decisions on protection of human health, has not sought the same high standards in its approach to screening sites and setting a cutoff.

A potential Superfund site must pass three levels of screening prior to site cleanup: 1) the preliminary assessment (PA), 2) the site inspection (SI) and HRS scoring, and 3) the remedial investigation and feasibility study (RIFS) and Record of Decision (ROD). Starting with the PA, screening is simple (only existing information is used), but at each of the two higher levels, increasingly more and better information is used. A site must be judged positive **at** each screening stage in order to enter the next screening stage and, finally, to receive a cleanup.

At each stage, some sites are eliminated and labeled NFA—No Further Action. * Elimination does not necessarily mean that a site is free from public health or environmental problems. First, because no screening process is perfect, some sites are judged negative-not requiring cleanup-when in fact they are positive. Second, sites are eliminated because it is estimated or shown that they will not score at least 28.50 using the HRS. Third, sites are eliminated because, for statutory or policy reasons, they are not covered by the Superfund program. All of these classes of rejected sites have been lumped together in the universe of sites that don't need cleanup.

Based on a health care model, two characteristics and two outcomes can be used to assess how well the three Superfund screening stages perform, both independently and collectively:[2]

- Sensitivity—What is the probability that screening will identify the *true positive sites,* i.e., those sites requiring cleanup? This is the valid hit rate of the screening method.
- **Specificity-What** is the probability that the screening method will identify the *true negative sites,* i.e., nonproblem sites that do not require cleanup? This is the valid reject rate.
- Accuracy—What is the probability that a decision made by the screening is correct? Accuracy is a dependent variable. It is affected by sensitivity, specificity, and the fraction of sites needing cleanup,
- **Precision-Is the** screening decision reproduce - ble if different people or offices examine the same site?

Embodied in sensitivity and specificity are two fundamental pitfalls: making false positive and false negative decisions. It is critical to understand that a screening test is not necessarily equal in its abilities to detect problems and nonproblems; sensitivities and specificities may differ widely.

For example, using x-ray examination (mammogram) to screen for breast cancer may have a relatively high *sensitivity* (find a high fraction of cancers) but a lower *specificity* (identify many noncancers as cancers). Although such false positives present many problems, in this case it may be better to have false positives than to have false negatives. Any positive finding can be followed up with more sophisticated testing. But a negative finding leaves the system without a second chance, and its true nature only becomes apparent if symptoms appear later when cure (remediation) is more difficult. Another form of medical examination may have greater *accuracy* because, for example, it can detect smaller size cancers. High *precision* would

[1] The term now used is NFRAP, no further remedial action planned.

[2] See, for instance, R.M. Thorner and Q.R. Remein, *Principles and Procedures in the Evaluation of Screening for Disease,* Public Health Mono@@ No. 67, May 1967,

mean the test would detect the same cancer if performed by different people at different times and under different conditions.

False Positives and False Negatives in Superfund

In Superfund, a *false positive is* a site that is selected for cleanup but really does not need one. Money is wasted and an opportunity cost may be paid because other sites do not get the cleanup attention they require in a timely way. A *false negative is* a site that is eliminated from the system even though it really needs cleanup. In this case, near-term costs are avoided but long-term costs, including environmental damages, are very likely to grow.

Improving the environmental performance of Superfund screening process means reducing false negatives, It is necessary to find out at what level, where, and why the process produces false negatives. When the problems are found, ways to solve them must also be found and then resources must be devoted to do the job. Management must *want* to evaluate and improve system performance, but current pressures are to meet numerical quotas with fairly constant budgets. There are no allowances for reassessing what has been done,

The result for Superfund is that there has been almost no critical examination of the efficiency and accuracy of screening procedures nor of alternative screening strategies. Some effort has been made at determining false positives but not false negatives.

By nature, the system responds to positive test results and not negative ones; the system has several chances to detect a false positive (because it stays in the system), but not a false negative (because it departs). But to detect a false negative (and to measure sensitivity and specificity) requires that money be spent on evaluating the successive levels of screening and, perhaps, the ultimate remediation to assess whether sites labeled as negatives and positives are really so. Clearly, no system would expend such effort on *all* findings because that would eliminate the reason for conducting screening tests, whose costs are supposed to be small relative to the final cleanup, In the health care field, research is conducted on smaller numbers of subjects in order to establish the sensitivity, specificity, accuracy, and precision of screening tests. The results are compared with some "gold standard, " usually a definitive diagnostic test or the closest thing to it. The costs and benefits of improving the efficiency and accuracy of a test are dealt with explicitly.

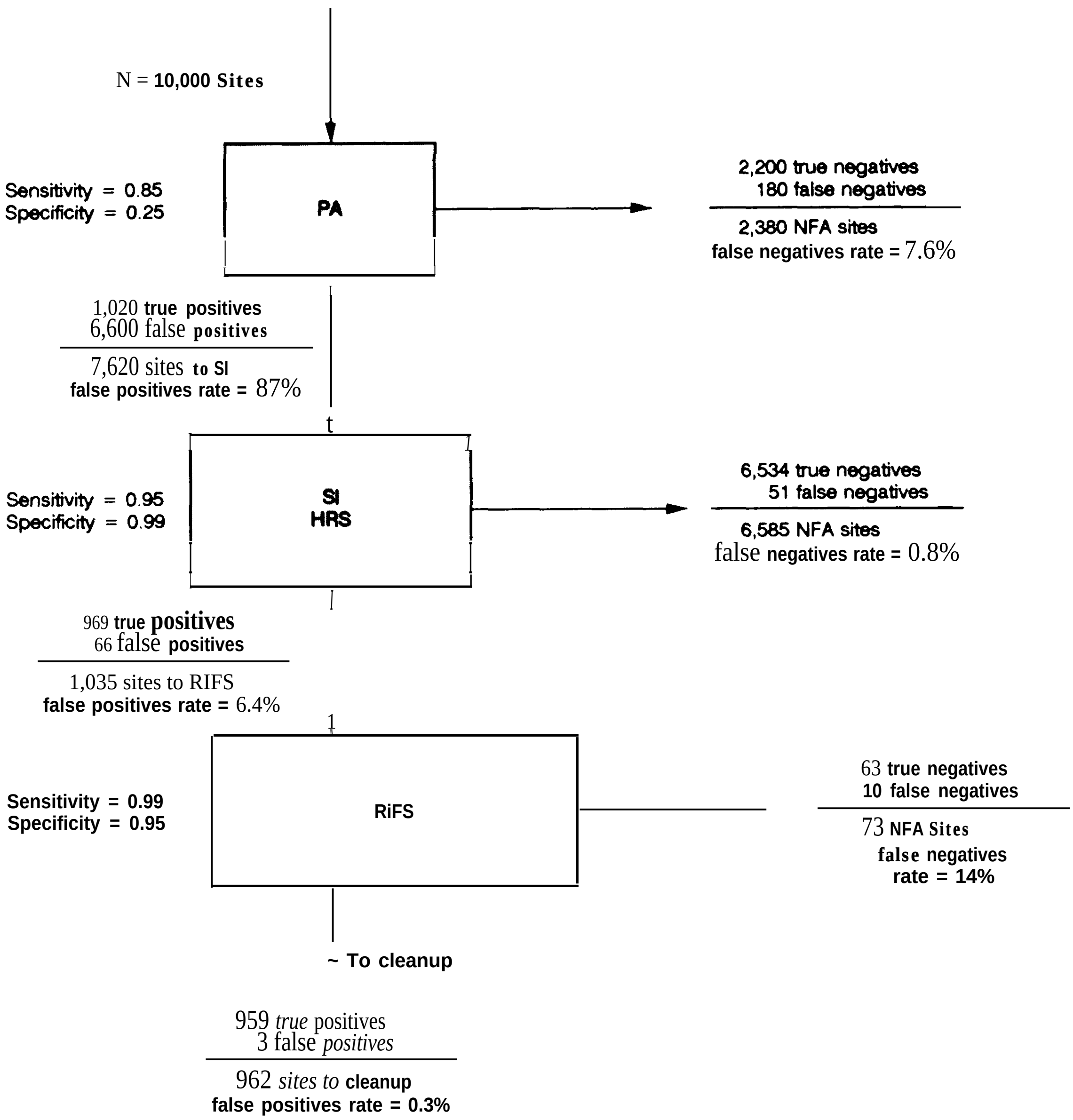
A Model of Superfund Screening

The percentage of false positives and false negatives for each screening stage can be calculated when three things are known: the true incidence rate (percentage of sites in the inventory of possible cleanup sites that actually require cleanup) and the sensitivity and specificity of each stage. Either special tests must be done or some reliable historical information must be used to obtain these figures; it is not possible to get them from current Superfund records. OTA has assumed values to gain insight into the nature of the current system, to illustrate possible problems, and to suggest strategies to solve the problems.

With the model shown in figure 2A-1, the three serial screening stages in Superfund allow for calculations-analogous to a mass balance-to track the disposition of sites as they move through the system. Positives from one stage pass on to the next, while negatives leave the system. As with any model, some details and richness of the real case are simplified or ignored. For example, OTA has combined the SI and HRS scoring into one stage, because for the most part the same information has been used for both, although in reality some sites are eliminated after the SI. Now, with two SIs (a screening and a listing SI) the level of the information is different and EPA has added another rejection point.

It is important to emphasize that there is no one correct result from the model. Numbers are assumed for key variables. For figure 2A-1, OTA assumed a CERCLIS inventory of 10,000 evaluated sites and a true incidence rate of 12 percent, or that 1,200 sites really require cleanup. We assumed that at the PA stage the *sensitivity is* good, but not exceptionally high, and resigned it a value of 0.85 (i.e., a 15 percent miss rate on the true problem sites) and the *specificity* is rather low, a value of 0.25 (i.e., 75

Figure 2A-1 -Estlmation of True/False Positives and Negatives



SOURCE: Office of Technology Assessment, 19S9.

percent of nonproblem sites pass through to the SI stage).

As figure 2A-1 shows, 7,620 sites pass the PA stage; 7.6 percent of the NFA sites are false negatives and 87 percent of the sites approved for an SI are false positives. That is, 180 NFA sites really *do* require cleanup and 6,600 sites that go on to the next stage *do not* really require cleanup.

At the SI/HRS stage the level of information is improved and the sensitivity increases to 0.95. The specificity increases to 0.99. Figure 2A-1 shows that 1,035 sites pass this second screening stage. The false negatives are 0.8 percent, and the false positives are 6.4 percent. The number of true problem sites missed (false negatives) is 51.

At the RIFS/ROD stage, the quantity and quality of information are greatly improved. OTA assumed that the sensitivity increases to 0.99 and the specificity is 0.95. The specificity was decreased somewhat to reflect the likelihood that investigators would have some reluctance to reject a site at this last level of screening after so much investment has been made in the site. Figure 2A-1 shows that 962 sites pass through the RIFS/ROD stage to actual cleanup; 14 percent of the negatives are false and 0.3 percent of the positives are false. Ten more true problem sites (false negatives) are missed.

Overall, out of the 1,200 true problem sites, 959 are detected and 241 sites are missed. The number of unnecessary cleanups is three. A total of 9,038 sites are eliminated. **It is only the number of false positives at the last screening stage that results in unnecessary cleanups. But false negatives drop out at each screening stage and accumulate.** Thus, for the three-stage process, 0.3 percent of the positives are false while 2.7 percent of the negatives are false. The overall sensitivity for detecting true problem sites is 0.80, less than for any of the individual stages. Thus, out of 1,200 true problem sites, 20 percent (241 sites) are missed because of the cumulative effect, The specificity is very high at 99.97 percent (i.e., nearly all the nonproblem sites are rejected); only 3 false positives get through the last stage.

Applying Results to Superfund

The model and the numbers assumed and calculated simulate current Superfund results. About the same size NPL is created (roughly 1,000 sites) from about the same universe of inventory sites and sites examined through the three screening stages. Available data show that the historical NFA rate at the first screening stage (the PA) has been about 20 percent (24 percent in the model) and that the NFA rate at the last screening stage is about 8 percent (7 percent in the model). Other numbers might lead to the same overall performance; therefore, the model shows several important things about the *possible* behavior of the current Superfund screening system:

- It probably does a good job of minimizing false positives; that is, very few totally unnecessary cleanups result, although responsible parties asked to pay for cleanups sometimes believe otherwise.
- It may do a poor job of minimizing false negatives; that is, a rather large number of sites that require cleanup can be missed with no indication that they exist; they are buried within a large number of true nonproblem sites. While some State programs may do a good job at detecting which are problems, not all can (see chs. **2** and 4).
- It is impossible for the second two screening stages, with their higher levels of sensitivity, to overcome or offset the inefficiency of the first screening stage where 180 out of the total of 241 false negatives are created; only 10 false negatives stem from the last screening stage.
- Most false positives come from the first stage and very few from the second two screening stages.

Ways to Minimize False Negatives

The results of the model suggest two fundamental strategies to cut down the number of false negatives and their attendant problems of high future cleanup costs and damage to human health and the environment. A High Risk Site Strategy creates a parallel track of sites and a Better Information Strategy results in a two-stage process,

High Risk Site *Strategy-A* case can be made to circumvent the three-stage screening system and its inherently lower overall sensitivity and very long evaluation time by going directly to the third stage. In the health care field a subpopulation with a higher incidence of a certain disease is identified, and this high risk groups is sent directly to a more advanced stage of screening. The key is to use preexisting information to define the subpopulation.

This strategy offers Superfund a parallel route to cleanup for some sites with a higher incidence of risk. Example subpopulations include: 1) sites that have been identified through historical aerial photographs, analysis of which clearly shows past hazardous waste management practices that lead to contamination; and 2) sites that have received emergency or other removal actions and that professionals who have worked onsite believe need a cleanup.

A high percentage of such sites are apt to require cleanup, perhaps 70 to over 90 percent. They could be **skipped directly** to the third screening stage **where the very** high sensitivity would confirm almost all of them. For example, for 1,600 such sites with an incidence rate of 75 percent (i.e., 1,200 true problem sites, the same as in figure 2A-l), 1,188 sites would be correctly detected, and 12 sites would be missed. This strategy results in a 1 percent miss rate rather than the 20 percent miss rate for the current system.

Better Information Strategy--lt is conceivable that the first screening stage, where most false negatives are created, can be improved to raise its sensitivity. This approach runs counter to the basis of the current three-stage screening process which is simple and low-cost (typically days or weeks and a few thousand dollars) at the first stage and gets much more costly and longer (typically a few years and several hundred thousand dollars) at the third stage. Improving the first screening stage means spending more money on a very large number of sites—an activity that could make subsequent stages redundant. This redundancy seems to be happening now; for example, pushing the use of the HRS into the PA stage. But, the current use of the HRS at the **PA stage does** not include using better information.

Making a significant improvement in PA screening so that its sensitivity increases is worth considering. For example, if its sensitivity is increased from 0.85 to 0.95, the PA and SI/HRS stages can be combined into a new, more efficient first stage with the benefits of the current second stages That is, this strategy uses the second and third stages of the original model. The result is that, after the third stage, 71 true problem sites are missed and there are 4 false positives in the total of 1,133 going to cleanup.

Instead of missing 241 sites in the current system and 12 sites in the High Risk Site strategy, 71 sites are missed in the Better Information strategy. The sensitivity for the Better Information strategy is 94 percent (as compared to 99 percent in the High Risk Site strategy and 80 percent in the current system). However, the basis for comparison is not quite the same for all three cases, even though there are 1,200 true problem sites in each. Although the current system and the Better Information strategy could be used on the same group of randomly selected sites within the entire Superfund inventory, the High Risk Site strategy is used on a selected group of sites for which it is known that the percentage of sites needing cleanup is high. The advantage of the High Risk Site strategy, therefore, depends on having information which reliably predicts that a site is a true problem requiring cleanup.

Comparison With EPA Attempts To Improve Screening

One of the paradoxes of Superfund is that the PA, the first screening stage traditionally gets the least attention, uses the least and probably worst information, and probably is implemented by the most junior, inexperienced people. This condition means that the sensitivity and specificity are probably low, as reflected in OTA's modeling of the current system above. EPA's interest (as detailed in ch. 2) is to reduce the workload of the SI/HRS, the second, more expensive screening stage. Thus the drive is to improve the specificity (i.e., finding nonproblem sites) of the PA rather than the sensitivity (i.e., finding problem sites). But, it is the sensitivity that determines how many false negatives are created.

The model helps to assess the effects of EPA's expansion of PA screening to reduce the workload at the SI/HRS stage; that is, to reduce as early as possible false positives. The subtlety is that it is possible to increase the specificity without increasing the sensitivity; that is, by increasing the specificity the number of false positives is decreased, but not the number of false negatives. If something is done to better detect true nonproblem sites, such as using crude field sampling and analysis to show no contamination, a specificity of 0.75 instead of 0.25 (as in the current system model) for the first screening step could be assumed. This reduces the number of false positives from 6,600 to 2,200. The number of sites going on to the SI/HRS stage-the workload-decreases from 7,620 to 3,220 sites, a 58 percent reduction. The false positive rate drops from 87 to 68 percent. The false negative rate decreases from 7.6 to 2.7 percent even though the actual

[3] This is similar to the suggestion in ch. 2 that screening be a continuum rather than one in which at a specific point, say the PA stage, it is assumed that enough information exists to make a site decision.

number of false negative sites remains constant (because a larger NFA base is created).

However, the real danger is that whatever action is used to increase the specificity also affects the screening's sensitivity. In fact, the likelihood is very great that the sensitivity would decrease, thereby increasing the rate of false negatives. For example. in a modified PA, using crude sampling and analysis with high detection limits and very few samples per acre could miss major contamination. Similarly, as is currently the situation, application of the HRS scoring at a time when very little reliable information exists could reduce the sensitivity as much as the specificity is increased.

Reducing the sensitivity, such that more false negatives are created, has an apparent effect of also increasing the number of sites eliminated and reducing the workload for the next screening level. If the sensitivity decreases from 0.85 to 0.80 at the PA stage, then an additional 60 false negatives are created (240 as compared to 180 in the current system).

Accuracy in Superfund Screening

The degree to which screening decisions are accurate is yet another problem. In Superfund, the increasingly critical factor is the use of the HRS. Just as in some medical tests, a cutoff score is used to decide whether a site is "bad" enough to merit cleanup. As discussed in chapter 2, the HRS has been criticized for many years by many people. No available evidence has established a valid relationship between the score—and certainly not the arbitrary cutoff value of 28.50--and the actual threat to human health and environment.

It is not clear that there is *any one* cutoff score that would accurately indicate that a significant environmental threat exists or does not exist. If there is one point of uncertainty below which no cleanup problem probably exists and another point above which there is almost certainly a need for cleanup, these points among HRS scores has not been determined. If such points were determined, then the policy decision would be whether or nor to consider sites between the points as positives or negatives.

Precision in Superfund Screening

The higher the precision of screening tests, the greater their reproducibility. No matter who applied the screen, or when, the result would be the same. In Superfund, good precision would mean that it would not make any difference, with regard to whether a site is judged to require cleanup, what EPA region a site is in, nor what contractor or State office performed the work, nor which people did the work, nor when the work was done. Unfortunately, no specific attempts (such as having some sites evaluated by different offices) have been made to evaluate the precision of the three-stage screening process and, especially, the HRS. What data exist, however, suggest a substantial level of inconsistent results in every aspect of Superfund implementation (see chs. 2 and 3). Thus, the probability is high that a site which is judged to be positive or negative could receive just the opposite label if it was examined at a different time by different people in a different office.

Conclusion

The examination of sensitivity and specificity in combination with an overview of problems with accuracy and precision in Superfund's screening steps leads to an unsettling conclusion. No detailed data have ever been intentionally gathered that could rate the worth of Superfund's screening steps. However, whatever analysis can be done with the meager information available leads one to suspect that current screening efforts may miss substantial numbers of sites that really require cleanup. But the system is much less likely to result in cleanups that are really unnecessary.

In fact, for every one unnecessary cleanup, the model used here suggests 80 sites are not cleaned up that should be. The costs of better or extra screening designed to minimize false negative sites seem small compared to the higher costs of delayed cleanup. Doubling preremedial costs, for instance, to 6 percent of the Superfund budget would add about $40 million to screening. That is comparable to today's average cost of cleaning up a site, *$30* million. If improved screening found most of the 80 sites, it is possible that hundreds of millions in future clean up costs could be saved.

When the problems of poor accuracy and precision are also taken into account, then it is clear that the margin of error in any estimate of false negatives and false positives is probably very large, even as much as plus or minus 100 percent. This means that if all errors were random there may be no significant problem of false negatives or the rate might be twice as large as the estimates made with the model used here. On the other hand, errors may be systematic, not random. Indeed, some actions have been discussed that bias results, and the pressures on Superfund point to a predilection to ignore false negatives while attempting to minimize false positives. Short-term costs are being minimized at the expense of higher long-term costs.

Chapter 3

Cleanups and Cleanup Technology

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Chapter 3
Cleanups and Cleanup Technology

What is a permanently effective treatment technology? The Superfund Administration and Reauthorization Act of 1986 (SARA) strongly supports its development, demonstration, and use for site cleanup, but the statute does not say exactly what "permanent," "effective," or "treatment" mean. The resulting ambiguity for Superfund has fueled public criticism of specific cleanups and clashes between statutory requirements and implementation. Some flexibility is necessary for the people trying to find cleanup solutions to complex sites. The challenge is finding an approach which follows statutory requirements and preferences, uses the latest understanding of science and engineering, and also allows enough flexibility for front-line people to solve tough problems.

OTA's analysis of site cleanup in this chapter focus on how well technology is evaluated and selected to solve contamination problems and to meet cleanup objectives. Ten key issues are identified and discussed.

This chapter is **not** a treatise on Superfund procedures and cleanup technologies. While many people want to know details about cleanup technologies, especially newer ones, the technology area is evolving rapidly and detailed descriptions of specific technologies are quickly out-of-date. [1] Also, the objectivity and reliability of available information cannot be guaranteed because so much of it comes from technology developers themselves. Moreover, engineering specifications have limited value to policymakers charged with making the Superfund program work more effectively and efficiently.

OTA's analysis is meant to provide a background for the discussion of policy options to improve Superfund implementation. Accordingly, general scientific and engineering principles and trends are set out, in somewhat of a tutorial style, which should be of particular use to the non-specialist in cleanup science and technology. Given the paucity of exact information, examples of site decisions also play an important role in OTA's analysis.

10 KEY ISSUES

Issue 1: Is there now available a full range of proven, safe, and cost-effective cleanup technologies so that land disposal and containment can be largely avoided?

In large measure, the answer is yes, Perhaps the best proof is the current smorgasbord of treatment technologies for different kinds of Superfund sites from hundreds of technology vendors. But land disposal and containment are still needed and particular treatment technologies accomplish different things.

Nor can cost-effectiveness be separated from cleanup objectives. That is, no cleanup technology is intrinsically cheap or exorbitantly expensive. The range of cleanup applications is very broad, and cost-effectiveness depends on what the cleanup need is, including what the contamination and site conditions are. Claims that a technology is intrinsically cost-effective are misleading. Yet, some technologies commonly used for generic applications earn the engineering label "proven." Assessment of the availability of treatment alternatives to land disposal, therefore, is linked to general cleanup goals (e.g., permanence, cost-effectiveness), specific site cleanup objectives (e.g., levels of residual contamination for specific contaminants to attain risk reduction objectives, compliance with regulatory standards), and an understanding of different generic cleanup applications.

Because not all treatments are the same, the general availability of all treatment technologies that are lumped together can be misleading. Some treatments are preferred over others, and if some cleanup problems have no good treatment solutions (e.g., very large municipal landfills).

The mere label of "treatment' for a technology can be misleading. The government has not established a clear hierarchy of preferred treatments and preferred environmental outcomes. One possible

[1] In its 1985 report *Superfund Strategy*, OTA listed specific technology vendors with some discussion of their new technologies. To a large degree, the information quickly became outdated; it was also unintentionally unfair to firms not listed. At this time, there is no convenient single source of the latest information on new cleanup technologies.

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hierarchy is given in box l-F, chapter 1. Treatment technologies, such as thermal destruction (incineration) and biological treatment, which actually destroy or detoxify hazardous substances, and technologies that recover contaminants for reuse are the most desirable; OTA concludes that such treatments offer permanent remedies. EPA has said that permanent remedy "has not been strictly defined. "[2]

Permanence is at one end of the performance spectrum for treatment technologies. At the other end, for example, are simple treatments that extract water from a sludge type of waste, reducing volume but leaving the hazardous substances in their original chemical form and quantity. For environmental protection, treatment that permanently renders hazardous substances harmless is most preferred. The reason is simple. To the extent that the treatment is maximally effective, there are no uncertainties: the source of hazard is removed, not merely reduced, separated, or contained. Permanent treatment provides maximum risk reduction, especially if it can be done for all of a site's contaminants. Russell E. Train, former EPA Administrator, stated the importance of permanent cleanups: ''Haunting Superfund is the nightmare of spending millions to clean up a site, then discovering the cleanup is far from permanent. '

Some treatments, however, only reduce mobility, such as chemical fixation, stabilization, and solidification; these also generally increase volume. Some are only separation technologies (e.g., soil washing, solvent extraction from soils, carbon adsorption, and precipitation of contaminants in groundwater) which may reduce volume but actually produce a more concentrated hazardous waste that must be treated or landfilled. Some separation technologies can (and often do) release hazardous materials directly into the environment (e.g., air stripping of contaminated water, soil aeration, and extraction of volatile chemicals from soil) unless contaminants are collected and some form of destruction technology is also used.[4]

Treatment and Permanence-To begin with, the word ''treatment is not especially informative technically. At best, treatment as applied to hazardous waste problems has come to mean anything other than land disposal of hazardous waste. By itself, treatment does not convey what happens to the hazardous waste. In particular, treatment does not imply a permanent transformation of hazardous material to harmless material.

Cleanup permanence may also be seen as a form of pollution prevention. A permanent treatment technology removes the source of future pollution. Other types of treatment leave hazardous material as an uncertain threat, which may require action later. In contrast to primary pollution prevention for industrial hazardous waste generation, cleanups start out with hazardous waste already created. It is only through destruction or recovery that source reduction can be applied to cleanup; this application might be called secondary pollution prevention.

Theoretically, every hazardous substance and contaminated material can be permanently treated to render it irreversibly harmless. Engineering, economics, and the ability to apply such technology to all site contaminants are another matter. Organic hazardous substances can be destroyed by supplying enough energy to break chemical bonds, such as through incineration or biological activity, and through chemical reactions, such as dechlorination, ultraviolet photolysis, wet air oxidation, and supercritical water oxidation. Materials containing toxic metals can be treated to recover the metals, converting them back into their original commercially valuable form. Even some organic hazardous substances can be recovered and sold commercially; recovery of oil from refinery waste sludges and contaminated soils is commercially available

[2] Response to question, in *Preliminary Findings of OTA Report on Superfund*, Committee Report on Hearing before the Subcommittee on Investigations and Oversight, Committee on Public Works and Transportation, U.S. House of Representatives, Apr. 20, 1988, p. 273.

[3] Russell E. Train, ' 'Big Questions Facing the Cleanup, " *EPA Journal*, January/February 1987.

[4] Increasingly, separation technology is used in conjunction with a destruction technology, but little attention may be given to the environmental release of contaminants from the. separation technology. For example, air stripping of contaminated groundwater may be used prior to biological treatment in a reactor; a case study which described a groundwater cleanup of such a combination provided no information on the relative contribution of the air stripping to cleanup versus actual destruction of organic contaminants by microbes. Robert Sanford and Donald Smallbeck, ''Startup of a Physical/Biological Treatment Plant to Treat Groundwater Contaminated With Chlorinated Hydrocarbons and Soluble Organics, " proceedings of Haztech International Conference, St. Louis, MO, August 1987.

through various solvent extraction processes, Acidic or alkaline wastes can be chemically neutralized. Asbestos can be classified. Therefore, in terms of scientific principles, destruction, recovery, or some form of chemical conversion are treatment approaches that produce **permanent** cleanups. In assessing commercial availability of alternative treatment technologies, therefore, it is useful to fist distinguish between those that offer permanence, in a scientific sense, and those that do not. Not all treatment technologies can meet environmental goals.

Reducing the volume or mobility of hazardous substances offers some environmental benefits relative to the goals of controlling the release of hazardous material into the environment and minimizing exposures to hazardous substances. Such treatment technologies may play an important role prior to using a permanent treatment technology. But, in themselves, reducing volume and mobility (or reducing exposure by encapsulating a toxic substance) does not produce the kind of **certain** environmental benefit that destruction or recovery do (even with less than perfect performance) because the source of chemical hazard remains.

Current EPA thinking on the various outcomes of cleanup approaches is different from OTA thinking. For example, under the heading of ''program principles/expectations, at a technical information forum for Superfund personnel, EPA said:[5]

- ''Protwtion can be achieved by the destruction or immobilization of waste through treatment or by preventing exposure through engineering and institutional controls. " (Although engineering and institutional controls must be used at times, this statement can be interpreted to mean that a Record of Decision (ROD) could consider land disposal and deed restrictions as comparable to incineration.)
- "Expect most remedies will involve a combination of treatment and containment technologies. " (Although this statement is true to a large degree and there is a role for containment technologies, this statement does not tell front-line personnel that treatment is to be maximized and containment minimized; see the discussion below on extent of permanence and different types of cleanup actions.)
- ''Highly toxic, highly mobile waste (waste that can be contained reliably with engineering controls, e.g., containment, capping) generally will not need treatment. ' (The problem is the limited information on and in the interpretation of what is highly toxic and highly mobile; the interpretation suggests to personnel a rationale for not selecting treatment.)

Is it useful to think of degrees of permanence? No, not for what a particular technology accomplishes. Superfund implementation, thus far, has shown that it is important to keep the distinction between permanence and volume or mobility reduction clear. Otherwise, too many treatments are credited with permanence. **However, EPA has favored use of the degree of permanence concept and this practice has been important in providing the flexibility—which OTA considers being excessive—to equate different cleanup alternatives as equally satisfying the goal of obtaining permanent remedies.** For example, former Assistant Administrator J. Winston Porter said: ". ., There are degrees of permanence, . . . Certainly digging everything up and burning it is about as permanent as you can get. On the other hand, if you take just putting a cap over it and walking away, that's about as least permanent as you can get. Then there is a gradation. . . . Certainly things like solidification, I would say, is not as permanent in the sense as some destruction techniques. . . . When we put a cap on or when we put monitoring wells in or we do in situ (in-place) solidification or various other things, we do it with the understanding that we hope that will work permanently, not in geologic time . . . but for some finite time period we expect that to work. '

In OTA's view, working for a finite time may mean months or years. What varies is not the degree of permanence but the degree of environmental protection provided by the treatment or containment technology. Indeed, even land disposal and contain-

[5]U.S. Environmental Protection Agency, materials distributed at EPA's Technical Information Forum, Arlington, VA, Feb. 22-23, 1989.

[6]Response to question, in *Preliminary Findings of OTA Report on Superfund*, op. cit., footnote 2, pp. 189, 191.

ment have sometimes been described as giving a degree of permanence.[7]

A related issue is the extent of use of a permanent technology at a site. It is not always possible to apply permanent treatment technology to all of a site's contaminants. When more than one technology is used for a cleanup, including technologies and methods other than destruction and recovery, only part of a site's contamination may receive permanent treatment. Therefore, if at all possible, the percent of hazardous site material rendered harmless through destruction or recovery should be calculated to describe the **extent** that permanent treatment technology is used. Maximizing the extent of such use to satisfy statutory preferences and requirements is the goal.

Three Limiting Principles for Permanent Treat- mets--Unless proven inapplicable, there are three fundamental limits to any destruction or recovery technology. First, no destruction or recovery technology can work on all conceivable hazardous substances. For example, incineration does not destroy toxic metals, and biological treatment is very chemical-specific. This limitation implies the need for effective pollution controls to deal with untreated substances.

Second, no process is 100 percent efficient. Incomplete destruction or recovery must be carefully examined and measured. EPA currently requires an efficiency of 99.99 percent for incineration (and even more for polychlorinated biphenyls (PCBs). If this requirement was applied to other treatment technologies, few would currently pass muster. This deficiency too implies the need for effective pollution controls to deal with untreated material. The deficiency also implies the need to set acceptable levels of residual un-destroyed or un-recovered contaminants at a site on the basis of insignificant health or environmental effects.

Third, a treatment may produce new hazardous substances as byproducts of chemical reactions. Testing for toxic byproducts takes special effort. While the problem is well known for incineration, it is an often neglected issue for other technologies, such as biological treatment. Also, a treatment process may use chemicals which themselves pose some problem, such as additives to make in situ biological or chemical fixation work effectively.

Conclusions—The market for cleanup technologies is rapidly changing, Over the past several years many new technology companies have entered the marketplace. Technology availability has increased, but evaluating different technologies has gotten more difficult. Increasingly, the competition will not be between containment/land disposal and treatment but among different generic treatment technologies-especially permanent ones—and among different options within generic categories. Although permanence is a key goal of final remedial actions, cleanup technologies which do not offer permanence have an important role to play in emergency responses, attempts to recontrol sites, and interim remedial actions. But there it is important not to blur the distinction between technologies which offer permanence and those which do not.

Issue 2: Is the Superfund system using proven cleanup treatment technologies-preferably permanent ones-where and when they are applicable and feasible?

Types *of Cleanup--This* question cannot be fairly answered unless it is understood that there are four types of cleanup actions. First, there is **emergency action,** for which any type of fast response necessary to reduce the immediate danger is appropriate. There is no requirement to choose treatment technology and, indeed, there would rarely be time to pursue treatment.

Second, there is what is now called **removal action.** Both emergency and removal actions can be taken on any site, without the requirement of the site being selected for the National Priorities List (NPL). Originally, removal action was supposed to deal

[7] A critique of an EPA study by a contractor working for responsible parties at a site: ".. · The FS [feasibility study] incorrectly eliminates from detailed consideration those alternatives, such as capping with groundwater renovation, which permanently reduce the mobility and volume of hazardous substances and which arc more cost-effective than the alternatives considered by EPA. (''Review Comments on the Re-Solve Site, Dartmouth, Massachusetts, Draft Feasibility Study and U.S. EPA Preferred Alternative, ' ERT Company, August 1987,) No mention of reducing toxicity is made. According to the contractor, leaving hazardous materials in the ground is a permanent remedy. It should be understood that EPA and its contractors have made similar arguments in their work. The Re-Solve site decision is one of the cases cited by OTA in its 1988 report as an example of Superfund at its best because of the treatment cleanup technology selected (i.e., dechlorination).

with imminent threats of release or exposure and was done relatively quickly and simply, prior to the remedial cleanup, often by removing hazardous material to a landfill. The amounts of such materials can be larger than the amounts treated subsequently during a remedial cleanup. Data from EPA indicates that less than 10 percent of removal actions used some kind of treatment technology (about half of these used destruction technology);[8] the vast majority of removals--over 90 percent—used land disposal and engineering or institutional controls.

But over time some removal actions have come to look like major cleanups, sometimes using treatment technology. Indeed, SARA increased the time and spending limits for removals. A number of multimillion-dollar removals examined by OTA are no different than major cleanups. For the period of fiscal year 1987 and about half of fiscal year 1988, EPA said that there were 22 removals for which it waived the 12-month/$2 million limit of SARA; the average cost for those removals was just over $4 million.[9] However, such multimillion-dollar removals are outside the stringent cleanup standards of SARA which apply to remedial cleanups,

Third, there is an **interim remedial action,** now called by EPA an operable unit, which is a partial remedial cleanup, in terms of part of a site or fraction of contamination targeted. Unlike the previous two categories, interim remedial action requires major site investigation and a feasibility study of cleanup options. Also, EPA issues a Record of Decision which describes the selected remedy and cleanup objectives.

Fourth, there is a **final remedial cleanup** which, as with an interim effort, requires major site study and a ROD and is covered by the stringent cleanup standards of SARA; that is, in these two remedial categories there is a clear statutory preference for using permanent treatment technology. A final remedial cleanup would set the conditions necessary for delisting a site from the NPL.

The Record on Technology Use—First, it is important to recognize that, contrary to some popular beliefs, SARA does not require EPA to select permanent solutions and alternative treatment technologies but only to give them **preference and to use** them "to the maximum extent practicable. " The statutory requirements are vague and permit many different interpretations. There is no government guidance to remove the ambiguities and inconsistencies. Considerable progress toward using more treatment technology has been made, but all too often it is not used. This was a major lesson from OTA's case studies, many of which either used no permanent treatment technology or no other type of treatment technology, or selected unproven and untested treatment technologies (see box 3-A for a summary from the 1988 report).

Second, there are many technical application and implementation issues for any generic cleanup technology; see box 3-B for an overview of such issues for incineration, and see table 3-1 for a summary comparison of the many types and sources of mobile and transportable incinerators available today. Over the past few years, there has been a substantial expansion, nationwide, of the mobile/transportable incinerator business. This competitive market has brought down prices. The key difference between mobile and transportable is that transportable units require significant effort to dismantle, set up, and move while mobile units do not. See boxes 3-C, 3-D, and 3-E for overviews of application and implementation issues for biological treatment, separation, and chemical fixation technologies.

All of these application and implementation issues illustrate the complexity of remedy selection. Despite increasing experience with cleanups and the introduction of more treatment options, the cleanup workforce has found remedy selection to be more complicated. The need for narrowing down cleanup alternatives as early as possible without, however, foreclosing on important options has become greater, But narrowing down requires in-depth experience and insight about generic types of sites and recent technology developments and experiences, so that truly infeasible or impractical cleanup alternatives can be eliminated while retaining important options.

[8] U.S. Environmental Protection Agency, op. cit., footnote 5, The figure of less than 10 percent for treatment compares to just under 70 percent fOr remedial actions in fiscal year 1988, but the data for removals is cumulative, covering all actions since the beginning of the program; the comparable cumulative figure for remedial actions would be much lower than 70 percent, but significantly higher than 10 percent.

[9] Response t. question, in *Preliminary Findings of OTA Report on Superfund*, op. cit., footnote 2, p. 200.

Table 3-l-Comparison of Mobile/Transportable Incineration Technologies

	Rotary kiln	Infrared furnace	Circulating bed	Electric pyrolysis	Plasma arc torch
Operating Temperature	1,200-1,800”F primary chamber	600-1,900'F primary chamber	1,500*F	3,000-3,200 °F	Over 10,OOO”F plasma plume
Residence Time					
solids	Up to several hours	10-180 minutes	About 30 minutes	Variable from minutes to hours	500 milliseconds, plasma plume
Gases	1-2 seconds	2 seconds	2 seconds	2 seconds	
Waste Form	solid, sludges, liquid	Solids, sludges, liquid adaptable	solids, sludges, liquids	solids, sludges, liquids	Liquids, certain liquified sludges
Estimated Throughput	1-5 tons/hour (mobile) 5-20tons/hour (transportable)	80-210 tons/day (tpd)	4 tons/hour	5-10 tpd, pilot 100 tpd, proposed Commercial	2.5-3 gallons/minute; 1 (on/hour
Energy Recovery	Yes, for some units	No	Yes		No
Estimated Cost	$100-$500/ton	$150-$200/ton	$100-$400/ton	$300-$400/ton, pilot (preliminary)	$800-$2,000/ton (preliminary)
Availability	Commercial	Commercial	Commercial	Pilot. Commercial in 1 year	Commercial unit in final testing; available by mid-1989
Movability	Mobile Transportable	Mobile	Transportable	Mobile	Mobile
Startup Time	24 hours (mobile) 4-6 Week (transportable)	1-2 weeks	3 weeks, not including site preparation	l-2 weeks, proposed commercial	1 week
Vendors	(Mobile) M & S Systems, Broad Brook, CT; ENSCO Environmental Services, Little Rock, AR; Thermal Dynamics, Mt. Kisco, NY; Vesta Technology, Ft. Lauderdale, FL; Roy F. Weston, West Chester, PA; Incinerex, Houston, TX; (Transportable) ChemicalWasteManagement, Oak Brook, IL; ENSCO Environmental Services, Little Rock, AR; Envirite Field Services, Atlanta, GA; InternationalTechndogy Corp., Torrance, CA	Environmental Treatment &Technologiescorp., Findlay, OH; Reidel Environmental Services, Portland, OR; Westinghouse Environmental Services, Pittsburgh, PA	Ogden Environmental services, San Diego, CA	Westinghouse Environmental Services, Pittsburgh, PA	Westinghouse Environment Services, Pittsburgh, PA

SOURCE: Adapted from B. Rey de Castro, “Six Burn Technologies Roll Onto Sites,” *Waste* Age, February 1989; and Paul N Cheremisinoff, “Mobile, Transportable and Package Treatment Systems,” *Pollution Engineering*, April 1989.

Box 3-A—10 Case Study Sites With Capsule Findings

Case Study 1
Chemical Control **Corp.,** Elizabeth, New Jersey
EPA Region 2; NPL rank 223 out of 770
Estimated cost: $7.4 million

Unproven solidification (chemical fixation) technology was selected to treat in situ highly contaminated subsurface soil, which previous removal actions had left below the watertable and covered up with gravel. No treatability study was used. The cost of incineration was overestimated. The cleanup will leave untreated contamination onsite.

Case Study 2
Compass Industries, Tulsa County, Oklahoma
EPA Region 6; NPL rank: 483/770
Estimated cost $12 million

Capping (containment) of waste was chosen over incineration. Capping was called a cost-effective, permanent cleanup even though it does not provide permanent protection comparable to incineration. No commitment was made to treat contaminated groundwater.

Case Study 3
Conservation Chemical Co., Kansas City, Missouri
EPA Region 7; NPL rank pending
Estimated cost $21 million

Capping of the site and a hydraulic containment system to pump and treat some contaminated ground water were chosen over excavating and treating contaminated soil and buried wastes, which was recommended in an EPA study and by the State. Water treatment cannot remove all the diverse contaminants at the site. The ROD said that no estimate could be made for the duration of the cleanup.

Case Study 4
Crystal City Airport, Crystal City, Texas
EPA Region 6; NPL #639/770
Estimated cost: $1.6 million

Excavation of contaminated soils and wastes (which were buried in a previous removal action) and their disposal in an unlined landfill with a cap over it were selected over incineration. No treatability study supported the conclusion that the selected remedy is permanent on the basis of the adsorption of diverse contaminants to site soil. Major failure modes for the landfill were not examined.

Case Study 5
Industrial Excess Landfill, Uniontown, Ohio
EPA Region 5; NPL #164/770
Estimated cost: $2 million

Providing alternate water to houses that have or are likely to have contaminated wells was a satisfactory interim remedial action. However, actions to address the source of contamination and to stop and treat contaminated groundwater are long overdue.

Case Study 6
Pristine, Inc., Reading, Ohio
EPA Region 5; NPL #531/770
Estimated cost: $22 million

In situ vitrification was developed originally for radioactive soils, but its use for chemically contaminated sites is still unproven. In situ vitrification was selected—without treatability test results—chiefly because its estimated cost was about half that of onsite incineration. But the estimated cost for incineration is probably high by a factor of 2. Incineration offers more certainty and probably would cost no more than the chosen remedy. Ground water will be pumped and treated by air stripping and carbon adsorption.

Case Study 7
Renora, Inc., Edison Township, New Jersey
EPA Region 2: NPL #378/770
Estimated cost: $1.4 million

The selected remedy makes use of offsite land filling for soils contaminated with PCBs. Also, biological treatment was selected for soils contaminated with diverse organic compounds and toxic metals and for contaminated groundwater, but no treatability study supported its selection.

Case Study 8
Sand Springs Petrochemical Complex
Tulsa County, Oklahoma
EPA Region 6; NPL #761/770
Estimated cost: $45 million

EPA originally said that solidification technology was ineffective for the high organic content wastes and that onsite incineration was effective. EPA then reversed itself and selected solidification for most of the cleanup, which the responsible party had claimed effective based on its treatability study. Incineration is to be used if solidification technology is not successfully demonstrated or fails after solidified material is landfilled on the floodplain site, but criteria for failure are unspecified.

Case Study 9
Schmalz Dump Site, Harrison, Wisconsin
EPA Region 5; NPL #190/770
Estimated cost: $800,000

A simple compacted earth cover over the soil contaminated with lead and chromium was selected. Solidification/stabilization treatment was rejected, although this was a textbook example of appropriate use of the technology. Voluntary well abandonment and monitoring was chosen over pumping and treating contaminated groundwater.

Case Study 10
Tacoma Tar Pits, Tacoma, Washington
EPA Region 10; NPL #347/770
Estimated cost: $3.4 million

No treatability study results supported the selection of chemical stabilization. Significant amounts of untreated contaminants as well as the treated materials will be left onsite. The effectiveness of the treatment is uncertain. Incineration was said to offer no better protection and was rejected because of its higher cost.

SOURCE: U.S. Congress, **Office of Technology Assessment,** Are We Cleaning *Up? 10* ***Superfund Case Studies,*** **OTA-ITE-362 (Washington,** DC: U.S. **Government Printing Office, June 1988), p.** 9.

Box 3-Key Issues for Onsite *Incineration*

Extra Cost Variables-Wastes or soils with: 1) high water content or large inert objects (e.g., buried automobiles, large rocks), 2) high levels of corrosive chemicals (e.g., chlorine), or 3).high levels of toxic metals require costly materials handling, special construction, or additional pollution control technology, respectively. Materials with low heat value (low organic content) require more external fuel or energy, increasing costs. Such needs do not eliminate the intrinsic advantage of incineration: the ability to destroy organic hazardous substances.

Unit Costs==Unit costs for mobile incineration depend on volume of treated treated becasue there is significant economy of scale. Smaller cleanups are proportionately higher in cost because of high mobilization"on, set up, and testing costs. For very high volumes, unit cost is substantially lower, but total site cleanup cost remains relatively high (e.g., for a large landfill).

Environtmental Risk--General concerns about environmental risks of incineration (e.g., air pollution, no standards for toxic air emissions) can increase costs (e.g., permits, tests) and public opposition which itself results in incereased costs and delay because more data and assurances of safety must be provided.

Imcinerator Market-An inCreasing diversity of mobile incinerators, differing in: 1) size, design, and type of heating (e.g., rotary kiln, infrared, fluidized bed, plasma-arc); and 2) the degree of past experience and proven reliability, requires more analysis prior to selection of remedy and causes greater variables in estimated costs.

SOURCE: Office of Technology Assessment, 1989.

EPA's data for source control RODS (excluding no further action and groundwater cleanup decisions) for fiscal years 1987 and 1988 indicates:

- **use of land disposal/containment in 52 percent of RODS in fiscal year 1987, down to 26 percent in fiscal year 1988;**
- destruction treatment (incineration and biological) in 21 percent in fiscal year 1987, which improved to 30 percent in fiscal year 1988; and
- separation technology in 7 percent in fiscal year 1987, which increased to 21 percent in fiscal year 1988;
- various types of chemical fixation or stabilization techniques in 13 percent in fiscal year 1987, which increased to 17 percent in fiscal year 1988.

Note that some **RODS used more than one technology and that some technologies were not categorized. Separation technologies were not necessarily followed by destruction.**[10]

In understanding the selection of treatment technologies, it is necessary to take into account cost, site conditions (e.g., hydrogeology, climate, geochemistry), Complexity and widely varying levels of contamination, and other factors that may rule out technology that otherwise appears technically feasible from a more scientific perspective. But nearly always there is more than one technically feasible treatment option and increasingly the options are for onsite treatment in mobile or transportable equipment or, to a lesser extent, for in situ application to undisturbed soil or groundwater. Onsite treatment offers the advantage of eliminating the costs and risks of transporting hazardous materials and, increasingly, the high costs and limited availability of some waste treatment technologies at commercial facilities. Moreover, different treatment technologies can be combined or even used in conjunction with land disposal/containment approaches; for example, only hot spots of contamination may be excavated and treated when there are truly enormous amounts of buried materials.

Different forms of a generic technology may vary so much in terms of equipment, cost, mechanism of hazard reduction, environmental safety, and other factors that Feasibility Studies and selections of cleanup technology may have to go beyond generic categories. This situation is definitely the case for forms of thermal and biological destruction that vary greatly. Serious problems result because greater expertise and analysis is required, which can lead to longer and more costly studies.

[10]U.S. Enviworm.wntal Protection Agency, "Solid and Hazardous Waste Report for Fiscal Years 1987 and 1988," and informal corrections provided to OTA.

Box 3--Key *Issues for Biological* Treatment

Lack Of Field Experience--The enormous promise of biological treatment, as a destruction technology for organic hazardous subtances and for the conversion or recovery of some toxic metals, is impeded by the lack of documented field experience in meeting stringent (low residual contaminant level) cleanup standards. This problem is exacerbated by aggressive marketing by an increasing number of vendors with little, if any, experience. Much vendor experience has been for confidential clients, which limits detailed public information.

Chemical Specificity-Biological effectiveness is chemical-specific, meaning that sites with diverse contaminants are difficult and require more testing, verification, and process monitoring. Even variations of a type of chemical can be very significant; e.g., PCB molecules with higher numbers of chlorine ions are difficult to degrade.

Sustaining Performance--Very low and very high contaminant concentrations pose problems for sustaining biological performance. Hazardous material is both a food source and at high concentrations, potentially, a poison to microbes, depending on many factors in addition to concentration.

In Situ Problems--In situ application (i.e., leaving wastes where they are) is more difficult than using above-ground engineered equipment (i.e., bringing wastes to the *biological process)* because: 1) degree and speed of effectiveness depend on controlling critical variables such as oxygen and nutrients to sustain biological activity, 2) natural soil or aquifer conditions can inhibit effectiveness (i.e., bacteria may not be able to reach contaminants because of low permeability subsurface soil or slow moving groundwater), and 3) variations in contaminant concentrations and unexpected contamination can drastically reduce effectiveness which is difficult to detect.

Correlations of Effectiveness--Varying degrees and rates of effectiveness have not been well correlated with various waste and site characteristics. This limits learning about technology and extrapolation of results to other sites.

Uncertain Choices--A very high level of R&D is underway and substantial new or different approaches introduce uncertainty into applicability and remedy evaluation; e.g., aerobic v. anaerobic bacteria fungi v. bacteria natumily occurring site bacteria v. proprietary microbes and genetically engineered bacteria; i.e., acceptance or rejection of the generic approach requires an increasing amount of treatability testing and analysis of specific techniques, requiring more cost and time prior to critical remedy selection decisions. This problem is exacerbated by a generally low level of microbiological literacy in the cleanup workforce, especially those who examine and select cleanup remedies.

Costs-Although there is, theoretically, an intrinsic economic advantage for biological treatment (particularly with thermal destruction technologies), because of low capital, energy, and materials costs, claims of comparative cost advantages for biological cleanups discount offsetting factors, including: high testing costs, the need for using other technologies before or after biological treatment high contingency costs to account for encountering upset conditions (sudden occurrences which cause treatment systems to crash-i.e., stop performing according to specifications), sometimes long processing *times, and similar costs* for competing generic technologies (even though they might not be permanent treatment technologies) or combinations of technologies, such as low-cost separation technology followed by incineration.

Proof of Destruction Above Ground-Above-ground processing may suggest contaminant destruction which actually is contaminant transfer to the air or water. Data to substantiate contaminant destruction is often lacking, and this issue is complicated by the use of other treatment technologies (e.g., air stripping of groundwater) in a site cleanup.

Toxic Byproducts--There is very little information on production of toxic byproducts.

Process Controls--Process controls may not reflect detailed determination of failure points; i.e., combinations of loading and engineering control parameters that cause biological treatment systems to exhibit sudden effluent deterioration and failure.

Biodegradability-Lists of chemicals that say whether or not they are biodegradable reflect scientific knowledge more than engineering information and field experience.

SOURCE: Office of Technology Assessment, 19s9.

Box 3-D--Key Issues for Separation Technologies[1,2]

Identifying Contaminants--The disposition of the separated contaminant (s) requires precise identification. Sometimes a contaminant is released into the air or disposed of in a landfill, although it is always feasible to destroy organic material through Some form of incineration or to recover toxic metals.

Concentration Levels--The effectiveness and efficiency of many techniques are sensitive to the concentration of contaminants; some techniques work cost-effectively within certain concentration ranges.

Many Contaminants Need Extra Treatment—When many diverse contaminants are present, any single technology is unlikely to be fully effective on all of them. Use of several technologies can meet stringent cleanup objectives but adds significant new costs, whose avoidance may compromise Cleanup objectives. Detailed treatability testing of site materials and onsite demonstration of system are critical.

In Situ Effectiveness--For in situ techniques, soil conditions, depth of contamination, and water can drastically reduce effectiveness. Complex site conditions increase costs substantially and increase the need to show, in site demonstration, that the technology works.

[1] Separation technologies include:

- Vacuum extraction and air or steam stripping of volatile organic chemicals from soil (in situ);
- Low temperature volatilization from soil (m situ or in process equipment);
- soil flushing or washing (m situ or in process equipment);
- Solvent extraction of soils (in process equipment);
- Ak9Uippiq , carbon adsorption, precipitation, ion exchange, or freeze crystallization of contaminants in water (in process equipment).

[2] Whether a separation technology an be used for contaminant recovery (offering a permanent remedy) depends al its ability to produce P - suitable far commercial use. In combination with destruction or recovery technology, separation technology can offer a permanent remedy.

SOURCE: Office of Technology Assessment, 1989.

Use of Land Disposal and Containment--No one should jump to the conclusion that land disposal/ containment options are no longer being selected, or that they will not be selected in the future. Although there are some kinds of sites for which containment remains an appropriate action, the issue is whether to call such actions permanent remedial cleanups. There are still sites where treatment technologies are ruled out, sometimes in a preliminary screening of alternatives and sometimes on the basis of poor information and evaluation, as **OTA's case studies** have shown.[11] In many cases, containment/land disposal options are being used unnecessarily. There is more experience in rejecting treatment technologies than in selecting them. Here are (in no special order) 23 generic explanations for rejection of treatment technology, which **OTA has found are often used singly or in combination** in studies for Superfund sites:

1. Land disposal or containment provide comparable environmental protection.
2. There is too little hazardous material to justify treatment.
3. There is too much hazardous material to treat cost-effectively.
4. Treatment technology provides unnecessary risk reduction at excessive cost.
5. Excavating material would pose unacceptable short-term risks because, for example, of volatile chemicals or explosive materials.
6. There is no treatment technology with enough reliability and implementability to use.
7. The treatment technology used elsewhere will not work for this site, because of its uniqueness.
8. Future land use restrictions are sufficient and the waste can be left in the ground.
9. Natural dilution of contaminated water will be enough.
10. No one is using the contaminated groundwater.
11. An alternative source of water has already been provided.
12. If treatment was used, the clean material would only get re-contaminated because of other sources of contamination.
13. Information on the true extent of contamination and risk exposure is still incomplete and more studies are necessary.

[11] U.S. Congress, Office of Technology Assessment, *Are We Cleaning Up? 10 Superfund Case Studies*, OTA-ITE-362 (Washington, DC: U.S. Government Printing Office, June 1988).

14. No test results show that the technology works for this site's problem.
15. The costs of the treatment technology cannot be estimated.
16. The local community does not want uncertain, innovative treatment technology to be used.
17. If incineration is selected, some commercial operation will begin after cleanup and other people's wastes will be treated on-site.
18. Regulatory permits cannot be obtained expeditiously.
19. The residues of the treatment are hazardous and will have to be disposed of at a permitted hazardous facility at great cost.
20. The law does not say that treatment technology must be selected, only that it be examined and given preference.
21. The technology will not treat all the contaminants at the site.
22. If the technology is used, then some other treatment technology will also have to be used afterwards for residues.
23. Natural treatment will take place through, for example, biodegradation, adsorption to soil, or release to the environment.

Of course, sometimes such explanations for rejection are valid. But when this is so it is necessary to give a well-documented technical case or logical analysis rather than mere assertion. Moreover, many times an obstacle could be effectively overcome if a decisionmaker has the will to do so. For example, poor information can be corrected and tests can be conducted.

Last, there is the emerging issue of how newly developing land disposal restrictions for hazardous waste under the Resource Conservation and Recovery Act (RCRA) affect Superfund cleanup decisions in response to the SARA statutory requirement to comply with current government regulatory standards. Briefly, EPA's current guidance to people implementing Superfund suggests several ways to justify using land disposal by evading land disposal restrictions, particularly treatment requirements: [12]

- The cleanup waste must be placed, but placement does not include: waste capped in place, waste consolidated within a cleanup unit, waste treated in situ, waste processed within the unit to improve its structural stability for closure or for movement of equipment over the area.
- The cleanup waste may not be a RCRA hazardous waste and is not sufficiently similar to a known RCRA waste.
- The cleanup waste may not be restricted in a regulatory sense.

Box 3-E—Key Issues for Chemical Fixation

Permanency-Although there are increasing claims of permanency for new and advanced forms of fixation, there is very little scientific evidence to verify irreversible molecular change for organic contaminants or chemical bonding for toxic metal atoms. Any such evidence cannot be extrapolated from one contaminant to another. Solidification (forming a hard solid) does not necessarily mean that the material is resistant to leaching-out of contaminants.

Contaminant Compatibility-There is too little recognition that using the technology for sites with diverse contaminants requires extensive fine-tuning of formulations. Incompatible contaminants can reduce effectiveness substantially.

Long-Term Effectiveness-Long-term effectiveness cannot be proven experimentally (unless permanency is demonstrated) and modeling has inherent uncertainties. For example, changing environmental conditions (e.g., acidity, chemistry, temperature) might cause increased leachability of contaminants from solidified/treated material.

Air Releases--Processing and mixing of materials can release volatile contaminants into the air.

Volume Increase—Often, there is a large volume increase which may complicate onsite disposal.

Dangers of Private Formulas-An increasing number of vendors offer proprietary formulations, leaving users with significant uncertainties, such as questions about worker health and safety, toxic byproducts, and patent infringement.

SOURCE: Office of Technology Assessment, 1989.

[12] U.S. Environmental Protection Agency, op. cit., footnote 5.

. If treatment standards cannot be met: apply for a no-migration petition; apply for a case-by-case extension; apply for an equivalent treatment method petition; delist the waste; or apply for treatability variance through rulemaking or administrative permission, particularly for soil and debris cleanup wastes.

It seems, therefore, that expectations that the RCRA land disposal restrictions might promote more use of treatment technology in cleanups should be tempered by the many ways such requirements may be circumvented. For example, many cleanups consist of capping waste in place or consolidating site wastes within a cleanup site.

New Technologies--Though more sites **are** using permanent cleanup technologies, new technologies still face difficulties. It may seem to some people that progress is being made because, for example, rotary kiln incineration and not land disposal is chosen for a cleanup. However, some other permanent technology, such as a newer form of thermal destruction or a type of biological treatment, might offer cost, environmental, or technical advantages but has not even been considered and evaluated. Although nearly everyone working within the Superfund system understands the congressional intent to shift to permanently effective cleanup technologies and acknowledges the public's support of that policy, numerous factors account for its slow and uneven implementation.[13]

One recent survey concluded, "The array of technological tools available for treatment of hazardous waste streams and site remediation continues to grow at an ever faster pace . . . In fact, technological advance is in many ways outpacing the rate at which treatment choices made by regulatory agencies can be put into action. . . . The regulatory push toward permanent solutions that can be accomplished onsite and that avoid present and future risk liability is likely to spawn many more new technologies of varying applicability. ' '[14]

A study by Tufts University concluded that ". . . there are elements which result in a bias against the use of innovative treatment technologies. . . Limited data on cost and operational history has resulted in screening out innovative technologies early in the evaluation process. Because of the liability for damages resulting from failure of the technologies, contractors, potentially responsible parties, and government alike are reluctant to recommend the use of innovative technologies that have not been fully demonstrated to remedy hazardous waste problems. "[15]

The frustration of technology developers is widespread. This is what one developer said at a congressional hearing: ''The Remedial Division, the group which should be performing cleanups as dictated by the principles of SARA, appears so wedded to A&E (architecture and engineering) firms for their Records of Decision that it appears virtually impossible to get a new technology accepted in any reasonable time."[16] EPA has made progress in overcoming obstacles to using treatment alternatives to land disposal and has recently clarified its policy objectives,[17] but use of new treatment technologies still faces major obstacles (see following issues).

There is a significant lag not only between research and development and demonstration but also between successful demonstration--considered here as enough onsite work with site materials to establish technical effectiveness and reliability—and full-scale application. This lag tends to push the expanding national cleanup effort toward older technologies rather than toward the risk and uncertainty—but the chance for bigger payoff--of newer technologies. Furthermore, the public may have little patience with delays in Superfund cleanups. In other words, insecurities inside the Superfund system and pressures from outside cause the adoption of newer

[13] See OTA's 1988 report and following issues.

[14] Jim Bishop, "Treatment Technologies,'' *Hazmat World*, June 1989.

[15] Center for Environmental Management, Tufts University, "The Use of Innovative Treatment Technologies at Superfund Sites, " *Environment.d Impact Assessment* Review, vol. 8, 1988, pp. 181-191.

[16] Paul S. McGough, statement made at hearing, Subcommittee on Transportation, Tourism, and Hazardous Materials, Committee on Energy and Commerce, U.S. House of Representatives, Hoboken, NJ, Dec. 7, 1987.

[17] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response memorandum, ''Advmcing the Use of Treatment Technologies for Superfund Remedies," OSWER Directive No. 9355.0-26, Feb. 21, 1989.

technologies to be slow even as the need for them is increasing,

Information transfer and communication are key problems too. For both the general public and members of the Superfund workforce, it is difficult to cope with the flood of scientific and technological data and details, which is increasing at a rapid rate as more vendors enter the market. But technology development and selection of new technologies are crucial to making Superfund work more effectively and efficiently.

***The SpeciaI Case of Pump and Treat for* Groundwater-Cleaning** up contaminated groundwater increasingly means using the pump-and-treat approach, which means that contaminated groundwater is pumped up to the surface and treated in some manner. The treated water may then be pumped back into the ground (through injection wells), sent to a municipal water treatment plant for further treatment, or discharged to a river. The increasing use of pump and treat is in response to the public demand for cleanup of contaminated groundwater. However, over the past few years, there has been increasing discussion in the technical community (particularly from EPA's Robert S, Kerr Laboratory, Ada, Oklahoma) of the uncertainty and probably ineffectiveness of pump and treat. Some key thinking and findings on this issue are excerpted below:

- '' [U]nless the hydrology and contaminant characteristics at the site are adequately understood, the perceived success of pump-and-treat technology can be misleading. A failure to understand the processes controlling contaminant transport can result in extremely long pumping periods and consequently, costly and inefficient remediation."[18]
- ''Using current site investigation and remediation technologies, it is not possible to locate all significant contamin ation, nor can anyone accurately predict contaminant movement, fate, exposure, effects, or remedial technology performance.[19]
- "[T]here are two principal phenomena of subsurface contaminant movement that limit the effectiveness of pump-and-treat remediation. One is the hydrologic effects of subsurface heterogeneity. In the real world, ground water flows through preferential pathways; that is, through zones of higher permeability . . . The practical effect on pump-and-treat remediations is that it may take much longer to flush out or exchange the water in zones of finer grained materials than is estimated from traditional mathematical models that average flow rates over the thickness of the aquifer. The result is the long tailing effect on (contaminant) recovery curves. . , This effect increases with the age of the contamination because of more time for the pollutants to diffuse into the finer grained subsurface materials.

  "The second phenomenon concerns the chemical and physical forces that retard the movement of contaminants in relation to water movement. Most contaminants sorb onto and into aquifer materials and 'partition' between the solid and liquid phases, Many common contaminants also have a vapor phase in the subsurface. . . . [T]he amount of contaminants in each of these phases is a function of the characteristics of the subsurface material and the chemical properties of the contaminant. If only samples of groundwater are used to estimate the amount of contaminants to be removed by pumping, that amount will often be greatly underestimated because, in general, most of the contamination will be associated with the solid phase. Slow contaminant transfer from geologic material to water, where it can be extracted by pumping, is further exacerbated when immiscible fluids are present."[20]
- "An analysis of the mechanisms that control separate phase migration and dissolution reveals that groundwater extraction as a cleanup

[18] Clinton W. Hall, ''practical Limits to Pump-and-Treat Technology for Aquifer Remediation, ' *Hazardous Materials Technical Center Newsletter,* July *1988.*

[19] William A. Wallace and David *R.* Lincoln, ''How Scientists Make Decisions About Groundwater and Soil Remediation, ' presented at National Research Council Colloquium *Remediating Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?*

[20] Clinton W. Hall (Director of EPA's Robert S. Kerr Environmental Research Laboratory), letter to OTA, Sept. 6, 1988.

technology is very inefficient-Petroleum hydrocarbon and organic solvent liquids are trapped within porous media as ganglia and lenses due to air-liquid and water-liquid interracial surface tensions.[21] Water table fluctuations, either regionally or locally, can emplace lighter-than-water liquids below the water table as lenses. Under conditions encountered in aquifers, these ganglia and lenses cannot be mobilized by groundwater extraction. . . . The time required for separate phase contaminant dissolution into groundwater is on the order of decades and produces a dilute waste stream that is expensive to treat. The low boiling points of these liquids indicate that steam injection could mobilize the trapped contaminant phase. A series of experiments has demonstrated the inadequacy of groundwater pumping and the feasibility of steam injection for complete recovery of separate phase liquid contaminants. '[22]

- ''Depending upon the nature of the subsurface terrain and the composition of the contaminants present, remediation may be relatively easy or virtually impossible. . . . [T]here needs to be a recognition that there are many existing sites of contamination that, if not entirely beyond our ability for rectification in an environmentally satisfactory way, may at least require many years to remediate, may involve enormous sums of money, and may create other environmental and social problems that may be equal to or greater than that posed by the contamination itself. Because of the great diversity of the problem sites, setting criteria and priorities for cleanup is not a simple task. An easy solution is not likely to be found. Even the effectiveness of proposed solutions is often quite uncertain because of the many unknowns inherent in site characterization and the absence of proven technologies for remediation. ' '[23]
- "New models have been developed that are potentially sophisticated enough to deal with almost any geologic or hydrologic setting. The problem now lies in our continuing inability to collect sufficient subsurface information to use in the models. Because of the nature of the subsurface, the uncertainties can never be resolved with today's investigation technology.

  " . . . [T]he hazardous waste engineer might reasonably want to know in which direction a plume of dense, pure-phase TCE (trichloroethylene) might flow along the base of an aquifer and whether or not it would be possible to follow it to a low point and extract it through a well.

  " . . . [T]he answer to the hazardous waste engineer's question is just not obtainable, and, therefore, the pure-phase TCE can neither be located, if it exists at all, nor extracted during the cleanup.

  "There is not now, nor will there soon be, quantitative guidance or standards to go by in designing hazardous waste site investigations. (Best judgment) will occasionally result in *errors:* unnecessary samples will be taken; data of the wrong quality will be collected and will have to be collected again; and other errors will occur."[24]
- ''For NAPLs (non-aqueous phase liquids) such as benzene and other petroleum products, which tend to float on groundwater, there have been successes in pumping a significant fraction of the NAPL to the surface. Yet for others

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21 The issue of whether contaminants sink or float in groundwater is very important. In general, petroleum-based materials are lighter than water, and chlorinated chemicals are heavier than water. Volubility in water also determines the physical state of contaminants in groundwater. Dense chlorinated solvents, for example, are not very soluble in water either; therefore, they will tend to sink in aquifers until stopped by the solid aquifer material, and then they may spread laterally. Over time, more of the contaminant may dissolve in the groundwater, particularly if the water is moving, exposing cleaner water to the contaminant. Lighter-than-water contaminants float on the surface of underground water. Essentially pure, discrete forms of insoluble liquid contaminants in an aquifer are just like above ground or subsurface soil sources of contamination, which enter the groundwater because of vertical downward motion, perhaps with the help of water entering the site and moving into the aquifer.

22 James R. Hunt et al., "Organic Solvents and Petroleum Hydrocarbons in the Subsurface: Transport and Cleanup," University of California, Berkeley, *Sanitary Engineering and Environmental Health Research Laboratory Report No. 86-11*, August 1986. Note that steam injection faces many of the same problems as pump and treat and it has not yet reached commercial availability.

23 Perry L. McCarty, "Scientific Limits to Remediation of Contaminated Soils and Ground Water, " presented at National Research Council Colloquium, *Remediating Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?* April 1989.

24 Hazardous Waste Action Coalition, American Consulting Engineers Council, *The Hazardous Waste Practice—Technical and Legal Environment 1988*, 1989.

more dense than water (e.g., chlorinated solvents, creosote, and PCB-rich oils), very little success has been achieved in even locating the subsurface NAPL sources, let alone removing them.

. . . [E]ven after exceptionally detailed site investigations are conducted, it is normally not possible to predict reliably where these (dense) NAPL pools are, Not knowing the size and location of (dense) NAPL pools and zones of residual (dense) NAPL makes it impossible to predict how long a pump-and-treat program must operate in order to clean the aquifer.

''The mass of NAPL at or below the water table is not known with sufficient detail at most sites to make reliable predictions of the time necessary for cleanup by pump-and-treat programs. In general, it is appropriate to view such approaches as remediation **in perpetuity** [emphasis added]. "[25] (In contrast to this view about NAPLs, EPA's view seems overly optimistic. *6)

- "Complex groundwater flow patterns present great technical challenges in terms of characterization and manipulation (management) of the associated contaminant transport pathways. . . . One result is that certain parts of the aquifer are flushed quite well and others are remediated relatively poorly. Another result is that those previously uncontaminated portions of the aquifer that form the peripheral bounds of the contaminant plume may become contaminated by the operation of an extraction well that is located too close to the plume boundary, because the flowline pattern extends downgradient of the well. The latter is not a trivial situation that can be avoided without repercussions by simply locating the extraction well far enough inside the plume boundary so that its flowline pattern does not extend beyond the downgradient edge of the plume, because doing so results in very poor cleansing of the aquifer between the location of the extraction well and the downgradient plume boundary.

  "It is not possible to determine precisely where the various flowlines generated by a pump-and-treat operation are located, unless detailed field evaluations are made during remediation. Consequently, there is a need for more data to be generated during the remediation (esp., inside the boundaries of the contamination plume) than were generated during the entire RI/FS process at a site, and for interpretations of those data to require much more sophisticated tools. '[27]
- "Originally, we were confident long-term groundwater remediation (i.e., pump-and-treat) could be accomplished in approximately 20 years. Now, with our present knowledge and experience, many professionals suggest these actions may take much longer, in some cases up to 100 years. , . . Is it cost-effective to continually remediate ground water or should we accept wellhead (point-of-use) treatment and rely on natural attenuation for the aquifer? If we do, then what will be the long- and short-term impacts on surface water and the environment? '[28]
- "Complex fate and transport mechanisms of contaminated ground water often make it difficult to predict accurately the performance of ground water remedial action, . . . To illustrate this principle, figure 3-1 presents three possible situations that may occur after several years of a groundwater response action. In the first scenario (case A), the target concentration will be reached within the desired time period. In the second scenario (case B), the target concentra-

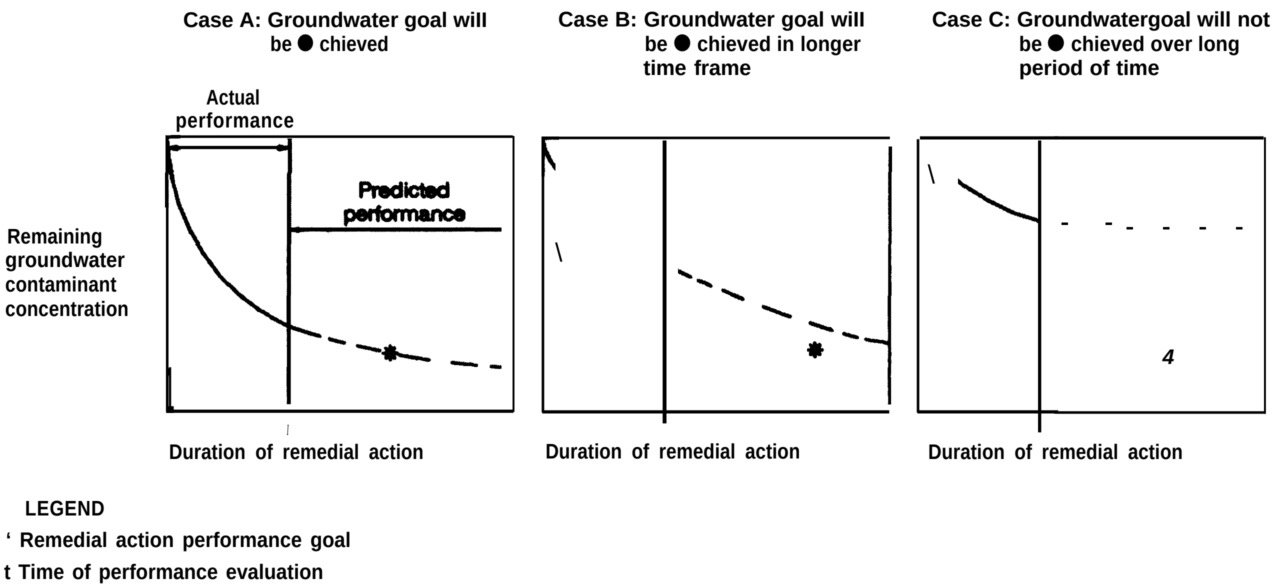
[25] Douglas M. Mackay and John A. Cherry, "Groundwater Contamination: Pump-and-Treat Remediation, ' *Environmental Science and Technology*, vol. 23, No. 6, 1989.

[26] U.S. Environmental Protection Agency, *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites*, December 1988. EPA's view is: ''The presence of dense non-aqueous phase liquids (DNAPLs) also may affect the extent to which contaminants can be removed from the ground water; points of accumulation are difficult to Identify, and, unless the well screen is located in the non-aqueous liquid phase, the contaminant will only be extracted slowly as it dissolves into the groundwater. '

[27] Joseph F. Keely, ' 'Performance Evaluations of Pump-And-Treat Remediations,'' draft of EPA Superfund Groundwater Issue Paper. See following discussion on the observational method.

[28] Stephen R. Wassersug and Christopher J. Corbett, ' 'Policy Aspects of Current Practices and Applications,'' presented at National Research Council Colloquium *Remediating Ground Water and Soil Contamination Are Science, Policy, and Public Perception Compatible?* April 1989.

figure 3-1-Possible Restoration Scenarios When Evaluating Performance Data



SOURCE: National Research Council, *Hazardous Waste Site Management: Water Quality Issues*, report on a Colloquim sponsored by the Water Science and Technology Board (Washington, DC: National Academy Press, 1988).

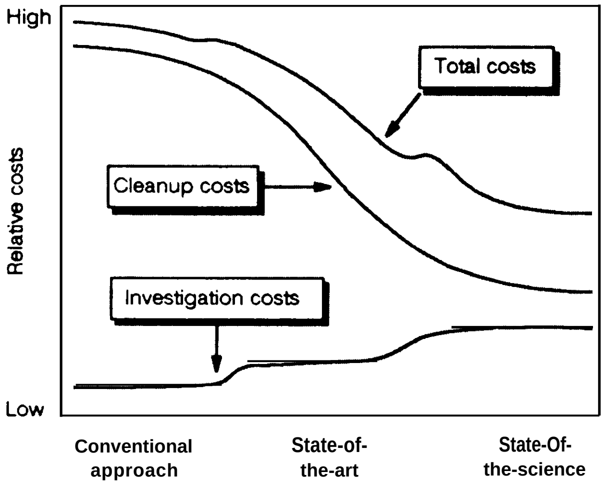
tion will be reached somewhat later than the desired time period. In the final scenario (case C), the target concentration will not be reached in a foreseeable time period. "[29] (This is an idealized portrayal wherein contaminant concentration declines continuously to an apparently irreducible level. In actual fact, contaminant rebound may occur after pumping is stopped and then started again because of diffusion of contaminants within spatially variable sediments, hydrodynamic isolation, sorption-desorption, and liquid-liquid partitioning. The main problem, however, is that case C seems to be a far more likely situation than originally thought.)

- ''There seems to be widespread overconfidence among those not directly" involved in groundwater quality research regarding the ability to predict transport and fate of contaminants in the subsurface.

"Additional effort devoted to site-specific characterizations of natural process parameters, rather than relying almost exclusively on chemical analyses of groundwater samples, can significantly improve the quality and cost-effectiveness of the remedial actions at such sites. . . . [S]ome investment in specialized equipment and personnel will be needed to make the transition to more sophisticated approaches, but those investments will be more than paid back in reduced cleanup costs (see figure 3-2). The maximum return on increased investments is expected for the state-of-the-art approach and will diminish as the state-of-the-science approach is reached (see table **3-2)** because highly specialized equipment and personnel are not widely available. It is vitally important this philosophy be considered because the probable benefits in lowered total

[29] Edwin F. Barth III et al., ''Establishing and Meeting Ground Water Protection Goals in the Superfund Program,'' *Hazardous Wrote Site Management: Water* Quality Issues (Washington, DC: National Academy Press, 1988),

Figure 3-2--Concaptuallzatlon of the Trade-offs Between Investigation and Cleanup Coats as a Function of the Sophistication of Site Characterizatlon Efforts



SOURCE: *Journal WPCF*, vol. S6, No. 5, May 1966,

costs, health risks, and time can be substantial."[30]

OTA's main conclusions from its assessment of pump-and-treat technology are:

1. **Superfund implementation (i.e., Records of Decision) currently conveys a sense of certainty about groundwater contamination and cleanup that is inconsistent with the above kinds of insights.** Some private sector practitioners also convey a different viewpoint; a recent article said this about pump-and-treat: **"This method is effective** with most, if not all, types of contaminants. Remediation time, while protracted, is predictable. "[31] This kind of general optimism misleads the public. Both duration and potential to achieve cleanup objectives are highly uncertain with the prevalent pump and treat method, especially for complicated sites. Little attention seems to have been paid to addressing multiple sources of aquifer contamination, which really adds complexity to groundwater cleanup. Other than non-point contributions to contamination (e.g., pesticide runoff), individual aquifers may face contamination from multiple Superfund sites. An EPA study of 877 sites found 12 aquifers threatened by three or more sites,[32] yet few Superfund cleanups seem to be integrated with other ones. All things considered, the current large commitment of money to pump-and-treat groundwater cleanups may be largely misdirected **with current practices.** Except for the simplest contaminated groundwater, current technology and practice do not offer a reliable cost-effective solution. The latest thinking about groundwater cleanup by **EPA's** Superfund office does not convey the generally negative view about pump and treat consistently found in the technical community .33 Moreover, inevitably, the public will learn what the technical specialists know. Indeed, Superfund's technical assistance grants virtually assure this. One of the frost reports from this program illustrates how this public knowledge will probably influence EPA cleanup decisions, as summarized in box 3-F.

2, **Because of the difficulty in cleaning up groundwater, much more attention should be given to identifying and removing the source of groundwater contamination.** In the past, the size and complexity of buried waste and soil contamination have sometimes lead to groundwater cleanup starting without any source elimination. While capping such a site has the merit of minimizing water infiltration, it does not preclude continued movement of contaminants into the groundwater,

30Joseph F. Keely et al., "Evolving Concepts of Subsurface Contaminant Transport,' *Journal of the Water Pollution* Control *Federation, vol. 58, No. 6, May 1986.* As an example of improved practice, see Steven M. Gorelick, "Reliable Remediation of Contaminated Aquifers," in *United States Geological* Survey Yearbook *Fiscal Year 1988, 1989.* The new methodology described are techniques that use combined simulation-management models; these join computer simulation techniques, for predicting subsurface contaminant migration, with advanced mathematical and statistical methods, for determining alternative and economical designs for remediation. Thousands of simulations for each site are necessary to assess and design reliable cleanups.

31Gary J. Ziegler, "Remediation Through Groundwater Recovery and Treatment, " *Pollution Engineering,* July 1989.

32U.S. Environmental Protection Agency, "Extent of the Hazardous Release Problem and Future Funding Needs—CERCLA Section 301(a)(1)(C) study, *' December 1984.

33U.S. Environmental Protection Agency, *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites,* December 1988. Months earlier, a former senior Superfund manager published an article which discussed "a recent analysis by EPA's own Office of Research and Development' that revealed the problems discussed here with pump and treat. Gene A. Lucero, "Son of Superfund—Can the Program Meet Expectations," *The* Environmental *Forum,* March/April 1988.

Table 3-2-Site Characterization

Conventional approach	State-of-the-art approach	State-of-the science approach
Actions typically token	***Recommended actions***	**Idealizes *approach***
Install a few dozen shallow monitoring wells	Install depth-specific well clusters	Assume state-of-the-art approach as starting point
Sample and analyze numerous times for 129+ pollutants	Sample and analyze for 129+ pollutants initially	Conduct tracer-tests and borehole geophysical surveys
Define geology primarily by driller's log and cuttings	Analyze selected contaminants in subsequent samplings	Determine percent organic carbon, exchange capacity, and other other properties of solids
Evaluate hydrology with water level maps only	Define geology by extensive coring/split-spoon samples	Measure redox potential, pH, dissolved oxygen, and other properties of fluids
Possibly obtain soil and core samples (chemical extractions)	Evaluate hydrology with well clusters and geohydraulic tests	Evaluate sorption-desorption behavior using select cores
	Perform limited tests on solids (grain size, clay contents)	Identify bacteria and assess potential for biotransformation
	Conduct limited geophysial surveys (resistivity soundings)	
Benefits	***Beneflts***	***Benefits***
Rapid screening of problem	Conceptual understanding of problem more complete	Thorough conceptual understanding of problem obtained
Moderate costs involved	Better prospect for optimization of remedial actions	Full optimization of remedial actions possible
Field and lab techniques standardized	Predictability of remediation effectiveness increased	Predictability of remediation effectiveness maximized
Data analysis relatively straightforward	Cleanup costs lowered, estimates improved	Cleanup costs lowered significantly, estimates reliable
Tentative identification of remedial options possible	Verification of compliance more soundly based	Verification of compliance assured
Shortcomings	***Shortcomings***	***Shortcomings***
True extent of problem often misunderstood	Characterization costs somewhat higher	Characterization costs significantly higher
Selected remedial alternative may not be appropriate	Detailed understanding of problem still difficult	Few previous field applications of advanced theories
Optimization of remedial actions not possible	Full optimization of remedial actions not likely	Field and laboratory techniques not yet standardized
Cleanup costs unpredictable and excassive	Field tests may create secondary problems	Availability of specialized equipment low
Verification of compliance uncertain and difficult	Demand for specialists increased	Demand for specialists dramatically increased

SOURCE: Joseph F. Keely et al., "Evolving Concepts of Subsurface Contaminant Transport," *Journal WPCF*, vol. 5S, No. 5, May 1966.

resulting from subsurface groundwater flow through the site's contamination or possibly the sinking of dense liquids. Nor is the long-term effectiveness of caps assured; many current Superfund cleanups put new caps on older ones which evidently were not effective. (The intrinsic problems of pump and treat should be borne in mind for soil cleanup based on flushing, because the same subsurface problems pertain.)

3. **Making pump and treat more predictable and effective requires improved practices which will tax the current workforce and may increase costs substantially.** Still, development of improved pump-and-treat practices is important. However, more strategic thinking and economic analysis should go to two other primary options:

a. Point-of-use treatment: "Serious consideration should be given to point-of-use treatment for contaminated groundwater rather than attempting to reverse the random movement of organic molecules at tremendous pumping and treatment expense. The pumping and treatment of billions of gallons of groundwater to recover a few pounds of spilled solvent requires serious rethinking. Technology development should focus on how to economically and consistently surpass low part-per-billion treat-

Box3-F--How a TecbnicalAssistance Grant[1] Analysis Concluded That a Pump-And-Treat Approach Did Not Offer a Reliable Cleanup of Groundwater

The following excerpts illustrate how an understanding of the limits of pump and treat can affect a community's perception of a remedy proposed by EPA, in this case one largely based on site containment and pump and treat. The community and its technical advisers, of course, wanted the groundwater cleaned up. But their insights into the limits of pump and treat led them to other alternatives, including obtaining the kind and quantity of information necessary to make pump and treat work effectively and giving higher priority to effective source control of the contaminants in the landfill (through identification of hot spots for excavation and treatment, for example). This particular experience also illustrates how the U.S. Geological Survey can perform analyses of use to Superfund site investigations and selection of remedies; their work was not integrated into EPA's efforts.

". . . [T]here are too few wells, particularly to the south and west of the landfill, to define the full extent of the contaminant plume or to understand the complex pattern of groundwater flow. The U.S. Geological Survey has reached the same conclusion. Furthermore, the EPA used inappropriately low flow rates to estimate the area of the potentially contaminated groundwater.

"... [A] groundwater punp and-treatment system based on ERA's current understanding of flow may be grossly inadequate to prevent the continued offsite contamination of groundwater. If potent NAPL [non-aqueous phase liquid] pools are present they may be drawn into the extraction wells and overwhelm the treatment system designed for much lower contaminant levels. Another possibility is that lowering the groundwater under the landfill (resulting from groundwater extraction) may actually dislodge NAPLs and thus aggravate groundwater contamination problems.

"An evaluation of the site remedy selected by EPA in the Feasibility Study is not possible at this time because the database defined by the RI is insufficient to evaluate the effect or the efficacy of the proposed pump-and-treat system.

".,. the USGS report prepared for ATSDR (Agency for Toxic Substances and Disease Registry) evaluated the hydraulic characteristics of the flow system over an area encompassing 4 square miles. This large-scale view allowed them to place the IEL site in a proper regional context and led to conclusions which are at odds with those reached by EPA.

"The approaches selected do little, if anything, to remove or even stabilize the potentially large amounts of toxins in the landfill. This is exactly what one would expect since they based the selection of the proposed remedies on a lack of data on what is in the landfill. "

(It should be noted that EPA's Proposed Plan for the site (December 1988) offers no information on risk or risk reduction or any specific information on the objectives of the groundwater cleanup. Nor does it say anything about the limits to or uncertainty of pump and treat. The Feasibility Study for the site speaks of meeting MCLs and preventing a lifetime cancer risk of from 1 in 10,000 to 1 in 10 million (i.e., the broadest risk range used by EPA), but gives no specifics.)

[1]Technical Assistance Grants were established by Congress m SARA to assist communities in obtaining help from independent technical experts.

SOURCE: "Comments on EPA's Preferred Remedial Alternative for the Industrial Excess Landfill Superfund Site in Uniontown, Ohio," prepared for The Concerned Citizens of Lake Township by The Clam Water Fund, Disposal Safety be., and The HampshireResearch Institute, May 31, 19s9.

ment levels with a margin of safety required for potable water supplies. "[34]

b. Other aquifer cleanup methods: **There is a clear** need for a focused R&D effort to find more reliable groundwater cleanup methods, including site investigation techniques. Some form of enhanced in situ biological treatment is particularly desirable, but other approaches, such as injection of steam or surfactants, also need more support. The in situ biological approach is probably the most important option and it is currently receiving much attention

[34]Douglas C. Downey, ''Applying New Technologies: A Scientific Perspective, ' presented at National Research Council Colloquium, *Remediating Ground Water and Soil Contamination: Are Science, Policy, and Public Perception Compatible?* April1989.

and some use. But the advice of two groundwater experts should be heeded: "Laboratory studies and small-scale field prototype trials are likely to yield overoptimistic expectations for the application and efficiency of these (new) technologies. ' '[35]

Another important view is: "In situ biodegration is frequently among the remediation options recommended for soil and groundwater decontamination. . . . Our experience has shown that a 250-milliliter flask has little or nothing in common with the contaminated subsurface and its response to nutrient and hydrogen peroxide (oxygen) additions. Permeability problems and rapid decomposition of hydrogen peroxide have both been documented in the field with little warning from laboratory experiments. While microbiologists have proven the principles of biodegradation in the laboratory, engineers are having less success achieving a uniform reaction in heterogeneous aquifers. "[36] An independent review of experiences with biological groundwater cleanups came to generally negative conclusions about their proven effectiveness, including: "While seeding of an acclimated or mutant microbial population holds a great deal of potential . . . results from previous attempts have not proven it to be responsible for the removal of contaminants. Further work needs to be done to demonstrate that seeding microbes is a viable technique for the restoration of contaminated aquifers. "3[7] One of the more detailed case studies for a Superfund site concluded". . . the large volume of ground water that has flowed through ***the*** contaminated zone has failed to produce appreciable removal of the sorbed contamination. . IB]iodegradative processes were a major means of dissolved contaminant removal [emphasis added].' **A** study of anaerobic biodegradation of groundwater at a Superfund site confirmed that trichloroethene resulted in the production of vinyl chloride as a toxic byproduct.[39]

4. **Cleanups using pump and treat may be stopped because data on pumped groundwater indicates that contaminant concentration has reached a stable low level, but in fact subsequent testing (or testing in different locations) might show that contaminant levels have increased or rebounded.** Original cleanup objectives should not be foregone (or changed to whatever the technology has been able to deliver) until there is convincing evidence that equilibrium has been achieved (case C in figure 3-1) and that no other cleanup options exist. Current **EPA** thinking on this issue is to favor a "flexible decision process" that includes using performance information to change the cleanup objectives.[40]

Moreover, there is some indirect indication that EPA is already adjusting its cleanup objectives for sites to reflect, in some way, the problems with pump and treat. For example, the cleanup level for carcinogens in groundwater at the Seymour Recycling site (which was assessed to pose a relatively high aggregate risk of **4** in 10,000) is an aggregate risk of 1 in 100,000 in addition to meeting individual MCLs (maximum contamination levels under the Safe Drinking Water Act), One of the reasons given to justify this cleanup level (which is less stringent than the more typical 1 in 1 million risk level) was "low levels of contaminants will continue to migrate when the extraction system is terminated. "[41] In other words, the more typical, more stringent cleanup level would be difficult to attain.

5. There is a distinct possibility that, for some sites, natural attenuation, including biodegradation, of contamination within the aquifer might produce essentially the same cleanup results as lengthy and costly pump and treat. Research on biodegradation is ongoing and some results are very positive, but it is not yet a reliable cleanup alternative. Indeed, a recent study of a site for which natural attenuation

35Mackay and Cherry, op. cit., footnote 25, 1989.

36Downey, op. cit., footnote 34.

37L.W. Canter and R.C. Knox, *Ground* Waler *Pollution Control* (Chelsea, MI: Lewis Publishers, 1986).

38Robert Doyle and Michael Piotrowski, "In-situ Bioremediation at a Superfund Site," *The Second Annual Hazardous Materials Management Conference/Central*, proceedings of conference March 1989, Tower Conference Management Co., Glen Ellyn, IL.

39Lyle R. Silka and Douglas A. Wallen, "Observed Rates of Biotransformation of Chlorinated Aliphatics in Groundwater," *Superfund* '88, proceedings of November 1988 conference, Hazardous Materials Research Institute, Silver Spring, MD.

40U.S. Environmental Protection Agency, op. cit., footnote 33.

41EPA, "Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites, ' December 1988.

was selected concluded that site conditions favorable to natural attenuation ''are not going to be found at a large number of sites, due primarily to complex hydrogeologic conditions and significant exposure potentials. '[42] Augmentation of natural biodegradation by supplying dissolved oxygen, for example, has possibilities, but success depends on a variety of factors, such as the soil permeability and groundwater flow rates being high enough.

6. It should be understood that there are appropriate uses of pumping groundwater to contain the movement of a plume of contamination and to treat relatively simple, well understood aquifers and relatively simple and well identified types of contamination. Indeed, beginning pump and treat very early at a site may be important as a recontrol measure. Improved practices are needed to make these applications more cost-effective. However, pumping contaminated groundwater and reinfecting it upgradient in order to prevent plume migration and contamination from entering a sensitive area (e.g., a withdrawal well for a municipal water supply, a river) is also uncertain. For example, one modeling study showed that the effect of pumping and injection was "to reduce the total amount of contaminant entering the river at the onset of the operation and to spread contaminant flow into the river at later times. ' '[43] The point is that the method reduced the average concentration of the contaminant entering the river over many years, but eventually all the contamination reached the river.

Comments on the Observational Method-The Hazardous Waste Action Coalition, a trade association of hazardous waste technical consulting firms, has endorsed what it calls the observational method as appropriate for hazardous waste site investigation, assessment, and remediation design and implementation.[44] In addition to hypothesized environmental benefits from improved recognition and resolution of the inevitable uncertainty about a site's contamination, reduction of contractor liability is a goal in adopting the observational method. The observational method seems to be especially relevant to the problems of groundwater contamination discussed above, The method is based on the correct belief that no amount of site study can eliminate all uncertainties about the site's problem(s) and the effectiveness of the selected remedy (ies). However, after examining the main points of the observational method, OTA concludes that in addition to its potential benefits there are significant implementation issues and problems, as discussed below under the five key contributions defined by the coalition. After this discussion, two alternatives or supplements to the observational method are presented.

1. "*The site remediation design is based on the most probable site conditions. '* Remediation design follows the formal government decision on cleanup objectives and remedy selection. Remedy design is currently based on the best understanding of the site's contamination and conditions. Therefore, this contribution does not say anything different than current and necessary practice. The implication that current practice presumes complete and certain understanding of a site's cleanup problems and natural conditions might have been true for some people early in the cleanup business; but most people are now skeptical about obtaining site information in the Remedial Investigation which is the last word. The need is only to obtain enough good information to select a cleanup strategy, the details of which will be worked out in the design phase.

2. "*Reasonable deviations from these conditions are formally identified and accounted for.* This approach seems beneficial. Presumably, the formal remedy design, performed by an engineering consulting firm, would identify potential deviations concerning site contamination and natural conditions which might arise from new information about the site. But there are typically a lot of possibilities which could be identified. This approach, therefore, might add significant new costs to the design part of the process. There is a potential for unnecessary

[42] Richard L. Hebert et al., "Case Study of Factors Favoring Natural Attenuation as the Preferred Alternative for Aquifer Restoration," *Superfund* '88, proceedings of conference November 1988, Hazardous Materials Control Research Institute, Silver Spring, MD.

[43] R.W. Nelson, ''The Need t. Update Groundwater Pollution Control Strategies—A Technical Basis and Historical Perspective,' Proceedings of the International Conference on Advances in Groundwater Hydrology, Tampa, FL, November 1988.

[44] The Bead of Directors of the Hazardous Wrote Action Coalition of the American Consulting Engineers Council endorsed the observational method on Mar. 16, 1989, and the coalition's members currently advocate this approach in publications, testimony, and presentations. The coalition's firms represent most of the major Superfund contractors.

contractor work. Moreover, presumably a really first-rate Remedial Investigation and Feasibility Study would do this under current practice, according to the degree of understanding about the uncertainty of the site's contamination and conditions.

3. *"Parameters are identified for further observation in order to detect deviations.'* Another part of the design study would presumably design continuing site investigation efforts to verify whether the remedy is working and whether previously identified potential deviations are occurring. There is a potential for continuing site investigation after a ROD and as part of remedy implementation. In current practice, most experts recognize that during remedy implementation new site information may arise, especially because information is obtained on the remedy's performance. But this situation is different than a directed effort to obtain new information about the site which might alter the selected remedy, except that an interim action (operable unit) already implies that key decisions have not yet been made about some part of the site. Remedial investigations now can proceed while an interim action is being implemented.

4. "*Contingency plans for each deviation are incorporated into the remediation design.*" The design study report would also presumably present detailed contingency plans (akin to a feasibility study) if such deviations became documented. However, contingency planning means that changes in the originally selected remedy might be made. OTA has expressed concerns about remedies changing after a ROD is issued, when public participation is minimal. Significant new information about a site after a ROD is now recognized as a possibility, and there is a procedure to amend a ROD or issue a new one without compromising public participation and accountability.

5. "*Post-remedial monitoring is established as an essential component of hazardous waste site remediation.* There is potential for more monitoring to replace action and closure to a cleanup. The law currently requires such monitoring if hazardous waste remains onsite, and EPA normally requires significant monitoring when there is potential groundwater contamination or when impermanent remedies are used.

Overall, the observational method changes the process of study and cleanup. This method may have technical benefits, but it also might complicate public accountability of the critical cleanup decisions for a site, although its proponents say it would improve communication and accountability. By focusing on uncertainties, the method may also produce increased uncertainty about remedy implementation, and health-based cleanup objectives may be transformed into technology performance ones (especially when pump and treat is used). As intended, contractor liability might be reduced because the cleanup process would become tentative and be maintained longer, and produce increased information to reduce the possibility that a selected remedy is ineffective; this last point is clearly a benefit. But considerably more contractor work might be created and there would be more reliance on the engineering judgments of contractor staff and the responses to them by either the government (for fund-financed cleanups) or responsible party (for settlements which give the responsible party implementation authority). Indeed, the people who have devised the observation method said "The party responsible for operating the remedial action will have to have the judgment required to determine if a deviation has occurred and which response to take. . . . In cases where more than one response is possible to a deviation, considerable judgment may be required to select the most appropriate response.'[45] To some degree, EPA appears to have accepted the observational method.[46]

Two alternatives or supplements to the observational method are: 1) improving the technical methods and practices used in site assessment and cleanup design to reduce and better understand uncertainties about a site, and 2) changing the kinds of cleanup decisions made to reduce the negative impacts of imperfect information on decisions. First, as discussed in the previous groundwater section,

[45] Stuart M. Brown et al., *Application of the Observational Method to Remediation of Hazardous Waste Sites* (Bellevue, WA: CH2MHill, April 1989).

[46] For example, in its guidance for groundwater cleanup, EPA said: "Data to reduce the uncertainty of important variables should be collected throughout the remedial selection [presumably pre-ROD], design, and construction phases to refine and modify the remedy." U.S. Environmental Protection Agency, op. cit., footnote 33.

shifting from the conventional to the state-of-the-art approach for site investigation (table 3-2 and figure 3-2) offers environmental and cost benefits. This shift recognizes the problem that the engineering community, to a large extent, is not using the best available techniques for site investigation. Although better techniques (e.g., the simulation-management model developed at the U.S. Geological Survey) require more skilled personnel, may take more time, and cost more money, they ultimately lead to more cost-effective cleanups, greater reliability, and fewer failures. In fact, even now there are wide differences in the capabilities and practices of firms working on groundwater cleanup. With the observational method, conventional techniques may remain dominant and change slowly as the more conservative, analysis-intensive process attempts to reduce errors and failures.

Second, key cleanup decisions can change to reflect an improved understanding of the complexity of site investigation and cleanup. The options include: 1) stressing the distinction between actions necessary because of current risks and actions that can be postponed because of uncertain, future risks; 2) emphasizing different types of remedial actions over time (i.e., emergency, recontrol, interim remedial, and final permanent); 3) refraining from calling a remedy complete and permanent when impermanent technologies or highly uncertain ones (e.g., pump and treat for groundwater) are used; and 4) avoiding making critical cleanup decisions after the ROD unless there is full public participation and accountability. For groundwater cleanup, for example, the alternative would be making a different decision about the groundwater cleanup, including: continuing the site investigation before committing to pump and treat or postponing cleanup if no significant current risk exists, trying a different cleanup method (e.g., in situ bioreclamation), or implementing a recontrol approach based on plume containment but not aquifer restoration. With the observational method, the increased use of pump and treat would probably continue and changes in the original cleanup objectives might be unknown to communities and other interested parties who are not directly implementing the cleanup (see following discussions of landfill cleanup decisions).

Issue 3: Is the current enforcement emphasis on obtaining settlements with responsible parties affecting remedy selection?

After examining nearly all fiscal year 1988 RODS, summary statistics on them, and studying some RODS in detail, OTA arrived at a number of findings about how settlements with responsible parties influence selection of cleanup technologies and standards, and about other major issues .47 The most important findings for the settlement impact issue are summarized first:

- Cleanup standards, the extent of cleanup, the permanency of cleanup, and the selection of cleanup technology are often compromised in formal or informal negotiations to obtain settlements with responsible parties. What responsible parties are willing to pay, together with the flexibility inherent in the current system, can lead to less stringent cleanups. Indeed, a former administrator of EPA said, "We do not believe it is wise to select a remedy that cannot be implemented because of . . . unwillingness of the responsible parties to agree to a settlement. '[48] Of course, when responsible parties are successful in obtaining remedies they believe more cost-effective, they correctly main-

[47]The detailed discussion under Issue 3 of RODs from fiscal year 1988 supplements OTA's 1988 case study report, *Are We Cleaning Up? 10 Superfund Care Studies* which examined fiscal year 1987 RODS. A number of observations in the discussion here pertain to general issues concerning Superfund implementation, such as conflicts between statutory requirements and cleanup decisions.

[48]Prepared testimony of Lee M. Thomas, in *Preliminary Findings of OTA Report on Superfund*, Committee Report on Hearing before the Subcommittee on Investigations and Oversight, Committee on Public Works and Transportation, U.S. House of Representatives, Apr. 20, 1988, p. 99. At the hearing, EPA's former Assistant Administrator J. Winston Porter aJso testified, "Let me tell you the worst result in Superfund, and that is if I get in a bind where the State won't pay the 10 percent—that means we can't move ahead with the fund-nor will potential responsible parties (PRPs) agree to do it,'' p. 189. Also, in EpA's removal program ''regional offices must aggressively pursue cleanup by the potentially responsible part (PRP) before initiating any Fund-financed removal action. " (Karen Burgan et al., ' 'Setting Removal Program Priorities, " *Superfund '88*, proceedings of November 1988 conference, Hazardous Materials Research Institute, Silver Spring, MD. Legally, EPA may not be able to perform a fund-financed remedial action without State agreement to pay the matching 10 percent, and if responsible parties will not settle and if EPA does not wam to delay cleanup until successful legal enforcement action, then again action becomes contingent on State agreement to pay the 10 percent. One way out of this dependency on State cooperation might be for EPA to take a removal or, as discussed in this report, a recontrol action which would not require State agreement.

tain that the government has affirmed their adequacy to protect health and environment.[49]

- The decisions for 12 sites discussed below, for which the desire for settlement is probably important may save responsible parties about $400 million, compared to estimated costs of more stringent remedies in the sites' RODS or in matched-site RODS. Roughly, that seems to represent about a 50-percent saving overall. In fiscal year 1988, OTA estimates that there may have been 50 to 70 decisions affected by the desire for and pursuit of settlement.[50] Through the decisions documented in these RODS, responsible parties may eventually save many hundreds of millions of dollars, perhaps as much as $1 billion. If all these settlements lead to permanent, complete cleanups, the savings are laudable. But will in fact those cost-saving remedies work effectively in the long term? Only time, effective environmental site monitoring, and effective government oversight will provide conclusive answers. But science, common sense, and experience suggest that, eventually, major follow-up cleanups may be necessary. And if some of these cleanups prove ineffective, then damage to public health and the environment may result.
- Cleanup standards, such as the acceptable level of residual soil contamination at a site after cleanup, are sometimes substantially less stringent at sites where decisions seem influenced by the government's desire to obtain a voluntary settlement with responsible parties—compared to sites where settlement is not an issue. These differences cannot be explained technically, for example on the basis of major differences in site conditions. While current risk assessment methods can easily lead to different results for the same conditions (because many somewhat arbitrary assumptions have to be made, and because it is not always clear just what data should be used), sometimes higher levels of residual contamination (less cleanup) result from using high levels of acceptable risk.
- When sites are in EPA's enforcement program and when responsible parties perform the critical Remedial Investigation and Feasibility Study (RIFS),[51] cleanup actions are much more likely to use land disposal and containment techniques rather than waste destruction technologies. For fiscal year 1988 RODS, 78 percent of RODS using waste destruction technologies were in the fund program, and 75 percent of the RODS using containment/land disposal were enforcement RODS. Some Superfund cleanup waste is still being sent to commercial landfills. And EPA's statistics on use of treatment cleanup technologies may present an overoptimistic picture, because many of the treatments do not destroy toxic material and sometimes deal with a very small portion of site contamination.
- In enforcement cases, low-cost cleanups that facilitate settlement are sometimes based on relatively speculative or unproven treatment (but not destruction) technologies.[52] They are tested for their effectiveness on site materials **after the** government has selected them and during Remedial Design, which is much less visible to the public than the pre-ROD activities. Assurances that consent decrees provide for the contingency of ineffective test results are not entirely satisfactory. Who will interpret the post-ROD test results? How much more time will be added to the already lengthy site cleanup process if another remedy has to be selected? Moreover, an important issue is whether specific cleanup standards committed to by the government in the ROD may be changed years later to accept the limited accomplishments of the selected technology. That is, health-based cleanup objectives may be replaced by technology performance standards, especially for groundwater cleanup. The way to promote use of innovative technologies is

[49]Responsible parties are not always successful in obtaining the remedies they want; see discussion in ch. 1 about Superfund syndrome and relative roles of communities and responsible parties.

[50]We arrived at this estimate by assuming that at least two-thirds of the RODs designated as enforcement (half the total) involved settlement and that perhaps as much as one-third of the RODs designated as fund might involve settlement.

[51]For some enforcement RODs, EPA does the RIFS, usually because responsible parties have declined the opportunity to perform the RIFS.

[52]This situation was revealed in OTA's 1988 case studies; see especially the case study for the Sands Spring site in Oklahoma.

through pre-ROD treatability studies which provide a basis for confidence in the technology selection for a particular site.

. For about the last 2 years, EPA has used a framework for evaluating cleanup alternatives (and the one in EPA's proposed National Contingency Plan) that permits virtually any kind of decision to be rationalized. This excessive flexibility affects settlements with responsible parties. EPA uses cost-benefit analysis of alternative cleanup approaches, in which the level of environmental protection is a variable. EPA's instruction to personnel implementing Superfund is, ''Make final determination of which alternatives provide overall effectiveness **proportionate to costs**"[53] [emphasis added]. But the statute requires a cost-effectiveness technique, which first sets specific environmental objectives of a cleanup and **then** finds ways to minimize costs. Alternatives that offer far less certain and effective protection of health and environment are sometimes given the same ratings as better techniques, making it appear that cleanup goals have not been compromised.

Research-**OTA** examined summary statistics on remedy selection provided by EPA for RODS classified either as enforcement or fund. In addition, OTA examined pairs of sites in three generic categories (wood preserving, PCB contamination, and lead battery); that is, sets very similarly contaminated sites whose RODS were issued in fiscal year 1988, one or more sites involving settlement, and one or more which did not. Sites were chosen solely on the basis of finding matches in the nature of site contamination and on the basis that there were no site condition variables that could explain substantially different cleanup decisions, Nine cases are discussed below.

Third, OTA examined all the fiscal year 1988 RODS in Region 5 for which containment/land disposal was selected. All these sites were landfills of various types. Five were enforcement RODS and three were fund RODS, but one of the latter said that EPA was negotiating with responsible parties for remedy implementation.

***Statistical* Patterns--From** EPA's summary statistics, we conclude that there is a substantial difference in cleanup technology for sites in the enforcement program compared to sites in the fund program. For example, in fiscal year 1988, the enforcement program selected land disposal or containment actions in 42 percent of its source control (these exclude groundwater action RODS), compared to only 12 percent for the fimd-fma.need program. Between fiscal years 1987 and 1988, the fund program substantially decreased its use of land disposal from 44 to 12 percent, but the enforcement program showed a smaller decrease from 64 to 42 percent. There has been wide agreement for some time that land disposal and containment are not permanent remedies, are bound to fail eventually, and pose uncertain long-term costs and threats to health and environment, Indeed, many of EPA's RODS that have rejected land disposal and containment cite these reasons for doing so. Moreover, the law expresses a particular policy against sending hazardous waste from Superfund cleanup sites to offsite landfills. In the past 2 years, 83 percent of the remedial action cases using offsite landfills were in the enforcement program.

Conversely, in fiscal year 1988, the enforcement program selected those kinds of treatment technologies (chiefly incineration and biological treatment) that permanently destroy toxic waste in 14 percent of its source control RODS; the fund program selected permanent treatment in 44 percent of its source control RODS. Between fiscal years 1987 and 1988, the fund program substantially increased its use of destruction technology from 26 to 44 percent, but the enforcement program's usage remained constant at 14 percent. The law explicitly expresses a preference for permanent treatment remedies over land disposal and containment.[54] Sometimes, treatment technology, for example at a very large landfill or mining waste site, could be rejected by invoking the statute's fund-balancing provisions for fund-financed cleanups; in such cases there may be no

[53] U.S. Environmental Protection Agency, op. cit., footnote 5.

[54] Treatment technologies that only reduce volume or mobility of hazardous waste do not guarantee permanence, but they are also preferred over land disposal and containment. SARA does not explicitly favor destruction technologies over other forms of treatment. EPA has not provided a technical interpretation of permanence the way OTA has.

other choice with current technology but a much less costly containment approach. But the nine examples given below are not such cases.

EPA's data on remedy costs shows that enforcement costs are less likely to be at the high range (above $20 million) and more likely to be at the low range (below $5 million) as compared to fund decisions. In fiscal year 1988, only 7 percent of enforcement costs were above $20 million but 16 percent of fund decisions were; also, 51 percent of enforcement costs were below $5 million, while 64 percent, of fund decisions were in this range. One plausible explanation is that, to encourage settlements, the enforcement effort selects containment remedies for source control (and possibly justifies taking no action for groundwater contamination) for relatively large sites in order to arrive at a cost acceptable to responsible parties. However, in order to balance this bias for using containment, relative to the need to be responsive to the statutory preference for treatment-based remedies which assure permanence, the enforcement effort selects treatment-based remedies for smaller sites. Because of smaller volumes of hazardous waste for treatment, the costs remain low enough to facilitate settlement.

For fund program RODS, having proportionately more remedies with costs at the low and high ends, a plausible explanation is that containment is more likely to be used for relatively smaller, simple sites and destruction technology for larger, more complex sites. In other words, this interpretation suggests that responsible parties for smaller sites pay more for cleanup than the government spends for similar sites, and responsible parties for larger sites pay less for cleanup than the government spends for similar sites.

Nine Cases

Four Wood Preserving Sites

These four Superfund sites have similar histories and similar contamination. The contamination is principally from the use of creosote, which consists of many toxic chemicals, including a number of known carcinogens.

The first site is the Brown Wood Preserving site in Florida, an enforcement program site. The Brown site may be the clearest example we have found of the environmental consequences where settlement is the goal. Responsible parties contracted for the RIFS. The ROD did not use EPA's required nine criteria for evaluating remedial alternatives. Most of the hazardous material from this site was sent to the Nation's largest hazardous waste landfill in Emelle, Alabama, in a removal action several months before the ROD was signed in April 1988. (Landfilling was rejected in the three other wood preserving site examples.) A total of 16,500 tons of the site's most contaminated sludge and soil was sent offsite. Ten thousand tons of less contaminated soil was left onsite for biological treatment which, however, had not yet been proven effective for the whole range of chemicals at this kind of cleanup.[55] A background document for the Brown site reveals that 840 tons of the carcinogenic chemicals (in the soil) were landfilled offsite and 50 tons were left onsite for biological treatment; that is, **94 percent of the carcinogenic contaminants were landfilled off-site.**[56] **The** cleanup level for contaminants was 100 parts per million (ppm) carcinogenic chemicals in the soil. (With exactly the same exposure route of soil ingestion for residents and acceptable risk of 1 in 1 million excess cancer deaths, the corresponding value for the Southern Maryland site in Maryland, discussed below, was 2.2 ppm, and for the L.A. Clarke & Son site in Virginia, discussed below, 0.08 ppm.) The ROD said that cleanup standards had been changed from the original risk assessment but did not say what the changes were.

In its explanation for the removal action, EPA's ROD said that it "contributed to the acceleration of the site along the Superfund enforcement process track. The ROD also said that the responsible parties "have been very cooperative in furthering

[55] A recent technical paper on biological treatment noted some problems with the kinds of chemicals found at sites contaminated by creosote. First, the rate of degradation of larger polyaromatic hydrocarbons decreases with increasing molecule size and decreasing volubility. Second, if the creosote is present as small droplets within pores of soil, the degradation process will be inhibited. Gaylen R. Brubaker, ''Screening Criteria for In situ Bioreclamation of Contaminated Aquifers, " *The Second Annual Hazardous Materials Management Conference/Central,* proceedings, Tower Conference Management Co., Glen Ellyn, IL, March 1989.

[56] This cleanup illustrates how important it is to have data that can be used to identify the contribution of different technologies to the *overall* cleanup. For example, EPA credits this site with using biological treatment, even though it addressed only 6 percent of the contamination,

the cleanup of the site. " The timing of the removal was significant. At a public meeting in October 1987, an EPA official explained that the RCRA land disposal bans imposed by Congress were going to make it impossible to landfill the site's toxic material and that he ''was told by Headquarters within the last couple of days that virtually all this type of waste will eventually have to be incinerated onsite or offsite. The type of land disposal whereby excavation and removal were accomplished will be a thing of the past. Therefore, the government cooperated in circumventing the congressional intent to prohibit land disposal of certain toxic materials.

The remedy approved by EPA was estimated in the ROD to cost $2.4 million (apparently $1.9 million for the landfilling and $0.5 million for the biological treatment), while the use of onsite mobile incineration was estimated to cost $5.4 million. EPA's analysis of cleanup alternatives acknowledged that onsite incineration would provide greater environmental protection, was more consistent with statutory requirements, and would take significantly less time to fully implement than the remedy selected. There was no explicit acknowledgment of the inconsistency between the selected remedy and statutory requirements and preferences.

Second, consider the June 1988 ROD for the Southern Maryland Wood Treating site in Maryland, a fund program site, EPA selected onsite mobile incineration for treating over 100,000 cubic yards of contaminated materials at an estimated cost of $38 million, including groundwater cleanup. There is no apparent viable responsible party to settle with. An early attempt by the responsible party at using biological cleanup at the site had failed. The ROD specifically rejected the use of a hazardous waste landfill at $23 million and biological treatment at $31 million; for landfilling, the ROD said that potential leaks and leachate migration made "the permanence of this option . . . dependent upon the expected life of the landfill, " and for biological treatment it said that it had ''a higher risk of remedy failure than thermal treatment. " In contrast to the Brown site in Florida, the Southern Maryland ROD presented extensive data on contamination, risks, and cleanup standards. The key cleanup objective selected was 1 ppm carcinogenic chemicals in subsurface soil necessary to protect groundwater—i.e., 1 percent of the 100 ppm standard for the Florida site. (In both cases the risk level was said to be 1 in 1 million excess cancer deaths.) The cleanup standard for surface soil was 2,2 ppm.

At a third site, an enforcement ROD was issued for the Brodenck Wood Products Co. site in Colorado. Most of the RIFS work has been done by responsible party contractors. A small amount of surface impoundment material (4,000 cubic yards of sludge and oil) will be incinerated onsite. Except for visibly contaminated soils beneath surface impoundments, the ROD commits to using onsite incineration only if the volume of soil is less than 2,500 cubic yards. If, as is likely, the volume is greater than 2,500 cubic yards-and it may be as much as 30,700 cubic yards-the material will be stored onsite for further study and, it appears, may not be incinerated, There is no technical or environmental reason why the larger amount of contaminated soil could not be incinerated, except that it would of course cost more—an estimated $11 million for the larger amount of incineration, instead of $1 million for either the small amount of incineration or the stockpiling.

The Brodenck ROD presents no actual cleanup standard for soils beneath impoundments, other than the somewhat subjective identification of **visible** contamination. Soils can be quite contaminated without being visibly contaminated. The more routine ROD requirement is a specific level of residual contamination above which soil would have to be excavated and remediated. Moreover, data in the ROD suggests that soil beneath the impoundments may be contaminated with dioxins, because relatively high levels were found in some impoundment sludges. This situation argues for using onsite incineration, sooner rather than later. (The presence of dioxins was also a factor in the decision for using incineration at the Southern Maryland site; dioxin contamination at wood preserving sites is likely when, in addition to creosote, pentachlorophenol was used, as was the case for the Brodenck site.)

A fourth wood preserving site—the L.A. Clarke & Son site in Virginia—illustrates a general problem facing analyses of Superfund implementation. Some site RODS that EPA classifies as a fund program may, nevertheless, reflect the consequences of a preference for and pursuit of voluntary settlement, a process that often begins **before the** ROD is issued. The L.A. Clarke & Son site is a sister site of the Southern Maryland Wood Treating site discussed earlier. Both sites are in EPA Region 3, L.A. Clarke & Son operated both facilities, and the estimated volume of contaminated material was nearly the same for both sites (the volume of material requiring cleanup at the L.A. Clarke & Son site was said to be 119,000 cubic yards). But the ROD for the Virginia site selected a combination of soil flushing, biological treatment (i.e., a combination of in situ bioreclamation, biotreatment in tanks, and land farming), and landfilling of an unspecified amounts of material which are not effectively treated by the in situ flushing and biological treatment.[57] The selected remedy would have to be proved effective by extensive post-ROD testing. (Biological treatment was selected in two of these examples [Broderick and L.A. Clarke& Son] and rejected in the other two [Brown and Southern Maryland], and its effectiveness for this cleanup is uncertain.[58]) The site's contamination is complex, including a layer of dense creosote that lies on top of a clay layer beneath an upper aquifer, which raises serious concerns about the selected remedy's ability to be effective. The flushing component would probably generate hazardous waste for land disposal.

Moreover, the L.A. Clarke & Son site ROD selected an acceptable concentration for soil for a standard group of carcinogenic chemicals of 10.3 ppm for protection of groundwater (corresponding to a risk level of 1 in 100,000 excess cancer deaths and 10 times higher than corresponding figure for the Southern Maryland site). Onsite incineration was not evaluated as a cleanup alternative and no explanation was given, but an offsite incineration option was estimated to cost $76 million. Cleanup of contaminated groundwater was deferred to a later ROD. The estimated cost for the L.A. Clarke& Son site cleanup was about half that for the Southern Maryland site, a difference of about $20 million. EPA has indicated that if a cleanup goal of 1 in 1 million risk had been used "the only feasible remedy would have been incineration, "[59] A few months after **EPA** issued the ROD, based on its own RIFS, a complete settlement was reached with a responsible party for implementation of the selected remedy; the ROD had identified the responsible party and said that negotiation with it was intended, and the responsible party had submitted extensive comments to EPA on its RIFS and proposed remedy. The ROD provides strong indication that the desire to allow the industrial facility to keep operating was a significant factor in remedy selection. To implement incineration, it would be necessary to remove the site's buildings because of the extensive contamination below them. The ROD noted that "many residents are skeptical of the treatment technology proposed in the preferred alternative and are unhappy with the length of time projected for the cleanup (the longest of the alternatives).' The desire of some residents to shut down the facility was also noted.

The L.A. Clarke & Son site decision is actually more indicative of environmental compromise and less protective than it first appears. The safe soil cleanup level was determined to be 0.08 ppm for ingestion (compared to 2.2 ppm for the Southern Maryland site), but the ROD used the figure for soil of 10.3 ppm for protection of groundwater based on a lower risk level of 1 in 100,000 instead of 1 in 1 million (compared to 1 ppm for the Maryland site). To justify replacing the 0.08 ppm figure for surface soil with a cleanup objective over 100 times higher, the ROD said, "To achieve surface soil levels protective of direct contact exposure, the site will be

[57] Nothing specified in the ROD precludes a major amount of the site's contaminated materials from being landfilled.

[58] OTA examined the results of a preliminary feasibility study on the potential for indigenous microbes to destroy the site's polynuclear aromatic hydrocarbons reported to EPA's RIFS contractor for this site in October 1986. There were 51 laboratory results for percent destruction of four chemicals in soil and surface water samples from different locations. Only 29 percent of the results were vety successful (i.e., 96 to 99 percent reduction of contaminants), nearly half of the results were zero or close to zero percent reduction, and the other 20 percent were partially successful but not sufficient for effective cleanup. The results are particularly important because they indicate a potential problem for achieving effective in situ bioreclamation selected for subsurface soils. But a report which designed a formal treatability study, issued in March 1987 by an EPA contractor, described those initial results as finding that "indigenous microbes were capable of degrading" the four chemicals tested. Apparently the 8-month $70,400 treatability study was not conducted prior to completion of the RIFS and ROD about a year later.

[59] In an undated internal EPA Region 3 memo provided to OTA. The memo also refers to a cost of incineration of $125 million which does not agree with the ROD, and says that the soil volume needing treatment was twice as much as at the Maryland site, which also does not agree with ROD information.

covered with 1.5 feet of seeded topsoil. This move is not standard EPA practice, especially as no institutional controls on future land use were imposed by the ROD for this containment solution. Indeed, the industrial facility is still active. In other words, cleanup costs were also reduced by replacing some biological treatment with crude capping; that is, soil cover and not an engineered hazardous waste landfill cap.

Three PCB Sites

Technologically, the cleanup of PCB contamination illustrates the availability of competing permanent treatment techniques, mostly incineration and to a lesser degree chemical dechlorination and biological treatment. The enforcement ROD for the MGM Brakes site in California, however, selected offsite landfilling of over 10,000 cubic yards of contaminated soils. The cleanup standard for soil of 10 ppm PCBs was for a risk level of 1 in 100,000 excess cancer deaths and not the more typical 1 in 1 million risk level. The estimated cost of the selected remedy is $5.3 million.

A previous Feasibility Study had selected onsite incineration at a cost of $8.4 million, but in response to public opposition EPA issued a revised FS and changed the remedy to offsite landfilling. The MGM Brakes site is still a major operating industrial facility and is a prime employer in the community. This fact may explain why, according to the ROD, community opposition focused on ''the economic and health risks' of onsite incineration. The ROD noted that there was no public opposition to the selected remedy of offsite Iandfilling. (Landfilling was rejected in the next two PCB cleanup exampies.[m])

The ROD for MGM Brakes noted that some testing of PCB dechlorination technology, which EPA has selected elsewhere for a Superfund PCB cleanup, had been done in 1987, but the ROD said that 'it was deemed impractical due to the nature of site soils' and because of "process control problems. " However, the ROD did not support this interpretation with specific technical data. Chemical fixation, which EPA has used elsewhere for a Superfund PCB cleanup, was rejected in part because it would not destroy the PCBs and would not offer a permanent solution (consistent with OTA's views on permanence), and also because treated materials would have to be landfilled which would require institutional controls such as deed and land use restrictions, The ROD said that ''EPA also does not have well-developed administrative capabilities to oversee and enforce institutional controls,"[61] But the selected remedy of offsite landfilling also has the disadvantages of impermanence and uncertainty,

But the most significant issue is the cleanup's apparent violation of the statutory requirement to comply with applicable or relevant and appropriate regulatory requirements. Regulations promulgated under the Toxic Substances Control Act (40 CFR 761.60) require that PCBs in concentrations greater than 500 ppm must be disposed of by incineration. The MGM Brakes ROD said, Soil sampling results showed a significant percentage of samples with PCBs in excess of (milligrams per kilogram) 1,000 mg/kg (1,000 ppm). ' The ROD referred only to a regulatory requirement that concentrations over 50 ppm be incinerated or disposed of in an approved landfill, Actually, the regulations speak of the range between 50 and 500 ppm for the option of land disposal or incineration.

Next, consider the fund program ROD for the LaSalle Electrical Utilities site in Illinois, The fiscal year 1988 ROD selected onsite incineration at a cost of $28.6 million for 23,600 cubic yards of soil and sediment. There is no viable responsible party to settle with. The cleanup standard is 5 ppm down to one foot and 10 ppm beneath one foot of soil; the ROD said that a soil concentration of 0.03 to 3 ppm of PCBs corresponds to a risk of 1 in 100,000 excess cancer deaths (indicating a relatively high residual

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[60]However, landfilling of PCB cleanup waste has been practiced elsewhere; for example, the cleanup of the Geneva Industries site in Texas is based on sending 47,000 tons of PCB-contaminated soil to the commercial hazardous waste landfill in Emelle, Alabama.

[61]This statement is particularly significant because many Superfund RODS rely on institutional controls as part Of the selected remedy. It also is a good example of regional autonomy, because EPA headquarters has not expressed this view and probably would not as policy or guidance because ıt frequently endorses institutional controls.

risk for the cleanup levels selected).[62] The least costly option of landfilling at about $3.5 million was rejected because of the "difficulty in assuring the long-term integrity of hazardous waste landfills. " The options of biological treatment and dechlorination were rejected initially on the basis of uncertain effectiveness and implementation times. A 1986 ROD for the LaSalle site had selected onsite incineration for contaminated soils in a residential area offsite. The 1988 ROD noted that costs for the earlier selected incineration cleanup, started in early 1988, had been 45 percent less than the original estimate ($15 million instead of $27 million) because of 'the current competitive atmosphere in the thermal destruction business. "[63]

Another fiscal year 1988 ROD labeled as fund program (like the L.A. Clarke site in Virginia) was that for the French Limited site in Texas, for which PCBs are a major contaminant in about 150,000 cubic yards of sludges, sediments, and soils. However, responsible parties have been very active at the site; they conducted a multimillion-dollar technology demonstration for in situ biological treatment and have produced a supplemental Remedial Investigation, which EPA said it used. Indeed, EPA overturned its original selection of incineration and selected in situ biological treatment in its ROD. (Biological treatment was not selected in the above two PCB site examples.) The estimated cost for the selected biological remedy was $47 million as compared to the ROD's estimated $120 million for the rejected onsite incineration option; the biological alternative was the second lowest cost treatment option (a containment option at $42 million was rejected). A few months after EPA issued the ROD a complete settlement was reached with responsible parties for implementation of the selected remedy.[64]

The French Limited cleanup standard was 23 ppm for PCBs which the ROD said corresponds to a risk of 1 in 100,000 excess cancer deaths. (This is a relatively high risk and a high level for PCB cleanup, which in the previous two PCB examples was 5 to 10 ppm,) The site study conducted by the responsible parties, as noted by EPA in its ROD, found that PCBs were not reduced to below the relatively high allowable PCB level of 23 ppm, and that some secondary chemical fixation treatment would be necessary. The ROD acknowledged that the pilot study had presented "no data . . . to show what portion of the decrease is specifically attributable to degradation. In other words, some of the apparent decrease in measured PCB contamination levels might not have resulted from molecular destruction by microbes but may have resulted from a transfer of PCBs to another medium, such as air or water. The current scientific literature on biological treatment of PCBs does not show that all PCB molecules (higher chlorine types) can be destroyed biologically to low residual levels.[65] A professional paper by people working for the responsible parties which described the remedy selection made no mention of the issue of PCB destruction.[66]

Moreover, the French Limited ROD also noted that "some degradation of the water quality in the upper aquifer did occur during the pilot study. ' Furthermore, "Recovery and treatment of the shallow aquifer is necessary to control any groundwater degradation which may occur during implementation

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[62] In other words, it seems that a trade-off was made, increasing the risk to reduce the amount of soil requiring incineration; however, the 5 and 10 ppm levels for PCBs are typical of many PCB cleanups. The risk assessment may have been overly conservative or a mistake may have been made (see discussion on risk assessment in ch. 1).

[63] This observation supports OTA's conclusion that competition among generic cleanup technologies and within classes of technologies has reduced unit cleanup costs, preventing permanent *remedies* from becoming exorbitant, as some people feared would happen as a result of SARA.

[64] The estimated cost for incineration seems hi@; using the unit cost from the LaSalle cleanup would suggest a cost of $90 million and a still lower cost is likely-perhaps $60 million—because of the much larger (six times) volume of material at French Limited and there are significant economy-of-scale effects for incineration.

[65] The effectiveness of biological treatment of soil contaminated with PCBs remains a controversial issue and there is a large literature on the subject. (see EPA, *Technology Screening Guide for Treatment of CERCLA Soils and Sludges*, September 1988; and S. Niaki, "Treatment Technologies for PCB-Contaminated Soils," conference proceedings Haztech International, St. Louis, Missouri, August 1987) EPA concluded that with more than 5 chlorines per molecule bacterial degradation was not readily observed. (EPA, *Microbial Decomposition of Chlorinated Aromatic Compounds*, September 1986.) Some commercial vendors of biological cleanup technology say that they are effective on PCB-contaminated soil, but little detailed data are available. professor John Waid of La Trobe University in Australia has informed OTA of promising results of a field test in the United States using his method, based on white rot fungus and landfarming techniques, to destroy PCBs in soil.

[66] Richard L. Sloan et al., 'The French, Ltd. Project: A Case study, *Superfund' 88*, proceedings of conference November 1988, Hazardous Materials Research Institute, Silver Spring, MD.

of the biotreatment remedy. " Based on our extensive study of RODS, such uncertainty about effectiveness and implementation problems would typically rule out an alternative. However, the ROD's evaluation of alternatives gave the selected remedy the same ratings for effectiveness and irnplementability as incineration, But the ROD acknowledged that incineration 'offers destruction of all of the contaminants to levels below the health-based criteria' whereas biological treatment would require stabilization for PCBs and that the stabilization would not destroy the PCBs. Chemical fixation had been evaluated and rejected in the MGM Brakes site ROD, which said that it ''would not provide a permanent solution for the site. " For most of the many commercially available forms of chemical fixation, effectiveness on PCBs is unproven.[67]

Two Battery Recycling Facilities

Lead is the principal contaminant of concern at two very similar battery recycling facility Superfund sites. Unlike organic contaminants (e.g., creosote and PCBs) discussed earlier, toxic metals cannot be destroyed by treatment technology; however, the statutory goal of recycling when it is feasible is the key issue for metals. It is through recovery and then recycling of toxic metals that a truly permanent remedy can be obtained. At both sites presented here, the chief problems are battery casings and contaminated soil, both surface and subsurface.

The enforcement ROD for the Gould site in Oregon selected a cleanup standard for surface soils of 1,000 ppm of lead; the standard for subsurface soil and the unrecyclable materials was the failure of EPA's EP Toxicity test. Twenty-nine-thousand cubic yards of contaminated soils will be treated by chemical stabilization and backfilled onsite. (OTA notes that the estimated volume appears to be based on the responsible party RIFS which used a 3,000 ppm level for lead [which EPA apparently rejected] and, therefore, underestimates the volume based on the selected standard of 1,000 ppm.) It was estimated that about 25 percent of the lead in the casings would be recycled, plus some other materials. Contaminated unrecyclable battery casing materials, from a total of 81,000 cubic yards of casings, will be sent to an offsite hazardous waste landfill. Estimated cost for the selected remedy at the Gould site is $21 million, but this figure does not count any income from sale of recycled material.

The fund program ROD for the United Scrap Lead site in Ohio selected a cleanup standard for 45,000 cubic yards of surface soils of **500** ppm of lead-one-half of the value for the Gould site—and the failure of EPA's EP Toxicity test for subsurface soils (unestimated volume, but could be two to three times surface volume) and 55,000 cubic yards of residual battery casing materials, Contaminated soils and battery casings will be treated using a chemical process developed by the Bureau of Mines, and the safe residuals of treatment will be replaced onsite. This treatment process uses fluosilicic acid to remove and purify lead for recycling. Similar to technology currently used in the mining industry, the process was evaluated in laboratory treatabilily tests and was found to successfully reduce lead content of soils and battery casings below the cleanup standards. Further tests and a pilot study will be conducted as part of the design phase to optimize the process. For the United Scrap site, the ROD noted that "the 500 ppm level was chosen in order to assure protectiveness. It is also the level chosen at other CERCLA sites nearby . . . Soils contaminated with lead at or above 500 ppm level represent a health threat. " Consistent with OTA's perspective on permanence, the ROD also said that

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[67] The selection of chemical fixation for the Pepper's Steel & Alloys site in Florida was an unusual decision. In addition to PCB contamination, the site also had very high levels of toxic metals which posed a problem for incineration. The site decision was based on test work and analysis by the responsible party which developed and now sells the chemical fixation technology. A full settlement was reached for this site. Significant uncertainty about long-term effectiveness remains. Indeed, about one month before the ROD was signed, EPA's expert on chemical fixation in its Office of Research and Development said, ''The subject report [responsible party's] does not provide conclusive evidence that soil from the waste site can be treated to provide a solid that will be harmless to the environment. The waste would appear to be capable of leaching unacceptably high levels of lead mto a highly used aquifer system. " A few weeks earlier, a professor at Louisiana State University submitted a report as a consultant to EPA's contractor; the report raised a number of issues about the limits of the testing done by the responsible party. After the responsible party began the cleanup, EPA said: ''Solidification/stabilization costs less than the other alternatives. It is also more likely to perform as expected. . An extensive testing program was conducted by EPA and Florida Power & Light to make sure that the stabilized and solidified materials would meet the goal of isolating the waste from the environment over an extended period of time. " About 2 1/2 years after the ROD and before the remedy was complete, an EPA Region 4 memo on the cleanup said, ' 'Time will tell if the remedy meets our expectations. . . . Universally accepted tests to characterize either short- or long-term performance did not and still do not exist.

''since the contaminants are removed and recycled, the possibility of future actions is eliminated. " The estimated cost **for the selected remedy is $27 million, which** accounts for sale of recycled material.

These two RODS illustrate:

- A surface soil cleanup standard for lead at the enforcement site half as stringent as that selected for the fund program site; this difference cannot be explained on the basis of fundamentally different exposure or risk factors. The consensus in the technical literature is that a cleanup level of 1,000 ppm for lead in surface soil could pose a significant health threat to children who might come into contact with such soil.[68]
- A selected remedy at the enforcement site which, in part, uses a treatment technology (stabilization) for soil that does not recover lead, whereas the treatment technology at the fund program site does. Institutional controls for the enforcement site are an important part of the remedy because lead will remain onsite. The ROD for the fund program site, which rejected chemical stabilization, said, "Since contaminants are contained rather than removed, the possibility for future remedial actions at the (cleanup) site or at the offsite landfill site will remain. " This position agrees with **OTA's** concerns about the uncertainties and impermanence of chemical fixation, compared to recovery of metal.
- The recovery of lead from casings at the enforcement site relies on a less effective mechanical separation technique (a grinding and physical separation operation); the one at the fund program site uses a chemical technique, which is likely to remove more of the lead, producing, therefore, a permanent remedy. Therefore, for the enforcement site, significant quantities of hazardous material will be sent offsite for landfilling, but for the fund program site safe treatment residuals will be backfilled onsite.
- It is difficult to compare costs for the two sites. About 80 percent of the cost for the enforcement site is operation and maintenance (mostly for offsite landfilling); the cost for the fund program site consists almost entirely of capital costs for the more sophisticated chemical recovery treatment facility (10 times more capital cost than for the enforcement ROD cleanup); the cost also accounts for revenue of about $4 million from selling recovered metal. Still, if the enforcement ROD had used the cleanup standard of the fund program ROD and its cleanup technology, then it might have cost perhaps as much as another $10 million.[69]

Eight Landfills

Sites at which wastes were buried initially vary greatly, some were used only for industrial wastes but many were municipal or mixed waste landfills. But there are also significant similarities from a cleanup perspective. For example, the cleanup of landfills nearly always is based on leaving the wastes buried, capping them, and, if necessary, addressing groundwater contamination, which is very common around such sites. The assumption is nearly always that the volume of buried waste is too large to consider excavation and treatment; little attention is normally given to identifying hot-spots of contamination amenable to excavation. In many cases these sites already have caps on them, but they

@At a major Superfund site in Michigan (Rose Township), the cleanup standard for lead in soil was 70 ppm, which is quite low for lead and illustrates the benefit of having uniform cleanup standards for common contaminants in soil, which for lead would probably be higher than 70 ppm. This site cleanup was also a settlement with originally stringent cleanup objectives. However, subsequently, as asked for by the responsi le parties, a portion of the incineration was replaced with less expensive soil flushing for volatile organic chemicals, and EPA's usual cleanup standard was dropped, with a new one to be determined by the responsible parties during post-ROD work. This suggests that a technology performance standard might replace a health-based one. The Natural Resources Defense Council testified that "The Rose Township reversal is a sobering reminder of the power wielded by PRPs, and of the *numerous means* by which a protective remedy can be undermined. Donald S. Strait and Jacqueline M. Warren, testimony before Senate Subcommittee on Superfund, Ocean and Water Protection, June 15, 1989. The reduction of cleanup cost issue was described recently: '''It was strictly a money thing, ' said Kevin Adler, the EPA's project manager. The maximum the companies would pay voluntarily was $14 million; any more and they'd take the EPA to court. Newsweek, July 24, 1989 The situation at the Rose Township site also illustrates the potential significance of distinguishing between current and future risk (see discussion in ch. 1 of policy option 1) because much of the justification for cleanup was baaed on speculative future risks. This appears to weaken EPA's position in obtaining stringent cleanups by responsible parties.

69 Actually, the estimated capital cost for the Bureau of Mines treatment plant was probably overstated because the equipment could be used at other Superfund sites and the capital costs distributed over several cleanup projects.

have not prevented the need for further action which, ironically, is often to use another cap.

Instead of matching a small number of similar sites, as in the previous sections, all the fiscal year 1988 RODS in Region 5 for which containment/land disposal was selected were examined to determine if there were effects from settlements with responsible parties. Summary findings are given in box 3-G Three of the eight RODS were labeled by EPA as fund and five were designated enforcement. That is, 62 percent of the containment/land disposal RODS were enforcement, compared to a national average of 71 percent. Region 5 is a large but representative EPA region.

The general conclusion is that enforcement containment RODS had significantly more issues related to effects from settlements or the conduct of RIFSs by responsible parties. Issues include the reduction of cleanup costs by: selecting simpler caps, consistent with municipal instead of hazardous waste landfill regulations; rejecting the use of incineration for small amounts of hazardous material (with costs similar to typical cleanup costs) or for large amounts (with costs which are high-perhaps $50 million to $100 million-but not necessarily infeasible);[70] avoiding or minimizing groundwater cleanup.

The total costs of the five enforcement RODS and the one fund ROD which EPA said it was negotiating with responsible parties (Belvidere) is $44.2 million compared to costs which might have totaled $283.6 million if more stringent cleanups considered in the RODS had been selected.

Conclusions

There is nothing intrinsically wrong with EPA's desire to maximize settlements which reduce the need for fund-financed remedies. OTA's research shows that EPA's emphasis on using negotiated settlements as its chief enforcement tool, however, is linked to EPA's ability to reduce cleanup costs to levels attractive to responsible parties by compromising environmental objectives. However, there is nothing illegal about this, because there is currently a lot of flexibility in statute and EPA's implementation of it to allow different kinds of remedies and levels of protection for similar sites. This conclusion suggests the need for routine EPA examination of remedy selection and cleanup objectives in RODS and, perhaps, a policy about enforcement which assures consistent levels of environmental protection, regardless of whether a cleanup is fund-financed or responsible party-financed.

But it is also important to note that there are examples of responsible parties showing great interest in performing first-rate cleanups, sometimes more consistent with statutory provisions than EPA's selected remedies. For example, at the Tyson's Superfund site in Pennsylvania the responsible party did its own technology demonstration and convinced EPA to change its ROD, replacing major offsite landfilling with onsite vacuum extraction and destruction of volatile organic chemicals, if further testing confirms its effectiveness.

OTA's analysis also shows that technical work in Superfund looks better when enforcement site decisions, in which non-technical considerations strongly affect outcomes, are separated from fund site decisions.

EPA spends hundreds of millions of dollars on its Technical Enforcement Support contractors. A major job for them is oversight of responsible party contractor work and supplemental work at enforcement sites. But this extensive EPA contractor activity is not preventing EPA decisions that sometimes compromise environmental protection. Given this and the increasing rate of settlements, the key question is: Will future government oversight, from the same system, reveal whether or not settlement cleanups performed by responsible parties are com-

[70] It is conventional wisdom that for large landfills it is economically infeasible to employ expensive cleanup technologies, such as incineration. But there has been no attention by EPA or others to exactly what level of cleanup cost is unacceptable or prohibitive. The statute gives EPA a way to reject very expensive *fund-financed* cleanups; it is called fund-balancing, which means that when costs for a cleanup get so high as to seriously reduce the government capability to address other Superfund sites, the expensive cleanup can be rejected on economic grounds, even though it might be the best environmental solution for the site. EPA, however, rarely invokes the fund-balancing provision when it rejects high cost alternatives for fund-finance cleanups. How much money is too much for a site? At enforcement sites where responsible parties-which for landfills often include local government---could pay a high cleanup cost, should high cost alternatives be dismissed automatically? The issue of whether the lower cost containment remedies being selected are permanent is also important, and whether settlements and consent decrees hold responsible parties liable for future major secondary cleanup *actions*

Box 3-G--Summarie s of Eight FY88 Region 5 Decisions Selecting Containment/Land Disposal

Belvidere Municipall No. 1 Landfill, Belvidere, Illinois: fund ROD, EPA did RIFS.

The ROD did not give specific groundwater cleanup levels, but extensive details from the site's risk assessment were given. The cap selected is consistent with that required for a hazardous waste landfill, even though the limited amount of hazardous waste was disposed before 1980. ((Men, EPA defends using a solid (municipal) waste landfill cap when there is documentation that hazardous waste disposal was prior to 1980.) The ROD rejected an incineration option for 790,(X)0 cubic yards at a cost of $127.6 million [which is low but realistic in today's market] chiefly because it was "so much more costly. " No fired-balancing argument was given, Environmental benefits for the incineration option were not given. The selected remedy's estimated cost was $7.9 million. The ROD said that EPA was negotiating with responsible parties to implement the ROD.

Kummer Sanitary Landflll, Northern Township, Minnesota: fund ROD, State did RIPS.

The ROD rejected a hazardous waste landfill cap, but justified it correctly on the basis of no documented disposal of hazardous waste and an estimate of the small increased protection over using the State's required municipal landfill cap, which is stringent. Incineration of the 1.3 million cubic yards in the landfill was eliminated early on because of short-term problems and "excessive cost" and because it was "cost-prohibitive." No explicit use of the fund-balancing provision was made. The selected remedy's estimated cost was $6.9 million to $12.5 million. A 1985 ROD had selected an alternative water supply: a future ROD will address groundwater cleanup. The case for deferring a decision on groundwater cleanup was well discussed

Oak Grove Sanitary Landfill Site, Oak Grove Township, Minnesota: fired ROD, State did RIFS.

The ROD acknowledged documented disposal of hazardous waste, but rejected using a hazardous waste landfill cap because only about 0.1 percent of the 2.5 million cubic yards of landfilled waste is hazardous was* and it is dispersed throughout the landfill. Using the hazardous waste cap had an estimated cost of $7.4 million to $14.6 million compared to the selected remedy's estimated cost of $5.1 million to $10.7 million. Incineration was eliminated early on because of cost and short-term risks. The deferral of the decision on groundwater cleanup was well presented

Cashocton City Landfill, Coshocton, Ohio: enforcement ROD, EPA did RIFS.

The originally proposed remedy (at $17.5 million) was changed because of comments by responsible parties primarily a lower cost option (at $8.9 million) was selected. Cost was reduced by eliminating a leachate treatment system and a system to vent landfill gases, but these were to be considered in the design of the remedy. Although groundwater contaminationon and signficant risks were documented in the ROD, no groundwater cleanup was selected; monitoring was selected instead. Even though there was documentation that 6.4 million pounds of hazardous waste were disposed in the landfill, a cap for a municipal and not a hazardous waste landfill (as was proposed initially) was selected. The ROD acknowledged that the responsible parties want an even less stringent cap and that waivers are possible later. The ROD contained candid discussions of the desire by the responsible parties to minimize immolate costs, even though EPA thinks that they risk higher long-term costs due to eventual cleanup needs. But clearly EPA gave the responsible parties what they wanted. From the ROD: "The PRPs' proposal suggests a remedy which is less costly, initially, but which could be substantially more expensive should the monitoring system detect changed conditions... . The PRPs. . . have expressed a preference for a less comprehensive (and less costly) initial containment option, with the understanding that should said initial action not be sufficient, the ensuing remedy could be more costly. While it may not be appropriate for the federal government to 'gamble' in this way, if financially viable private entities agree to undertake the remedy and are willing to enter into an enforceable court order by which they would be obligated to quickly act in response to changed the government maybe willing to consider a remedy by which the PRPs explicitly assume such a risk." How well this arrangement does not jeopardize public health and environment depends on effective EPA oversight of post-ROD activities and fast responses by responsible parties should they be necessary.

Republic Steel Quarry Site, Elyria, Ohio: enforcement ROD, EPA did RIFS.

The decision not to pursue groundwater and sediment cleanup was well supported. The ROD gave good details from the site's risk assessment. However, the ROD selected offsite Iandfilling for 100 cubic yards of contaminated soil at an estimated cost of $63,2(M). The alternative to use offsite incineration at an estimated cost of $279,700 was rejected because of its higher cost.

Mason **County Landfill, Mason County, Michigan: enforcement** ROD, EPA did RIFS.

To its credit the ROD selected **a cap consistent with a hazardous waste landfill because industrial slurry and** sludge wastes had been disposed there (prior to 1978). The ROD gave good details on the site's risk assessment results and the case for deferring a decision on groundwater cleanup was well presented. An alternative of using chemical fixation for excavated material at a cost of $43 million was rejected on sound technical grounds. Incineration for the relatively small landfill (140,000 cubic yards) was rejected without detailed examination, but its cost might be about $50 million. The selected remedy's estimated cost was $2.8 million.

Allied **Chemical/Ironton Coke Site,** Ironton, Ohio: enforcement ROD, responsible parties did RIFS.

Cleanup levels for groundwater cleanup were given in the ROD. However, numerous statements indicate that the pump and treat method is not likely to reach those levels, will be stopped when "technical unfeasibility is demonstrated" during cleanup, and a formal waiver from regulatory requirements for contaminant concentrations will then be implemented. The ROD had few details from the site's risk assessment. Options to excavate most and all of the site's hazardous materials and incinerate them were seriously examined. But they were rejected because the overall environmental protection was not rated higher than capping the landfill, and because of high costs ($92.2 million and $218 million). The ROD acknowledged the difficulty of the selected remedy being effective for the layer of dense non-aqueous contaminants which have settled at the bottom of the site. The higher cost incineration option which would treat all 456,000 cubic yards of site hazardous material was actually overestimated in cost by close to $100 million, based on current costs for onsite incineration. The ROD referred to the high cost incineration option as "cost prohibitive" and offering advantages "not commensurate with the costs. " To its credit, the ROD selected a hazardous waste landfill cap; hazardous waste disposal had stopped in 1977. The estimated cost of the selected remedy, which also includes **a slurry wall around the disposal area was $13.1** million. The ROD included a discussion about comments from the Department of Interior: "DOI asserted that the major advantage of the selected remedy is cost, and without reviewing the cost assumptions, asserted that future operation and maintenance of the preferred alternative will meet or exceed the cost of the most expensive alternative [incineration of all site hazardous material]. DOI also raised concern about the source of money for continued long-term operation and maintenance, and the future environmental consequences if long-term operation and maintenance% is not conducted. "

Waste Disposal Engineering, Andover, Minnesota: enforcement ROD, responsible parties did RIFS.

The ROD lacked details from the site's risk assessment and specific cleanup objectives for the groundwater cleanup. Optimism about the pump and treat groundwater cleanup was contradicted by other ROD statements: "The extraction system will effectively intercept all [emphasis added] contaminated ground water migrating from the Site in the Upper Sand aquifer and currently entering Coon Creek. . . . The extraction system will be active indefinitely, and will greatly reduce, if not eliminate, any loadings to Coon Creek, . ." Serious attention was given to excavating and incinerating a confirmed hot-spot called the Pit. But it was not selected, even though only 5,500 cubic yards was estimated to cost $6.3 million. The argument was that only 10 percent of the site hazardous waste was in the Pit. But this position is undermined by many statements in the ROD which refer to the Pit as the "major," **"dominant," and "most serious" source of groundwater contamination. There is no mention of the benefit of permanently removing such a major confirmed source of groundwater** contamination. Moreover, the cost for the incineration is overestimated by about 100 percent and the issue of 'severe safety risks' from excavation seems overstated because a test excavation in 1986 did not result in safety problems. To its credit, the ROD selected a hazardous waste landfill cap, even though disposal had stopped in 1974. The selected remedy's estimated cost was $11.4 million, which includes a slurry wall around the Pit and pumping from within it.

SOURCE: Office of **Technology Assessment**, 19S9: **based** on **examination** of EPA RODS.

parable environmentally to fund-financed cleanups and SARA's stringent cleanup requirements?

The issue that seems important for future Superfund implementation is: Is there a better way to get responsible parties to pay for cleanups without compromising environmental goals? After all, SAM'S cleanup requirements do **not** distinguish between enforcement and fund-financed cleanups. EPA could maintain uniformly high environmental standards for all Superfund cleanups and make cleanup decisions independent of who pays for cleanup. EPA could use the tough enforcement tools given to it by statute to get those responsible for creating Superfund sites to pay for environmentally effective cleanups that are consistent with statute and congressional intent. The more EPA uses strong enforcement tools, the stronger its position in reaching voluntary settlements which do not require compromising environmental goals. However, it should be noted that responsible parties believe that settlement cleanups **are** effective environmentally and satisfy statutory requirements. Indeed, there generally is enough flexibility or ambiguity in key statutory requirements to permit some widely different interpretations. Moreover, EPA's implementation has already included so many different types of cleanups for essentially the same types of sites that responsible parties can easily point to the least stringent cleanups as precedents for cleanups providing effective environmental protection. (See several policy options in ch. 1)

Finally, OTA's findings on effects of settlements should also be examined with regard to other cleanup programs into which potential Superfund sites may be deferred, especially programs in which responsible parties routinely select and implement cleanups (e.g., EPA's corrective action program within its RCRA hazardous waste regulatory program, the leaking underground storage tank program, and many State cleanup programs). Such cleanup programs include many more sites than in Superfund and influence Superfund in several ways (*see* ch. 4).

Issue 4: Are analyses and selections of cleanup technologies inconsistent and, if so, does it matter?

OTA's 1988 case studies have documented substantial cleanup inconsistencies among and within the 10 EPA Regions and EPA headquarters. The inconsistencies are for critical decisions about cleanup objectives and remedy selection. The situation can be credited to excessive regional autonomy—there literally are 11 different EPA and Superfund programs.

An environmentalist's 1987 analysis of 10 post-SARA RODS is consistent with OTA's case studies:

> Our review of the 10 RODS reveals a disorganized, confused bureaucracy making seat-of-the-pants, poorly documented decisions that fail to protect public health and violate the law. Seven years into the program, we have not progressed beyond ad hoc and inconsistent process that was the hallmark of Superfund's grim first few years. [The] Superfund program . . . continues to make bad and inconsistent cleanups the rule and the reality. The inconsistent approaches *taken* in the 10 RODS underscore the urgent need for the agency to develop specific national policies for its regional offices to use in making such decisions.[71]

A rarely addressed consequence of inconsistent decisions was also noted:

> In short, the agency's erratic, inconsistent approach to cleanup standards today could compromise the fiscal integrity of the fund years into the future.[72]

A study by Washington State University and Battelle's Pacific Northwest Laboratory on improving site study methodologies said:

> Although EPA has provided general guidance for conducting an RI, EA (endangerment assessment), and FS, detailed procedures are not readily available to implement these guidelines; as such, analyses tend to be inconsistent from site to site, and the quality and quantity of documentation varies.[73]

Another recent observation was that:

71 A.B. Early, testimony before the Senate Subcommittee on Superfund and Environmental Oversight, June 25, 1987.

72 Ibid.

73 Kenneth E. Hartz and Gene Wilson, "“~As and RAAS Methodologies as Integrated Into the RI/EA/FS Process,” *Superfund* '88, proceedings of conference November 1988, Hazardous Materials Research Institute, Silver Spring, MD.

> The ROD process, occurring in ten EPA regions as well as at headquarters, results in wildly inconsistent remedies and sometimes conflicting rationales,[74]

Why is there so much inconsistency? Different information is used. For example, the unit cost of a technology such as mobile incineration may vary by 100 percent or more (see OTA's 1988 case studies). The problem is caused, in large part, by having many different contractors working on sites for 10 EPA regions that are responsible for selecting remedies. At the Pristine site in Ohio, incineration was rejected because it w as estimated to cost twice as much as the selected remedy (in situ vitrification). In fact, its cost was overestimated by a factor of 2, according to detailed incineration costs contained in two feasibility studies on other sites by the same contractor, but at a different regional office of the contractor.

Different technical criteria and different structures for analysis are used in feasibility studies and RODS. Some RODS have analyses that really do help a reader understand why the remedy selected is better than the others. But, more often, the analyses can be used to justify any remedy selection because either they are superficial and qualitative, or they are lengthy and redundant with no sharp distinctions. A State official summed up his view of EPA's method to evaluate cleanup alternatives and select a remedy:

> Sometimes it seems that "guidance" is followed so faithfully that common sense is neglected. Flexibility is a crucial missing component when remedial alternatives are developed and evaluated, but it is overutilized in actual remedy selection. In our view it is best to consider a wide, variable range of alternatives and allow the best one to emerge. Instead, EPA does a rigid evaluation of generic remedies, only to be confronted with a choice between several square solutions for a round problem. At that point flexibility is too late.[75]

Variable interpretation of SARA's provisions on remedy selection is also important in understanding the presence of inconsistent Superfund implementation. EPA has tacitly encouraged subjective, variable, and inconsistent interpretations of statutory language. No attempt has been made to clarify the meaning of terms such as treatment, permanence, reduction in toxicity, cost-effectiveness, and future failure modes. Nor has there been any attempt to establish hierarchies for types of treatment technologies and their outcomes. The current use of nine different criteria-apparently with equal importance and no hierarchy-to evaluate cleanup alternatives does not help to make clearly understood, sharp distinctions. Regions and specific remedial project managers emphasize whatever criteria they choose to.

Some of the nine criteria could have been simple requirements to be met by a selected remedy rather than criteria for which alternatives have different levels of performance (e.g., compliance with regulatory standards, long-term effectiveness, community reaction, State support). Also, the overlapping and ambiguity of some of the environmental criteria (e.g., short-term effectiveness, reduction of toxicity, mobility or volume, implementability, overall protection of human health and the environment) fosters an analysis that can be made to support any decision.

The inclusion of cost (but not cost-effectiveness) has also facilitated ruling out alternatives early in the screening process and in combination with the flexibility of the preceding environmental criteria facilitates a cost-benefit kind of analysis. All of this is compounded by the lack of detailed analysis, including references to the technical literature, scientific principles, and actual data. In its place is qualitative assertion and cost-benefit reasoning.

As OTA's case studies have documented, use of any treatment technology and, in some cases, even use of land disposal or containment are interpreted as meeting SARA's requirements and preferences concerning the examination and selection of remedial cleanup technologies. Confirmation of this OTA conclusion comes from a study of fiscal year 1987 RODS which concluded, "The degree to which selected alternatives are cost-effective cannot be determined based on the limited discussions and

[74] Roger J. Marzulla, ''Superfund 199 1: How Insurance Companies Can Help Clean Up the Nation Hazardous Waste, paper presented to Insurance Information Institute, Washington, DC, June 13, 1989.

75 Michael J. Burkhart, Director of New Mexico's Environmental Improvement Division, letter to OTA, July 5, 1988.

rationales provided in the documents reviewed."[76] This conclusion is all the more significant because the study also concluded that:

> . . . cost was the most significant factor in the selection of remedial alternatives in the decisions reviewed. Thirty-four percent of RODS reviewed selected either no action or the least costly alternative other than no action; 8 percent selected the most costly alternative evaluated. In 40 percent of RODS, more protective alternatives not selected cost at least an additional $10 million; some of these remedies cost an additional $100 million or more. . . . [C]ost appeared to play a more significant role in the selection of remedial alternatives than did risk.[77]

This work supports our previously discussed finding concerning money saved by responsible parties as a result of settlement-impacted RODS, and the conclusion that cost-effectiveness has given way to cost-benefit thinking which leads to selection of low-cost remedies and rejection of higher cost remedies which, however, offer higher levels of environmental protection. In other words, **not using the statutorily required cost-effectiveness form of decisionmaking has lead to inconsistent cleanup decisions in Superfund.**

In addition to the case studies, a few more examples from RODS illustrate the diversity of ways to comply with the statutory requirements:

- For the Powersville Landfill site in Georgia, the selected remedy consists of capping the landfill, grading of the surface, groundwater monitoring, providing alternate drinking water, and restricting the site deed. The 1987 ROD said: ''This remedy satisfies the preference for a treatment that reduces toxicity, mobility, or volume as a principal element. . . . [T]he remedy utilizes permanent treatment technologies to the maximum extent practicable. ”
- For the NW 58th Street Landfill in Florida, the selected remedy closes the landfill in accordance with regulatory requirements, including leachate control and probably capping, groundwater monitoring, and providing municipal water to some private well users. The 1987 ROD said: “The statutory preference for treatment is not satisfied because treatment was found to be impracticable due to the magnitude of waste to be treated (estimated 27 million cubic yards). ’ Treatment of contaminated groundwater was rejected because the contamination is too widespread; a 1985 ROD selected air stripping at the water treatment plants, The ROD also noted that: “The present worth estimate of the cost of excavation alone is $439 million, Since this is two orders of magnitude higher than the other alternatives that would provide comparable protection, this alternative is rejected on the basis of cost [emphasis added], ” But if treatment offers better protection, then the selected remedy does not offer comparable protection and is not cost-effective. The fund-balancing provision of the statute, which provides a way to avoid spending so much at any one site that cleanups at other sites would be jeopardized, could have been used, but was not, to justify rejection of excavation and treatment.
- For the Tri-City Oil Conservationist Corp. site in Florida, the selected remedy was no further action. The 1987 ROD said: “The statutory preference for treatment is not satisfied because treatment was found to be impracticable. Treatments which reduce toxicity, mobility, or volume of wastes would not have been cost-effective at this site because of the small volume (850 cubic yards) of wastes present. The ROD also said “. . . the remedy utilizes permanent treatment technologies to the maximum extent practicable given the small volume of contaminated materials. ” In fact, the 850 cubic yards had been removed and landfilled in 1985 and, therefore, the volume present that the ROD actually addressed was zero.
- For the Vega Alta Public Supply Wells site in Puerto Rico, the selected groundwater remedy was treatment of some well waters and shutdown of some others with connections to another source of water. The 1987 ROD said: ''The statutory preference for treatment, while not fully satisfied in that the sources still need to be considered, is partially addressed in that

[76] Carolyn B. Doty and Curtis C. Travis, ''The Superfund Remedial Action Decision Process' draft, Oak Ridge Nationat Laboratory, undated, received by OTA in May 1989. The study was done for EPA and did not analyze the effect of responsible parties on cleanup decisions.

[77] Ibid.

the groundwater treatment system reduces the toxicity and volume of contaminants.

- For the Presque Isle site in Pennsylvania, the selected remedy was no further action, The 1987 ROD said: "This remedy satisfies the preference for treatment that reduces toxicity, mobility, or volume as a principal element. Finally, it is determined that this remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. " All the deep well-injected wastes will be left onsite.

EPA has examined the presence and cause of inconsistent Superfund implementation with regard to risk assessments, an important part of the RIFS process that leads to setting cleanup goals which cleanup technologies must then meet. Some of the EPA report's findings substantiate an organization and management structure that also explains inconsistent technology analysis and selection like this:

- "The current guidance, Regional review, and HQ oversight systems will not necessarily detect or prevent inconsistencies. "
- "Guidance cannot ensure consistency. Unresolved technical and policy issues and the continuing need for judgment leave room for differences to emerge. "
- " . . . [N]o one group. , . has a broad view of all risk assessments, limiting HQ's ability to identify inconsistencies between sites or Regions."
- ' 'Regions, intent on their own work, know little about the actions of other Regions.
- "... [N]o one really knows the extent of inconsistency. As the number of assessments grows, it becomes increasingly likely that some significant inconsistencies will go undetected. '[78]

The report omits the possibility that non-EPA activities might elucidate the presence and significance of inconsistent Superfund implementation, including congressional oversight, studies by public interest groups, and news media coverage. Instead, staying within its own perspective and system, EPA concluded that no major new actions were necessary but that existing activities could be strengthened. OTA does not concur. The level of inconsistent Superfund implementation is so high that it is reasonable to seek new ways to remedy the situation.

A more recent study of fiscal year 1987 RODS also found many problems in the processes leading up to RODs.[79]

Summary--Inconsistency is not necessarily bad. But similar Superfund sites and cleanup problems have received different cleanups with different, uncertain, and sometimes relatively low levels of environmental protection. Variable environmental protection is the central problem with inconsistent Superfund implementation. Counter to statutory requirements and preference, non-treatment, impermanent remedies based on land disposal, containment of wastes, or wait-and-see monitoring are often selected. ROD selections of untested and uncertain treatment technologies also occur. Particular treatment technologies have become favorites of some EPA Regions and are ignored by others. Moreover, as said earlier, some treatments do not destroy or detoxify site contaminants and cart crowd out more effective treatments, which may be more costly. Inconsistency makes the marketplace very difficult for technology developers, creating major uncertainties that have little to do with the merits of the technologies.

Issue 5: Are there incentives built into the Superfund program for making broad use of improved cleanup technologies?

There are nearly none.

SARA does, of course, provide a basic national policy framework that favors improved treatment technologies, and public opinion helps, But this policy can be responded to superficially, ignored, and misinterpreted. There are far more penalties than rewards for going with new solutions over older ones, even though the older ones may not offer reliable, permanent long-term protection.

All those who bear costs generally see treatment alternatives as more expensive in the near term than conventional containment/land disposal and monitoring options. Those who pay include responsible

[78] U S Environmental Protection Agency, Evaluation of the Preparation Of Risk Assessments for Enforcement Activities,'' September 1987.
[79] Doty and Travis, op. cit., footnote 76,

parties, States, and EPA. EPA also is driven by a desire to distribute funds over as many sites as possible and by its interest in facilitating agreements with responsible parties so that they pay for cleanup. Responsible parties may worry about the long-term uncertainty and liability of newer cleanup techniques. Engineering consulting companies worry a great deal about liability for ineffective work or work that is judged later by different standards. Inevitably, engineers see less risk with favoring use of 'standard' off-the-shelf technologies. Few people want to be the first to use a new technology on a major scale. The view of professional consulting engineers is this:

> Engineers incorporating unproven technologies in their designs are gambling with their clients' money. If the gamble backfires, the engineering firm could be held liable. Thus, engineers are not like] y to often make use of unproven technologies in remedial designs. This results in an impasse: engineers do not want to use unproven technologies, but technologies cannot reach commercial status unless they are used.[80]

Within government, there are also bureaucratic pressures on people to finish reports and RODS, pressure that goes against what could be a more lengthy and costly examination of alternative treatment technologies.

There is an important exception regarding incentives. Some responsible parties have been very aggressive in examining and selecting newer treatment technologies, chiefly because they see a reduction in cost over some other alternate-often another older, more expensive treatment technology. Moreover, responsible parties want to minimize their future liabilities and, therefore, sometimes work very hard to have a permanent remedy selected. Indeed, some EPA decisions to use land disposal have been changed because of responsible party work that demonstrated the effectiveness of treatment technology; this happened at the Tyson's site in Pennsylvania.

Last, an important disincentive built into the current system is the need to obtain a regulatory delisting of the residue of a treatment operation if the material is to go offsite after treatment. The RCRA regulatory program has considerable inefficiencies. If delistings cannot be obtained quickly, then the cost of using a treatment technology escalates, because the residue is automatically considered hazardous unless found otherwise through the delisting process. This situation means that the residue must go to a permitted hazardous waste facility or that one must be built onsite, instead of a lower cost solid waste one or just backfilling the material into the site. Uncertainty about delisting and high cost of residue management can block adoption of effective treatment technology.

issue 6: Will using permanently effective cleanup technologies mean that cleanup costs will skyrocket?

No one seriously believes that American society can afford Superfund cleanups at **any** cost, regardless of who is paying for the cleanup. But discussions on cost and, eventually, where the money comes from, and liability issues have obscured some basic points about technology which, after all, is the tool with which cleanups are accomplished, The same is true about discussions of cleanup standards and goals that ignore the means of meeting expectations.

Better cleanup technology is not the enemy of cost reduction. In the long-term, permanently effective technologies avoid uncertain and possibly high future repeated cleanup costs. Certainly in the long-term and probably in the short-term, technological innovation and development will reduce costs as well as increase technical effectiveness to meet stringent cleanup goals. These gains are clearly happening for some cleanup technologies already. Competition among more vendors and more available treatment capacity is also helping to reduce costs. In several areas, such as thermal destruction and removal of volatile organic chemicals from contaminated soil, unit cleanup costs for permanent remedies have decreased in the past few years.

Combinations of newer technologies at complex sites can also reduce total long-term costs, particularly use of separation technologies to reduce the use of more expensive destruction technology such as

[80] **Hazardous Waste** Action Coalition, American Consulting Engineers Council, *The Hazardous Waste Practice-Technical and Legal Environment 1988.1989,*

incineration, For example, a variety of in situ techniques can remove volatile organic chemicals from soil which can then be burned, thus avoiding the high cost of excavating the contaminated soil and burning a largely inert, uncontaminated mass.

More reliable comparative data on costs of different permanent and containment/land disposal technologies are needed. In particular, it is critical that actual cleanup costs be collected, analyzed, and disseminated to compare with data from vendors and with estimated costs in feasibility studies. One preliminary study of 30 completed Superfund cleanups found that cost estimates tend to be less than actual costs at all stages of the projects (i.e., feasibility study, ROD, design, and contract procurement). The study noted, ''Even at late project stages the estimates do not 'hone in' accurately on actual costs. ' '[81]

OTA's 1988 case studies show an average cost of $20 million for a cleanup considered consistent with SARA and $10 million for one which can be questioned, but some of these costs are only for parts of a site's total cleanup.

On the one hand, EPA said: ''More permanent remedies are not necessarily slower or more expensive remedies. ' '[82] But EPA's Assistant Administrator J. Winston Porter had said earlier: ' 'There's probably not enough money in the world to clean up all the sites permanently. "[83]

OTA has examined EPA's official figures for estimating the average cost of a remedial cleanup in its regulatory impact analyses, as published in the Federal Register. In 1984 and 1986, EPA said a remedial cleanup would cost $7.2 million in 1984 dollars. In 1987 and 1988, the figure was adjusted upward to $8.6 million, but only to reflect the earlier cost in 1986 dollars (no real change). In 1989, the figure became $13.5 million in 1988 dollars, the first real increase since 1984 and **after SARA.** (Interestingly, the net present value of operation and maintenance over 30 years at a 10 percent discount rate remained exactly the same at $3.77 million in 1984, 1986, and 1988 dollars, If these calculations are not mistaken, then such costs are decreasing in real terms.)[84] More recently, EPA said that the average construction cost per site is $25 million, which with study and administrative costs might total $30 million. In other words, EPA's data indicates that some increase in remedial cleanup costs has been foreseen because of the more stringent requirements in SARA, but not what would be described as skyrocketing costs. However citing an average cleanup cost is not especially instructive, because costs vary enormously (from several hundred thousand dollars to the $50 million to $100 million range) and because a number of site actions may be taken over some years at a particular site.

However, there has been a lot of rhetoric about skyrocketing cleanup costs. A view from the responsible party community is: '', . . SARA includes a strong bias in favor of permanent remedies and onsite remedies and requires that applicable or relevant and appropriate State and Federal standards be applied. , . . SARA has created a cleanup process with great potential for inflating costs. EPA has estimated that the cleanup requirements in SARA would drive the cost of a Superfund cleanup from its present average of about $8 million-$9 million per site to between $25 million and $30 million per site. '[85] The major cause of the shift in cleanup costs has been the shift away from impermanent remedies based on containment and landfilling. Indeed, a study for the Chemical Manufacturers Association estimated high post-SARA costs of over $60 million for using incineration, This compared to $27 million for using incineration for hot spots and onsite containment which was called modified permanence.[86] However, the scenario based on **using**

[81]Independent Project Analysis, Inc., ''Better Cost and Schedule Estimates for Hazardous Waste Cleanup," background package, Great Falls, VA, January 1989.

[82]*EPA Journal*, 13(1), January/February 1987.

[83]*Environment Reporter Current Developments*, Sept. 26, 1986, p. 778.

[84]These figures are from the following Federal Register notices: Sept. 21, 1984; June 10, 1986; Jan. 22, 1987; June 24, 1988; Mar. 31, 1989.

[85]T.M. Hellman and D.A. Hawkins, in H&@&~ Wrote *Site Management: Water Quality Issues* (Washington, DC: National Academy Press, 1988), pp. 98-119.

[86]Susan Fullerton et al., ''Impact Analysis of SARA on the CERCLA Remediation Program, ' *Superfund* '88, proceedings of November 1988 conference, Hazardous Materials Research Institute, Silver Spring, MD.

incineration pervasively for Superfund cleanups overstated costs for achieving permanent remedies, because incineration is more expensive than some other technical approaches, unit costs for incineration have decreased, and it would not be used for very large landfills.

Sites with large amounts of landfilled material definitely pose a particularly difficult problem for using excavation-treatment approaches. Consider a volume of 1 million to 10 million cubic yards. There may be hundreds of sites in this range, typically old municipal and industrial landfllls whose leachate is hazardous. Though the actual amount of hazardous substances in the landfill may be very small, they are distributed within a large mass. At a low cost of $200 per cubic yard, the cleanup cost would range from $200 million to $2 billion-both costs are beyond the routine capabilities of Superfund for fund-financed cleanups. It is not a question of cost-effectiveness, because containment does not offer comparable protection to treatment. Large landfills illustrate an appropriate use of the fund-balancing provision of Superfund. That is, cleanup at too many other sites might be blocked because of enormous individual site cleanup costs. But the containment remedy should not be called permanent. Very low cost in situ permanent treatments or clever ways of identifying hot spots of contamination for excavation and treatment are needed. Otherwise, traditional containment approaches will prevail.

Another major problem is that decisions are made with unreliable cost estimates. As one insightful analysis concluded: "It is difficult enough to estimate costs at this early (screening) stage of the feasibility study when 'old' technologies are involved; it is hardly prudent to try to estimate the costs of innovative technologies before a much more detailed analysis (not to mention extensive pilot testing) is performed. "[87] OTA's case studies have revealed major under-and over-estimates of cost. While it is generally recognized that a desire to minimize cleanup costs might be influencing decisions, it is another matter that estimated cleanup costs can easily be manipulated to create the appearance of too high a cost for a treatment alternative (that allows cost-effectiveness to rule it out) or too low a cost (that makes it appear that cost is not the main reason for rejecting it).

Finally, there will be increasing debate over how **much contaminated material** will be treated in a cleanup and to what levels of residual contamination. The shift to treatment technologies is being compromised by limiting the extent of treatment in order to reduce costs while still getting credit for using treatment. Some cleanups may use treatment for very small fractions of site-contaminated materials. A good example of this issue is a study done by two national environmental organizations for a community group concerned about the selection of remedy for a Superfund site in New Hampshire. The report concluded:

> The community-based plan would provide permanent treatment for a much greater volume of soil, would destroy nearly all PCB's and would clean up groundwater to a cancer-risk level that is 100 times lower than EPA's cleanup, Equally important, the community-backed alternative is cost-effective. . . . [A]ll of the above benefits can be achieved for a total cost that is less than 13 percent higher than EPA's substandard cleanup. The new Superfund clearly indicates that such increases are warranted where they bring about large benefits.[88]

Note that the remedy selected by EPA **did** include incineration.

Another example is the complaint for the Bayou Bonfouca site in Louisiana:

> Although the remedy selected by the agency involves the excavation and incineration of some contaminated sludges, 20,000 cubic yards of contaminated soil will be left onsite and covered with a cap to keep out rainfall. The entire area is characterized by standing water and saturated surface soil,[89]

Issue 7: Are research and development producing a steady stream of more cost-effective cleanup technologies?

[87] D. Truitt and J. Caldwell, ' 'Evaluation of Innovative Waste Treatment Technologies, '' Waste Management Conference-Focus on the West, Colorado State University, June 1987.

[88] H. Cole et al., "The Ottati and Goss/Great Lakes Container Corporation Cleanup Decision: A Bad Precedent for the New Superfund, " National Campaign Against Toxic Hazards and Clean Water Action, June 1987.

[89] Early, op. cit., footnote 71'

The answer is yes. The cleanup market is enormous and private sector funds so available, because of the perceived volume of business, that extensive R&D is constantly producing new and improved cleanup technologies. Government spending and university activities have also increased, some with the help of SARA programs. The activity in separation and biological treatment technologies is particularly intensive and productive.

Of particular importance is the rapid emergence of in situ cleanup technologies; these have the advantage of eliminating the need to excavate contaminated soil or to extract groundwater, which add expense, and sometimes cause concern over site worker safety (for soil) or releases of contaminants into the environment (for soil and groundwater). Moreover, testing and demonstration of cleanup technologies at cleanup sites are taking place at an increasingly rapid pace because of actions by responsible parties, EPA Regional offices, States, and the formal SITE program (discussed below) established by Congress. Still, this technical activity is not necessarily reflected by program decisions and commitments at actual sites.

The main problem continues to be a "clogged pipeline. " That is, R&D efforts are driven by continued optimism about the number of cleanups, the availability of government cleanup funds, and the availability of venture capital. But the cleanup market rarely meets the expectations of technology developers. Enormous amounts of money can be spent in ways that do not create business for companies selling newer cleanup technologies. Paradoxically, the rapid growth of Superfund and the public pressures on the government to produce more cleanups as fast as possible do not necessarily promote the adoption of **newer, innovative** cleanup technologies. Already one company with anew form of thermal destruction, which had received a lot of attention and had passed several site demonstrations successfully, has gone bankrupt. Some biological treatment companies have failed. Moreover, the competition is constantly increasing so that available business and opportunities for site demonstration are being distributed over more technology companies. Small market share can limit company success and continuing technology development.

Government agencies themselves that spend lots of time and resources developing a technology may interfere with fair competition among other, privately developed technologies. For example, EPA developed its own mobile incinerator and gave it preferential treatment, publicity, and work over privately developed mobile incinerators, But the EPA incinerator offered no significant technological advance. Indeed, EPA's interest in incineration has dwarfed its interest in biotechnology, although the agency has tried to offset this imbalance in the past year. New York State with some EPA assistance has spent substantial time developing a plasma thermal destruction unit without the same level of success of some private enterprises. Such government activities make sense to the extent that private industry is not already doing similar development and if they do not remove comparable testing, demonstration, and application opportunities from private technology developers. In the cleanup area, there is some basis for believing that direct financial development of cleanup technology by government agencies has not been adequately justified. Nor is there any evidence that the government efforts have been cost-effective.

The EPA SITE Program—in 1985 and 1986, Congress had discussed the need for a joint government industry effort to aid the introduction of innovative technologies into the Superfund program during its initial authorization period, and later Congress created the SITE program in SARA. Thus far, the SITE program has had mixed results. A few corporate participants in the program commented on it recently:[90]

- "Those hoping involvement in SITE will turn quick profits in the short-term may be disappointed. " (Carl Brassow, Soliditech, a subsidiary of United Resource Recovery.)
- "[SITE was] very slow moving." (Mark Zwecker, American Combustion Inc.)
- "The analytical expense that the EPA went to was close to $1 million. We could have cleaned up the entire site for less than half that amount." (James Malot, Terra Vac Inc.)

A recent survey of the program found that:

[90] *Environmental Business Journal,* May 1989.

> Nearly one-third of the interviewed company officials (28 technology developers) claimed that the contractors hired by EPA to sample, test, and analyze data were unsatisfactory.. . . Some industry representatives felt the contractors were slow, inexperienced, and generated irrelevant data. . . . One official commented that contractors continue to analyze and re-analyze the same data, making more money for themselves and taking away dollars from both industry and EPA,[91]

In this same study, of the five technology companies that had completed their demonstrations, four had problems with EPA's contractors that prompted the study to note, "Future demonstrations may be hindered unless the contracting system is improved in the future. "

An issue that merits more attention is the degree to which participating technology developers in SITE are sometimes making public statements to advance their commercial interests, despite the lack of SITE results to back up those claims. Moreover, sometimes EPA officials seem to be cooperating in such efforts. For example, a report by EPA's Inspector General documented several instances where publications spoke about a successful test within SITE "despite a lack of successful operations. ' '[92] Indeed, EPA's published results on the B.E.S.T. process,[93] which portray test results as successful, are in disagreement with the results of the Inspector General's office. A broader issue, therefore, is whether there is an inclination within the SITE program to emphasize positive findings and to discount negative results. Similarly, for an incineration technology, the Inspector General's report said that "PCBs and particulate (mainly lead) were released into the air and thousands of gallons of wastewater containing lead were sent to the local wastewater treatment plant. " But EPA's SITE program said, '[Lead] remained in the ash and was not transferred to the scrubber water or emitted to the atmosphere."% The SITE program literature does not explicitly point out that the test results show that the stringent requirements of the Toxic Substances Control Act for PCB destruction were not met.

In an article in a technical magazine, the president of a participating company said, ''The EPA's Paul DePercin, project manager for the HAZCON SITE field evaluation, stated the test '. , , was an unqualified success in stabilization of heavy metals and PCBs in the presence of 25 percent by weight of oils and grease. "[95] In fact, some months later, EPA's Demonstration Bulletin in March 1989 said that volatile organics were primarily released to the environment during processing, and that test data showed that base neutral/acid extractable organics were higher in the treated samples than the untreated ones. No data to support effective stabilization of PCBs was obtained. The only clear positive result was the lack of toxic metals in leachate for treated materials. But this result is what is expected of commercially available chemical fixation technologies. To its credit, the SITE program also publishes Application Analysis Reports which give a broader and more interpretive presentation of a demonstrated technology; the one for the HAZCON technology (almost 2 years after the site demonstration) said: "Data shows immobilization of organics in a few instances but not in most. . , . It can be concluded that immobilization of volatile and semivolatile organics does not usually occur. '[96] While this official EPA work does not rule out the technology for Superfund cleanups involving organics, EPA definitely shifts the burden of proving effectiveness to detailed site-specific treatability and demonstration tests.

In the June 1989 issue of *Chemical Engineering Progress,* Gee-Con said in an advertisement: "Deep Soil Mixing and its sister technique, Shallow Soil

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91 J. Calarese et al., ''An Evaluation of the EPA SITE Demonstration Program, ' Worcester Polytechnic Institute, Washington, DC, Project Center, December 1988.

92 Inspector General, U.S. Environmental Protection Agency, ''Review of Region 4's Management of Significant Superfund Removal Actions,' Sept. 26, 1988.

93 U.S. Environmental Protection Agency, Project Summary, "Evaluation of the B. E.S.T. (TM) Solvent Extraction Sludge Treatment Technology Twenty-Four-Hour Test, " November 1988.

94 U.S. Environmental Protection Agency, demonstration bulletin, "Elw~c Infrared Incineration, ' April 1989.

95 Ray Funderburk, "EPA's SITE Test of Solidification," *Pollution Engineering,* December 1988.

96 U.S. Environmental protection Agency, ''HAZCON Solidification Process, Douglassville, Pennsylvania, " April 1989.

Mixing, have been proven effective in the U.S. EPA's Superfund Innovative Technology Evaluation (Sites) program at Hialeah, FL, where PCB-contaminated soil was stabilized in place. ' But at that time no report had been issued by EPA on the demonstration.

A critical concern about the SITE program is that it has never focused on truly innovative technologies, ones that would make major breakthroughs in particularly difficult cleanup applications and ones for which prior R&D has justified field demonstration. Some of the technologies in EPA's SITE program are variations of well-known, commercial technologies and have been demonstrated several times already or have even been used for an actual cleanup. It appears that the SITE program has become a public relations opportunity for companies. OTA's examination of the 30 technologies and firms in the SITE[97] program indicates that at least 21 technologies have been commercially available for some time, used in cleanups, and cannot be interpreted to be innovations. Four other technologies are variations of existing, commercially used technology. An EPA spinoff program is the Emerging Technologies Program to develop "cutting-edge technologies. The goal is to prepare technologies for demonstration; direct financial assistance is available to support R&D. Of the seven technologies in the program, two are known commercial technologies,

One company has told OTA: "Three years ago the Terra Vac process was being labeled as 'unproven' technology even though the process was initially developed over six years ago at a Superfund site. Terra Vac's independent application of the technology at more than 60 sites across the country has done more to promote the technology than the reams of data collected during the demonstration and still awaiting final evaluation. Instead of paying (Terra Vac) for worthwhile services rendered while partially cleaning up a Superfund site during a demonstration, EPA paid five times as much for a subcontractor (who is one of our competitors and now offering **our** technology to clients) to learn the process from Terra Vac. "[98]

To some extent, the SITE demonstration program looks redundant or like a formality that EPA imposes on technology companies, and it may be impeding development and adoption of truly innovative technology. In most cases thus far, several years or many months have passed before the results of demonstrations have been completely analyzed and presented to the public. Meanwhile, some companies can complete actual cleanups and may have enough data to convince others that the technology merits adoption. Waiting for ''proof' from a SITE demonstration may only maintain the stigma of being ''unproven' and ''innovative. An added complexity, in the case of thermal destruction technologies, is that some companies have also carried out test burns at sites in order to meet various government requirements, The results of these are just as important as those from formal demonstrations.

Issue 8: Are the rules clear on what constitutes proof of cleanup effectiveness for new technologies?

The answer is no. There seems to be much disagreement on how to prove that newer cleanup technologies work. Inconsistent cleanup technology selections are being made because there is no clear, generally accepted understanding of what amount and type of information are reasonable proof of effectiveness and reliability. Moreover, the engineering side of technology selection can obscure fundamental environmental protection goals, with the result being the rejection of environmentally more effective cleanup technologies.

The key problem is how to bridge the gap between technology selection decisions and laboratory results or very limited use of a newer technology. The problem is compounded by rapidly changing and increasing data and experience as well as by increasing numbers of companies and individuals implementing Superfund.

There are at least three types of inquiry where actual Superfund site materials are tested; in order of

[97]U.S. Environmental Protection Agency, ' 'The Superfund Innovation Technology Evaluation Program-Progress and Accomplishments Fiscal Year 1988,:; March 1989.

[98]James Malot, President of Terra Vac, personal communication, spring 1989.

increasing cost they are: treatability studies, pilot studies, and site demonstrations.

Non-site materials (prepared to simulate actual site waste) are generally used in laboratory experiments carried out as part of R&D programs or by technology developers. In these cases, the materials are typically very simple chemically compared to complex mixtures of contaminants at many Superfund sites. The unavoidable risk is that field tests may not be successful even though laboratory tests were. This risk is greatest for in situ techniques where actual site conditions and not just the chemical nature of the contaminants are important.

Overall, it is not clear to everyone implementing Superfund just how these various types of tests differ or what has to be done to satisfy EPA in reaching a conclusion, which itself is currently informal, that a given new technology can be considered as proven for some types of Superfund cleanups.

Treatability Studies--Increasing attention is being given to treatability studies in which actual site materials and newer treatment technologies are evaluated in offsite laboratory facilities. Treatability refers to the ability of treatment to work effectively on site hazardous material. Relatively few treatability studies are currently being done before RODS; an EPA survey of fiscal year 1988 RODS found that only 4 of 50 source control RODS examined discussed treatability studies.[99] A key issue is when such studies are done; another is with what technologies they are done. OTA's 1988 case studies showed that treatability testing of technologies was often delayed until the post-ROD Design Phase, which is not subject to much public scrutiny. It is difficult to accept the legitimacy of selecting a remedy **before tests** show that the selected remedy can work unless, of course, the technology has been widely used on similar problems successfully. For example, a pre-ROD test of commonly used forms of incineration is probably unnecessary for most cleanups. Yet, if tests are delayed, then negative post-ROD test results also mean major delays because it is necessary to go back to the study stage; such a delay happened at the Conservation Chemical Co. site in Missouri, and at the Re-Solve site in Massachusetts. Clean Sites, Inc., has described two of its sites. At one, a post-ROD treatability study will "likely indicate that the selected remedy will not be effective' and delay is likely. At the other site, the treatability study is being conducted 3 years after completion of the feasibility study.[100]

Considering its historic lack of confidence in Superfund, the public is likely to be suspicious of exactly how post-ROD test results will be verified and what criteria will be used to conclude that the test results are positive enough to proceed with the remedy's implementation. This suspicion is particularly true for remedies implemented by responsible parties. The danger is that cleanup objectives can shift from health-based to technology performance.

If the basic purpose of treatability testing is to provide data on the feasibility of a cleanup technology for site materials, then it must be done during the RIFS and before the ROD. Otherwise, it is possible to rule out or select technologies without enough credible technical data to support the ROD analysis and decision. For post-ROD treatability tests with negative results, there are incentives and pressures to avoid re-opening the ROD, carrying out another feasibility study, and possibly performing another treatability test.

On the other hand, if the purpose of the test is to get more detailed data to implement the Design Phase, then it could be done at the beginning of the stage. A pilot study definitely fits into this legitimate need to obtain refined engineering data for reliable design of the cleanup.

Selection of technologies and test laboratories is another issue. Based on their technical expertise, innovative technology developers (and not Superfund contractors) should perform treatability studies. Their self-interests requires detailed documentation of results and careful review by government and independent experts. Another problem is fairness in ensuring that all interested and qualified parties have equal access to laboratory results. Very often only one treatment technology or company has the advantage of a treatability test. Remedy selection and establishing of site cleanup objectives may be

99 *Superfund Report,* July 5, 1989.

100 Clean Sites, Inc., *Making Superfund Work,* January 1989.

biased in favor of a particular technology within a generic class.

Engineering consulting firms that perform Remedial Investigation and Feasibility Studies are not necessarily expert enough about new cleanup technologies to conduct treatability studies. There may be a conflict of interest if treatability testing is done by companies that also perform RIFSs or by responsible parties, both of which may have a financial interest in certain technologies remedy selection. The point is not to legally prohibit such practices, but to raise the conflict-of-interest issue. EPA has a responsibility to ensure fairness in order to ensure that the most effective cleanup solutions are found.

Another issue is: Is the technology considered proven from a scientific perspective? If so, is its appropriateness for a specific site to be demonstrated through a treatability study? In most cases the answer should be yes. If the range and levels of site contaminants are different from a previous demonstration, it is necessary to perform a treatability study.

Alternatively, can an innovative technology that has not been tested very much at the laboratory stage nor considered proven by EPA be adopted for use on the basis of a positive treatability test result? Unless the answer to this question is yes, doing treatability studies (which increase as more new technologies enter the picture) as part of the RIFS process may be a waste of considerable money because they can be expensive, from tens to hundreds of thousands of dollars. But, on the other hand, allowing a treatability study to be sufficient for remedy selection shortcuts the R&D process. Such a shortcut is likely to sidestep obtaining data on the more subtle aspects of performance, including production of toxic byproducts and the dependence of effectiveness on contaminant concentration.

Pilot Studies-A valid reason for a site pilot study or small-scale test (including incinerator test bums) is that laboratory results cannot take into account actual site conditions. For example, even treatability studies on site materials do not necessarily encompass site climatic, hydrological, or biological conditions. Nor do they address materials handling problems found in the field. Pilot studies are essential for evaluating in situ techniques such as soil washing or flushing, biological treatment, chemical stabilization, vitrification, and extraction of volatile chemicals. It is unlikely that a treatability study would provide a sufficient technical database for full-scale use of an in situ treatment technology, and this deficiency is often true for relatively conventional above-ground technologies that treat contaminated groundwater, for example. Another technical problem is highly variable concentrations of contaminants which are not likely to be properly assessed in offsite treatability studies.

Often the issue of scale-up is also pertinent; that is, either an onsite or offsite pilot study (which may also be called a treatability study) is needed to examine feasibility on a larger scale than can be done in laboratory tests. Trying to determine the relationship between scale of use (e.g., volume) of waste and cost is, however, difficult and expensive. Some pilot studies, however, could probably be extensive enough to accomplish smaller cleanups, because the concept of scale-up does not have its traditional engineering significance for cleanups. There is no standard size or type of cleanup. For example, quantities of contaminated soil to be cleaned can range from hundreds of tons to hundreds of thousands of tons at a site, and volumes of contaminated surface and ground waters vary greatly. Sometimes, a small unit or several small modular units or combinations of smaller units of different technologies may be quite feasible for a cleanup. Moreover, there is some flexibility for cleanup duration because imminent dangers rarely exist by the time a remedial cleanup is done. Many recent pilot studies have been nearly complete cleanups of relatively small sites. For example, a 3-month pilot study of in situ bioreclamation, based on supplying nutrients and oxygen to the aquifer to promote degradation of gasoline by indigenous organisms, cleaned up 90 percent of the groundwater contamination. The study noted that it would have taken conventional pump and treat 7 years to achieve such a result.[101]

Site Demonstrations-There is probably nothing more convincing to skeptics than the successful

[101] Edward A. Radecki et al., "Enhanced Natural Degradation of a Shallow Hydrocarbon Contaminated Aquifer,' in proceedings of Haztech International Conference, St. Louis, MO, August 1987.

results of a technology demonstration that successfully cleans up part or all of an actual site. This reaction is especially true for in situ techniques. Still, there are many uncertainties yet to address. Site contaminants and conditions vary substantially, and one or more successful demonstrations may not be adequate to select the technology at a significantly different site. Who has conducted the demonstration and the accuracy and reliability of the data are also important factors. Many times technology developers speak of their successful demonstrations at cleanup sites, often without EPA or any government agency being formally revolved. EPA and others may not recognize those tests as acceptable demonstrations, for good reason. In a great many cases, the technology company and the site owner make very little technical data available to substantiate their claims.

General Comments-Frustration on the part of technology developers and controversy about the selection of cost-effective permanent technologies are explained by insufficient rules for the burden of proof that EPA requires before newer technologies can be selected. Equally important is the poor dissemination of information to an increasingly large number of people and organizations implementing Superfund and other cleanup programs.

Moreover, there is evidence of inconsistency about remedy selection in the history of the Superfund program (see OTA's 1988 case study report) which sends confusing signals to technology companies and raises the issue of fairness. While some technology companies are being made to jump numerous high hurdles, others are being treated quite deferentially. Other than government personnel, people in the engineering consulting firms that work for government and industry as well as for responsible parties can help technology companies substantially if they choose to do so. An enthusiastic supporter of a technology can get treatability or other tests done and can even build a case for ROD selection without test data. Conversely, consultants can also easily kill a cleanup alternative without any detailed data.

Although the frequently heard complaint is that new technologies cannot get tested or used at Superfund sites, in fact many treatment technologies are being selected without any significant technical data to support the decision. For example, an extensive study by EPA's Inspector General for two removal actions said:

> Region 4 funded commercial testing and development of two hazardous waste treatment prototypes: SHIRCO's infrared incinerator and Resources Conservation Company's Basic Extraction Sludge Treatment (BEST) unit. To fund the tests, the Region sidestepped several internal controls; such as permitting, delisting, and contracting regulations. Region 4's selection of the two technologies was speculative and unsupported by scientific or engineering fact. Nevertheless, both prototypes were used to conduct full-scale operations at removal sites prior to evidence that the manufacturer's performance claims were true.[102]

Several examples were also given in OTA's 1988 case studies, including the Chemical Control site in New Jersey and the Sand Springs site in Oklahoma. We have two other examples to add.

At the Lipari Landfill site in New Jersey, for example, a positive treatability study for biotreatment was ignored, but a cleanup approach based on soil flushing was adopted for the site cleanup even though the technique had never been documented to be successful at a similar site. The long duration of soil flushing was a major point noted by a number of parties unhappy with the selection of soil flushing at Lipari. A major factor of concern was the diverse types of contaminants at Lipari, some of which were shown to be difficult to remove by water flushing. For several PCB-contaminated sites in Indiana a novel incineration approach based on burning both municipal solid waste and site-contaminated materials was selected. But it had not been tested or used elsewhere. In both cases, there has been considerable community opposition to the selected remedy because of the lack of convincing data on technology feasibility.

Finally, the situation is made even more complex and ambiguous because there is no evidence that information from various types of testing done by many different parties involved in the national cleanup effort, inside and outside of the Superfund program, comes together in some central way for

[102]Inspector General, op. cit., footnote 92.

analysis and transfer. Testing protocols are absent and there may be redundancy and technical inconsistencies among treatability testing, pilot studies, and demonstrations on the same technologies. While EPA has made progress in addressing this problem, there is now no effective Federal effort to provide independent professional review and expeditious distribution of validated information nationwide.

Issue 9: Is poor information affecting the use of better cleanup technologies?

The latest technical information on generic and specific cleanup technologies, their costs, and their performance and implementation at sites does not travel far. Similarly, the considerable experience from private, State, RCRA corrective action, and non-EPA Federal agency studies and cleanups may go untapped, along with the expanding reservoir of cleanup-related R&D, including university work. Theoretically, much of this activity could have a positive impact on Superfund, including making it more efficient and effective.

A particularly striking example of poor communication about cleanup technology with EPA happened for the Crystal City site in Texas (one of the case studies in OTA's 1988 report and a cleanup decision that has been criticized by the local community, State and national environmental groups, and Members of Congress). In defense of EPA's selected remedy which was based on land disposal, the Region 6 Administrator testified that "No technology was found that could effectively remove (arsenic) from the soils. . . . Arsenic, a principle pollutant of concern at this site, cannot be effectively removed from the solids by alternate treatment technologies. ''[103] In a ROD that was signed at the same time that the Crystal City ROD was signed in September 1987, "on-site flushing of soil with an acidic water solution to remove arsenic was selected for the Palmetto Wood Preserving Site in South Carolina. A month before the Crystal City ROD, EPA had formally acknowledged in regulations for the RCRA program that chemical fixation was proven, available technology for waste with arsenic; and the ROD for the French Limited site in the same State and region (and signed by the Regional Administrator a month before the testimony on Crystal City) also acknowledged the applicability of chemical fixation for arsenic.

Some poor information transfer is unavoidable because of the rapid rate of growth and in change. But most of the problem is probably due to insufficiently focused EPA activities, arising from the highly decentralized, fragmented nature of the Superfund program and-just as importantly-the whole national cleanup effort. OTA has examined a number of documents that EPA uses in its technology transfer activities. Often only a superficial level of information is being reported. A person would still have to expend considerable time and energy to obtain the detail necessary for a good technology evaluation. A remedial project manager with little experience and a heavy workload is not likely to be able to do this research. In other cases, highly detailed voluminous studies are prepared at considerable expense, but hardly anyone seems to be using these documents (from EPA's Office of Research and Development) because it would take so much time to use them effectively. They are meant for researchers and experts, not practitioners at the frontline of Superfund.

Some part of the problem of poor information may also result from insufficient attention to the problem by contractors. OTA agrees with the perspective of a technology developer: "The REMS and ARCS contractors (types of contracts for the remedial program) are at best six months behind on individual technology development programs, and more frequently 18-to-30 months. " The developer, therefore, believes that bringing technology developers into the RIFS process through the conduct of treatability studies ''is a way for EPA to effectively help the technology transfer from the developers to their contractors. '[104]

Another problem is the generally inexperienced and, therefore, cautious workforce. There is a preponderance of civil engineers and hydrologists working in the cleanup, but these people are likely

[103] Robert E. Layton, testimony at hearings before the House Subcommittee on Environment, Energy, and Natural Resources, Apr. 11, 1988.

[104] James A. Heist et al., ''Remediation and Treatment of RCRA Hazardous Wastes by Freeze Crystallization, " presented at EPA's Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International, June 1989.

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to lack the expertise and experience necessary to understand many new forms of cleanup technologies based, for example, on complex chemical engineering or biological treatment. Moreover, the rapid expansion of cleanup technologies has resulted in increasingly exotic and sophisticated technologies which only a few people implementing Superfund understand. A judgment that a newer technology is proven, reliable, and applicable-or unproven, unreliable, and inapplicable-may depend on the limited and recent experiences of the contractor company (or really, individuals within the company) instead of the accumulated experiences of all parties within the national cleanup system, within and outside of Superfund.

Technology loyalty, instead of an open mind, can also be a problem when organizations other than technology developers exercise it. First, as Superfund contractors have diversified, some of them have a stake in the adoption of a particular technology that they own. For example, at least one contractor owns an incinerator, several have developed techniques to physically remove volatile organic chemicals from contaminated soil, and one's parent company sells raw materials to a technology vendor. This problem is compounded by the fact that sometimes the identity of the company performing a Superfund study is not revealed. The more one looks carefully, the more one finds Superfund contractors, their parent companies, or their subsidiaries involved with the ownership of cleanup equipment and technology.

Technology companies themselves are a problem because of the limited information they provide. They sometimes may not make necessary information available because they cannot afford to get it or do not want to get it. The waste treatment industry has long been frustrated with the slow adoption of treatment technologies. While the treatment industry fosters the appropriate use of newer treatment technologies, it sometimes contributes to premature selections and inappropriate use as discussed in OTA's 1988 case studies. It is just as unwise to select an untested and unproven technology as it is to reject a risky, innovative one with real promise to solve a difficult problem. Both actions can lead to an ineffective cleanup that wastes money, increases environmental risks, and creates a worse cleanup problem for the future.

Limited information from technology companies is an especially important problem for emerging biotechnologies. People knowledgeable about this area said,

> Past attempts at bioremediation have failed to establish conclusively biodegradation of chlorinated aromatic compounds in large-scale systems and have not yielded information useful for other systems, even those similarly designed. . . . Failure to consider testing and evaluation of bioremedial processes can lead to a credibility crisis. Left on its own, the race to market environmental biotechnology within the entrepreneurial private sector may not only prevent the effective technical development of this technology, but may also lead to market failure. The inability to analyze and correct failures and to enhance successes leads to a perception of unreliability and a major erosion of confidence. 105

Technology companies may sometimes want to keep information confidential or may have to, in the case of cleanups on sites unknown to government officials. Technology companies may also be worried about giving information to RIFS contractors which may compete against them for field work or which may have a competing technology.

The overselling of a technology is a real problem. Providing detailed available data often is in conflict with marketing efforts because the data reveals the limits of the testing or application to date. Oversell is especially prevalent because usually few contaminants have been worked on successfully relative to the enormous variety of contaminants found at Superfund sites. Too many technology developers extrapolate successful test results to other chemicals or site conditions without a valid theoretical basis for doing so. They ignore or underestimate the importance of technology specificity. For example, biological treatment which works for one chemical may not work for others present at a site; site conditions such as the soil chemistry and porosity may require significant changes in the design of a bioreactor or the materials that are added to assure effective microbial destruction.

[105] Tennessee Valley Authority, Center for Environmental Biotechnical Applications (University of Tennessee); and EPA, "A Proposal for the Development and Application of PCB Bioremediation Technology for the Texas Eastern Sites," September 1988.

One more factor is the often confused need for Federal and State regulatory permits for onsite cleanup activities (there is no uncertainty about the need for using permitted offsite waste treatment or disposal facilities, although their regulatory compliance status remains an issue). A need for permits increases information requirements significantly. Debate persists on the need for permits for onsite work—by law, none are needed for work on Superfund sites—but sometimes States have exercised their prerogative to require State environmental permits under their existing regulatory programs. The problem is that many cleanup technologies are not now regulated by existing programs, especially hazardous waste programs. If no specific regulatory standards exist, it can be difficult to get agencies to issue permits. Another issue is the need to get permits for mobile equipment, with technology companies and other parties wanting to reduce the complexity, costs, and delays associated with permitting.

Issue 10: Is experience leading to easier, faster, and less expensive analyses and decisions on cleanup technologies?

Just the opposite appears the case. Even though some individuals may be moving up a learning curve, the **program** does not appear to be gaining substantial efficiency. There are three key problems,

First, not many people see past the conventional wisdom that every cleanup site is unique, with the implication that every site decision must be on a case-by-case basis. Although there is as much truth to this as there is that every person is unique, sites can be grouped by important commonalities of site conditions and problems. Overly stressing the uniqueness of every site does not necessarily make the system worse as it expands, but it does hinder a global view. It also promotes unnecessary site studies, which add more cost and delay than providing truly useful information. Belief in site uniqueness stands in the way of using cleanup objectives and technologies selected at similar sites, because site differences currently obscure site similarities.

Another part of this problem is that there has been reluctance by EPA staff to admit and openly communicate the failures of cleanups at sites, even though this could substantially affect other decisions. OTA's examination of RODS indicates that most failures are for containment and land disposal approaches and, less frequently, simple forms of treatment such as chemical stabilization. There often seems to be an attitude that maybe the technology can be made to work at other sites or that other EPA regions have the right to make their own decisions and mistakes. Moreover, public criticism of Superfund makes it difficult for EPA officials to acknowledge cleanup failures.

Each site study and decision has the potential for being made in isolation. To the extent this is true, then the more sites and cleanup technology options, the worse the situation. Indeed, there are so few central management controls imposed on the program that it is difficult to see Superfund as learning and maturing from its own experiences, and less so from other cleanup programs. Instead, disparate working elements of the program act independently, too free of central oversight and control which would help the elements learn from each other's positive and negative experiences.

Second, the increasing numbers of generic and specific cleanup technologies outpace the transformation of information into wisdom, They increase the amount of information ideally obtained in the RIFS and place difficult demands on the workforce. Considerable information on exact site and contaminant conditions is necessary to rule out or to defend the selection of particular technologies. There are fundamentally different constraints to different generic technologies, such as thermal v. biological treatment. Increasing numbers of technologies also means that increasing combinations of them can be assembled, at least theoretically, to clean up complex sites.

Technology specificity, where effectiveness varies for different hazardous substances, takes on more importance as the range of cleanup technologies expands, because for many of them no theoretical or scientific case can be made for non-specificity. Although specificity has been a problem even for containment techniques (e.g., effect of some chemicals on slurry wall permeability), it is less relevant for older incineration techniques. Generally, technology specificity has not been adequately dealt with. In fact, the frequent practice of using short lists of indicator contaminants, instead of the full array of chemicals present at a site, to reduce the RIFS workload conflicts with evaluating and using diverse permanent cleanup technologies. Indicator contaminants might make sense for simplifying risk assessment. But physical and chemical properties that affect cleanup technology feasibility may vary substantially from health effects.

Specificity can be a problem with treatability studies because they too may rely on indicator chemicals to evaluate a technology's performance. The ultimate risk is the use of cleanup technology thought to be generally proven effective and found to be applicable through a site treatability study but that, nevertheless, does not work effectively on the full range and often wildly fluctuating concentrations of contaminants at a complex site.

Moreover, analyses and decisions themselves are coming under more scrutiny. The increasing numbers of technology companies mean that more parties want their technologies fairly and carefully considered in cleanup decisions. Technical assistance grants to communities are supposed to help the affected public make sure that the best technologies are used. Grants may also provide another opportunity for technology developers to enter the system. Responsible parties want to free themselves of future liabilities and to cut unnecessary costs. They can introduce new cleanup alternatives into the process. All of these concerns mean that the time and cost of "defensible' RIFSs and RODs are likely to escalate--competing with full-scale cleanups themselves-and thus the introduction and adoption of newer technologies may suffer. Increased overhead costs due to more extensive studies--often several hundred thousand dollars-at a large number of sites might offset cost savings from using improved technologies at a much smaller number of sites. Delays alone can be sufficient to stymie technology companies at a critical point in their development. A way to address this problem is to use the most experienced and expert people, with certain types of sites or technologies, to screen alternatives and reduce the number of alternatives studied.

Third, the general level of inexperience in technical and management areas of the national cleanup workforce in government and industry is a major problem on its own. The rapid expansion of activity coupled with a steady stream of new technologies requires major efforts to prevent delays and poor work. As the role of contractors has grown, it uses government programs as breeding grounds for its workforce. The constant shift of people from government to the private sector, because of substantially higher salaries and probably better working conditions and potential for promotion, **keeps the government workforce inexperienced. This** makes effective government oversight and management of contractor activities difficult, if not impossible. One observer recently summed up the current contractor system as being ''wasteful, disorganized and inefficient."[106] On top of this, there is also a high degree of mobility of the most experienced people among contractors as contractors compete to maintain or increase market share or business volume. Some of those with the most technical expertise go into management.

The result is a national cleanup workforce which is expanding rapidly, which is in constant motion, with few people having institutional memories or loyalties, for whom information transfer and education through working with experienced people is minimal, with no substantial improvement in average level of experience, and where labor costs are increasing. These problems will not cease without effective organization and management controls and clear and explicit policies.

[106] Roger J. Marzulla, ''Superfund 1991: How Insurance Companies Can Help Clean Up The Nation's Hazardous Waste,' paper presented to Insurance Information Institute, Washington, DC, June 13, 1989. Also see U.S. Congress, Office of Technology Assessment, *Assessing Constructor Use* in *Superfund*, OTA-BP-ITE-51 (Washington, DC: U.S. Government Printing Office, January 1989).

Chapter 4

Other Cleanup Programs and Superfund

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Other Cleanup Programs and Superfund

INTRODUCTION

To most observers, the Federal Superfund program is *the* Nation's environmental cleanup program. In reality it is but one—the most visible—part of a complex, not necessarily comprehensive, fragmented and generally uncoordinated national effort to clean up chemically contaminated sites.

Besides the Superfund program, the national effort consists of separate programs for hazardous waste facilities and underground storage tanks; programs to remediate sites with mine wastes and mill tailings and to close old mine shafts and pits; programs that clean up specific materials, such as PCBs and asbestos; and individual Federal agency and State cleanup programs. When the national cost of this system is added up, the current annual Superfund budget of about $1.5 billion is matched by an estimated $1.7 billion spent by the other programs. Spending by private parties increases this cost by perhaps $1 billion.

Actions, or inaction, by these other cleanup programs affect how the Superfund program works, what the Superfund program accomplishes, future demands on the program, and, just as importantly, people's perceptions of the program. Depending on the goals of the Superfund program, it may be important for Congress to consider ways to limit some interactions and enhance others. A particular, important long-term issue for Superfund is whether impermanent or incomplete cleanups from other programs might someday become Superfund sites. In a broader context, Congress may wish to consider whether a set of separate, overlapping and parallel programs is the wisest way to clean up the environment.

OTA's review of other programs shows that they suggest ways to improve Superfund; many examples are used throughout this report. Overall, however, many effects of other programs are less positive. This chapter discusses those impacts, which lead to:

- underestimates of Superfund needs, because: 1) the movement of sites among programs may delay effective cleanups under Superfund, and 2) cleanups in other programs, rather than preventing the growth in numbers of Superfund sites, can create future Superfund sites as a result of incomplete, or less stringent cleanups in other programs;[1]
- overestimates of the needs of Superfund when sites that qualify for and at one time might have been placed in the Superfund program are shifted to other programs; and
- implementation problems because Superfund must share the available national workforce and supply of technology with other programs.

Some details on the national cleanup effort surrounding Superfund are provided in table 4-1. OTA has not done a comprehensive assessment of every Federal cleanup program and has not been able to obtain details on all State programs. In all cases, OTA sought only the kind of information that could shed light on the interaction of the programs with Superfund. Federal programs were chosen because of their obvious connection to Superfund. Included were Federal agency cleanups, which are partially covered by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and are overseen by EPA, and Federal cleanup programs that EPA has designated as current or future homes for sites deferred from Superfund. To reduce the analytical burden of 50 State cleanup programs, OTA has chosen to focus on programs, such as California, Illinois, New York, and Minnesota, that are highly regarded by most people. California and Illinois, for instance, have reputations for advancing treatment technology; Minnesota is always used as an example of the benefits of using enforcement to clean up sites.

A PYRAMID

The national cleanup effort may best be likened to a dynamic pyramid with the Superfund program occupying the pinnacle, the most visible portion of the pyramid. The height of the pyramid is growing as most cleanups occur and new sites are added below the pinnacle. The bottom of the pyramid

[1] If the Superfund program has t. assume just 10 percent of the cleanups now the responsibility of other programs, it could add $24 to $61 billion to the cost of the Superfund program (see table 4-1).

Table 4-1--Other Cleanup Programs

Program	Federal statute	Federal agency	Estimated annual budget ($ millions)	Federal funding method[a]	Estimated number of sites needing cleanup	Estimated national oost of cleanup ($ billion): Agency	Estimated national oost of cleanup ($ billion): OTA[b]
RCRA corrective action	RCRA	EPA	14	9	2,000-5,000		12 to 100
Leaking underground storage tanks (LUST)	RCRA	EPA	50	t	350,000-400,000 (tanks)	32	
Federal facilities[c]	CERCLA[d] and RCRA		800	9	5,000-10,000		75 to 250
States......................	na		500	e	6,000-12,000+		3 to 120+
Asbestos in schools	AHERA	EPA	50t	9	40,000 (schools)	3	
	na	na	na	na	31 7,000+ (buildings)	51	
Inactive uranium mill tailings ...	UMTCRA	DOE	111	y	24	1.3	
Abandoned mine lands	SMCRA	DOI	193		22,300	55	
Marine sediments	na	na	na	na	?		> 10
Total			$1.7 billion			$242 to $612 billion	

na. not applicable
[a]g=general revenues, t=tax/trustfund.
[b]Based on min/max numbers of sites and min/max estimated cost per site.
[c]DOE data includes onty cleanup of hazardous wastes.
[d]Sixteen Federal agencies have sites to clean up.
[e]States fund own programs supplemented by about $200 million annually from Superfund.
[f]Minor part of cost; @q State and local government funded.

SOURCE: Office of Technology Assessment, 1989.

already covers thousands of sites more than Superfund.

It did not start out this way. Over time the Superfund program has been constricted, while the national cleanup effort has grown. These two trends are continuing. Two new cleanup programs are on the horizon: one to clean up toxic sediments found in many marine environments, another for cleaning up oil spills. And, while the major narrowing of Superfund occurred in 1982 with the writing of the first National Contingency Plan (NCP), EPA management practices continue to shrink the applicability of CERCLA. The longtime but growing efforts of EPA and others to defer cleanups away from the Superfund program was formalized in a comprehensive policy statement in the December 1988 proposed revisions to the NCP.[2]

The net effect of the narrowing of Superfund and the growth of other cleanup programs is that CERCLA and some of its unique provisions (i.e., public participation, cleanup standards, and permanency) are increasingly covering the fewest cleanups in the country. The bulk of the cleanups (those that conceivably affect the most people) at some lesser degree of cleanup might, over time, produce new generations of sites qualifying for cleanup under Superfund.

Other effects are highlighted in the two following statements. The first refers directly to the growth of other cleanup programs and their relationship to Superfund and was made by officials of ICF, one of the Superfund program's major contractor. The problems identified were called a "special challenge" to the Superfund program.

> These new programs will place additional burdens on the same infrastructure already shouldering the expanded Superfund program. They will create increased demands for environmental engineering talent and for analytical laboratory services. They will also place demands for program implementation on the States, many of whom are already strained to accommodate the current Superfund and RCRA programs. Moreover, unless the jurisdictions of these programs are carefully defined, there is a possibility of overlap, duplication, and inefficiency,

[2]This will not be part of the final NCP scheduled for 1990. The EPA administrator told Congress in June 1989 that the proposed deferral policy has been deferred for reconsideration during reauthorization of the Superfund program.

> with deleterious consequences for the objectives these programs are intended to serve.[3]

The second statement refers to complications of a multitude of programs within one State-New Jersey:

> Thus ''major' cleanups are being conducted by different programs through different statutes presenting the problems of inconsistency on every topic, from public to private remediation, from regulated units to whole site, from in-house guidance on soils to ground water standards . . . overlap was presumed to be high. In a Department with limited resources and an enormous number of sites to address, overlap could not be afforded.[4]

As a result of these kinds of findings, New Jersey is implementing a new strategy to assure that sites of similar complexity be cleaned up using "the same technical standards and approaches . . . By developing a cohesive strategy, duplicate and inefficient actions will be minimized in achieving comprehensive and consistent management actions.

SHRINKING SUPERFUND

As a statute, CERCLA conveys broad coverage.[5] It begins with the statement:

> To provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites.

The definitions of "hazardous substance" and ''release' and the restrictions on the use of the trust fund provide some limits. For instance, petroleum and various forms of natural gas used as fuel have been excluded from the definition of hazardous substance. A release has been defined very broadly but specifically excludes: workplace exposures, engine exhaust emissions, nuclear materials covered by other statutes, and the normal application of fertilizer. In general, the fund is to be used for government response costs taken for removal and remedial actions and the investigations that proceed them. It cannot be used for response actions at Federal agency facilities.

Limiting Through the NPL

The major restrictions on CERCLA coverage have been accomplished through the NCP, and the National Priorities List (NPL) is the device through which EPA first restricted coverage. While the NCP restrictions have been written by EPA and been approved by the administration, Congress has not totally accepted them. For instance, the Superfund Amendments and Reauthorization Act (SARA) requires EPA to revise the Hazardous Ranking System (HRS) and reconsider the cutoff score (see ch. 2).

In 1980, under CERCLA, Congress asked for a "criteria for determining priorities among releases . , . " and for EPA to use the criteria to create a list of ''national priorities."[6] EPA developed the HRS and proposed an initial 418 NPL sites in response to Congress asking for at least 400 sites initially. EPA implied program restrictions in the first NCP and then clearly stated in a revised version in 1985: ''Fund-financed remedial action is available only for sites on the NPL.

One way to interpret the original request by Congress for criteria and a priorities list is that it set up some way for a new program to determine which sites to start cleaning up frost. Reliable information was scarce in 1980. There were thousands of suspected sites in the country and there was a danger that the program could be quickly overwhelmed. The 1980 conference report on CERCLA says that the NPL was to serve "primarily informational purposes identifying for the States and the public

[3] James R. Janis and Edwin Berk, ICF Inc., ''Superfund: Significant Accomplishments, " proceedings of *Anatomy of Superfund, 8th* Nationat Ground Water Quality Symposium, September 1986, Kansas City, MO.

[4] New Jersey, Division of Water Resources and Hazardous Waste Programs, ''Case Management Strategy Manual,'' draft, May 1989.

[5] There was discussion during the debate over CERCLA in 1980 about placing limits on the program. An amendment by Congressman Dave Stockman would have restricted cleanup under CERCLA to only those sites posing only ''a significant threat to human health. It was rejected by the House committee. During the floor vote in the House, another amendment was submitted to restrict EPA from cleaning up ''any dump *site in the country* '' It, too, was rejected. [*1980* Congressional *Quarterly Almanac*, p. 588,]

[6] CERCLA, Section lo and (B)

[7] 50 Federal Register 5862, Feb. 12, 1985, p. 5867.

those. . . sites . . . which appear to warrant remedial actions.

EPA made the HRS and the NPL a way to limit Federal responsibility under CERCLA. EPA decided that a' 'national priority' was not just a site that might require early attention but the ***only*** category of site requiting CERCLA attention. From the language in the NCP, the decision was clearly taken to conserve the trust fund, which was seen at that time as a finite, one-time allocation. Explaining the agency's 1982 decision, EPA said:

> The purpose of this restriction was to ensure that the limited Fund monies were only used for remedial action at NPL sites.[9]

And, by labeling NPL sites as those "posing the greatest potential threats to human health and the environment, ' EPA fostered the concept of the Superfund program as one to remediate the *worst* sites. [10]

Limiting Through Management

Limiting the size and duration of the program has been an overriding objective of the managers of the Superfund program. The attempt to hold the size of the NPL to the original 418 sites is well known now as the "there will be no Son of Superfund" strategy. Since 1983, when congressional action prompted wholesale changes in Superfund managers, program cost has still been the driving force. For example, the evolution of the preremedial part of the Superfund program (discussed inch. 2) and its effect on the size of the program may be as effective as the original strategy but more subtle.

Limiting program size (and, therefore, cost) has been carried out primarily by holding down the number of Superfund sites: by not going out and actively looking for potential sites, by not placing all known potential sites in the official inventory, by eliminating sites at high rates as they proceed through evaluation stages, and by deferring sites out of the program. The program is also constricted by delaying actions, by reducing the extent of cleanups, and by using low-cost remedies. All of these tactics and their effect on the environmental mission of the Superfund program, which EPA does not explicitly address when using them, are discussed elsewhere in this report.

Deferring Cleanups Elsewhere

Deferral moves sites *qualifying for the NPL* out of the Superfund program. EPA offered for consideration a deferral policy in the December 1988 proposed NCP. Even though near-term implementation of that comprehensive policy has been halted by public opposition, deferral has been occurring since 1982. Then, EPA stated that active RCRA facilities would not be placed on the NPL and asked for comments about its policy, at that time, of including mining sites.11

Less well known are deferrals practiced by the removal program. According to a 1988 paper, it is EPA policy that when time permits the regional office must "aggressively pursue cleanup' by a Potentially Responsible Party (PRP) or State or local government before initiating Superfund cleanups.[12]

EPA has justified deferral, not on an environmental basis, but on the basis that, because another cleanup authority exists, it is appropriate to defer to that authority. EPA does not determine a site will receive a quicker, better, or even *comparable*

8U.S. Congress, Senate Report No. 96-848, 1980, p. 60. Post-CERCLA and with the development of the NPL, the term 'remedial action'' has taken on a legal definition. It is no longer just a reference to an environmentally needed cleanup but is a cleanup that qualifies for the Superfund program under CERCLA.

950 Federal Register 5862, Feb. 12, 1985, p. 5867.

10Worst sites is a concept rarely defined. To some people it means complex sites; to others, sites that are expensive to clean up. Worst Cm also imply greater risks although when applied to NPL sites makes unfounded assumptions about the accuracy of HRS scoring. The worst sites can also be sites that pose current risks v. sites that pose future, speculative risks.

1147 Federal Register 58476, Dec. 30, 1982, p. 58478.

12Karen Burgan and Bruce Engelbert, U.S. Environmental Protection Agency, and Verna Montgomery, Booz, Mien & Hamilton, Inc., ' 'Setting Removal Program Priorities,' proceedings from *Superfund* '88, 9th National Conference and Exhibition, Washington, DC, November 1988, pp. 32-34, cleanup if the cleanup is deferred to another program. According to several public interest groups:

> . . . *the* [deferral] proposal is also devoid of any analysis of the likely environmental effects of deferral.[13]

Individual proponents of deferral do often assume that by scattering cleanups among more authorities and by avoiding the CERCLA process and procedures, the pace of cleanups will quicken.[14] That conclusion, however, ignores the limited national supply of technical resources and assumes that the process and procedures do not contribute to the desired CERCLA outcome and that other programs have the people and funding to handle additional work.

The real significance of avoiding CERCLA may be to encourage deferrals. EPA has reasoned that requiring States to "strictly conform to NCP requirements might result in fewer States choosing to undertake a site remediation that could be deferred.[15] As part of EPA's discussions with the Department of the Interior (DOI) to gain acceptance for the deferral of mine sites to DOI's Abandoned Mine Lands Reclamation (AMLR) program, a Superfund official said:

> EPA's position is that States choosing to use AMLR funds to clean up non-coal sites would **not be** subject to the standards and procedures prescribed in the National Continence Plan (NCP) [emphasis added].[16]

In the December 1988 proposed deferral policy, EPA reasoned that expanding deferral of sites should be done because it ''may be appropriate' and because it will conserve CERCLA effort and funds for sites where "remedial action cannot be achieved by other means. "[17] Logically, this implies that, to the extent that other cleanup programs offer less stringent cleanups than Superfund, sites moving to other programs (or their communities) are penalized. EPA proposed to

> . . . view the non-Federal [agency] section of the NPL merely as a list for informing the public of hazardous waste sites that appear to warrant CERCLA funding for remedial action through CERCLA funding alone [emphasis added].[18]

This shrinks the CERCLA program (and, perhaps, applicability) down to only those sites that cannot be deferred to other programs. It also appears to eliminate the listing of CERCLA enforcement sites (EPA suggests formally deferring those to responsible parties) since they would not be paid for with CERCLA funding.

The comprehensive deferral policy would turn the Superfund program into the "court of last Federal resort, ' which is not the same as saying that Superfund handles the *worst* sites. That is, a *worst* site (i.e., one with an HRS score of 28.50 or more) would be moved to another program if it qualifies under another program. Once there, however, it may receive a less stringent cleanup than if it were in Superfund, the public may get less of an opportunity to participate and could not obtain Technical Assistance Grants (TAGs), the Agency for Toxic Substances and Disease Registry health assessments would not be done, and cost recovery on sites that

13 'Comments of Natural Resources Defense Council, U.S. Public Interest Research Group, and National Audubon Society on U.S. Environmental Protection Agency's Proposed Rule for National Oil and Hazardous Substances Pollution Contingency Plan, " Mar. 23, 1989, p. 5.

14 In letters to OTA supporting cleanup deferrals to States, both the National Governor's Association and the Association of State and Territorial Solid Waste Management Officials say that foregoing the procedural requirements of the NCP will hasten cleanup actions but not Jeopardize the integrity of the cleanup itself.

15 53 Federal Register, Dec. 21, 1988, p.5 1418.

16 U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, letter from J. Winston porter to Jed O. Christensen, director, Office of Surface Mining, Department of the Interior, Jan. 20, 1988.

17 53 Federal Register 51394, Dec. 21, 1988, p. 51415. See ' 'Cements of Natural Resources Defense Council, U.S. Public Interest Research Group, and National Audubon Society on U.S. Environmental Protection Agency Proposed Rule for National Oil and Hazardous Substances Pollution Contingency Plan," op. cit., footnote 13, for counter arguments to EPA's use of the "appropriate factors" clause of CERCLA to support the proposed deferral policy. These organizations say that EPA's interpretation ''ignores the clear thrust of the legislative history, and subverts CERCLA's carefully structured program to expeditiously identify, list, and remedy the worst sites in the country according to nationally uniform, protective standards' [p. 13].

18 53 Federal Register 5 1394, Dec. 21, 1988, p. 51416.

return to the Superfund program could be compromised.[19]

SUPERFUND STANDS ALONE

National programs to clean up the environment and protect the public have been a growth area ever since the 1970s. The Clean Water Act was enacted in 1972. Its premise was that, by slowing the rate at which contaminants were added to the Nation's surface waters, natural attenuation would eventually produce clean water. The same perspective was the basis of the Clean Air Act in 1970. The Clean Water Act also contains a provision allowing the Federal Government to act in emergency situations when petroleum products are spilled in waterways.

Superfund is unique because it is the first-and only—program designed expressly for environmental cleanup and for all media. Amendments under SARA in 1986 added sections on cleanup standards, which included a call for permanent remedies, and public participation, which provides for technical assistance grants. These are features that no other cleanup program has.

Other cleanup programs are not as stringently guided by statute or by current regulations.[20] Most other statutes have the kind of flexibility of the original Superfund statute (later rejected by Congress in SARA) that allow site-by-site decisions on the meaning of protection of human health and the environment. Public participation is mentioned in other statutes but not to the extent that it is in CERCLA.

Programmatically, most other programs-again, unlike Superfund-have dual roles. They set and enforce management regulations for active facilities while at the same time setting and enforcing cleanup regulations and procedures. Examples are the RCRA and Underground Storage Tank (UST) programs and those implemented by DOI under the Surface Mining Control and Reclamation Act (SMCRA) and the Department of Energy (DOE) under the Uranium Mill Tailings Radiation Control Act (UMTRCA).[21]

For dual programs, cleanup goals may clash with other program goals. For example, the RCRA program has identified the preservation of adequate waste management capacity as a critical item of Concern.[22] Thus, at active RCRA sites EPA (and States) must balance their regulatory responsibilities to compel cleanup with their goal to keep sufficient treatment and disposal facilities open. Additional pressure arises from the congressional requirement in SARA that States provide assurance that capacity will exist to manage hazardous wastes or face the loss of Superfund cleanup funding.[23]

One stated mission of the management side of many dual programs is to ''prevent Superfund sites. " The phrase implies either preventing uncontrolled sites from being abandoned or from becoming expensive, complicated sites, or both, Future Superfund sites are also prevented by proper management practices and, more fundamentally by not generating hazardous substances that need to be managed.[24] Thus, a major contribution to the national cleanup effort each regulatory system could provide is to encourage pollution prevention and to provide early warning and site discovery. The latter entails having both effective inspection and enforcement, which is often lacking,[25] Under the Leaking Underground Storage Tank (LUST) regulations, EPA rejected, as too costly, a requirement that implementing agencies actively seek out tanks that have been abandoned.

[19] EPA argued in the proposed policy that Provisions could be made to retain these features but they would add to the costs of cleanups.

[20] Alone among the Federal programs OTA reviewed, RCRA corrective action *may eventually* have regulations or guidance that is similar to Superfund. However, the program has been underway for 4 years without regulations and very minor guidance, allowing for maximum flexibility. Meanwhile, sites are being studied, remedies are being selected, and cleanups are occurring.

[21] Both the DOI and DOE programs deal with mine waste problems. Most of the information in this chapter on the DOE and DOI programs relates to the cleanup of *inactive* sites. Under SMCRA, the DOI's Abandoned Mine Lands (AML) program remediates both coal and noncoal mine areas. The DOE program is narrow; it only has authority over uranium mill tailings that are a consequence of processing uranium mine ores.

[22] U.S. Environmental Protection Agency, *The Hazardous Waste Management System*, 1987.

[23] SARA, Section 104(k).

[24] See OTA's *Serious Reduction of Hazardous Wastes* and *From Pollution to Prevention: An Update on Waste Reduction*.

[25] See, for instance, General Accounting Office, *Hazardous Waste Facility Inspections Are Not Thorough and Complete*, GAO/RCED-88-20, November 1987,

Cleanup programs differ among themselves in other ways. For example, the UMTRCA inactive uranium mill tailings and AML mine cleanup programs are like Superfund in that the government is responsible for evaluating sites, making remedy decisions, and doing the actual cleanups. Others are purely enforcement programs in which the government role is to coerce others, through administrative or court orders or negotiation, to evaluate and clean up sites. Usually, in the latter case, the government holds an oversight role but, as OTA's work on the Superfund program has shown, oversight is dependent on having sufficient resources and expertise, Like Superfund, "but unlike other programs, the LUST program does have a trust fund to handle cleanups it cannot get done through enforcement, The AML program is a hybrid. It has no enforcement provisions and is funded by taxes collected from the coal industry. AML funds cannot be used for a cleanup if a responsible party is known. Thus, once a PRP search is successful under Superfund, a mining site becomes ineligible for the AML program.

Contracting Links All Programs

In all of the programs, including Superfund, consultants and contractors are heavily relied on to do some or all of the study and field work. The South Carolina State program, for instance, has three major contracts that consume most of the available resources: 1) a remedial activities (physical cleanup work) contract, 2) an RIFS study contract, and 3) an emergency response contract.[26]

By and large the contractors hired for other programs are the same firms that Superfund hires. For instance, NUS has a contract to survey DOE's facilities; Ebasco Services, Inc., won NASA's site evaluation contract; and Roy F. Weston has a DOE and several U.S. Army contracts. The UMTCRA program at DOE is contracted out to a joint venture of Jacobs Engineering and Roy F. Weston. In California, of seven State remedial contracts, five with a total value of $23.5 million were held in 1988 by Superfund contractors.[27] As discussed later, this expanding but largely inexperienced workforce adds stresses to Superfund, as well as the other programs,

Programs Proliferate

Despite its unique role, Superfund has not been used to incorporate new cleanup efforts. Three other cleanup programs were created prior to 1980 when CERCLA was enacted; the other programs were created since then. Instead of building a comprehensive cleanup effort by adding newly recognized problems to existing programs, Congress has filled the gaps by building new, separate programs.

The growth of cleanup programs has followed the Nation's traditional structure of single media environmental programs and the existing authority for mining issues. That is, as knowledge about a new cleanup problem has become available, its solution has been crafted within the confines of existing structure. As each separate program is developed, its authority excludes that given to existing programs. Thus, CERCLA prevents the Superfund program from handling certain uranium mill tailing cleanups already handled under UMTCRA and the LUST program cannot clean up hazardous wastes released by underground storage tanks regulated by RCRA. The Superfund program has spawned new programs. Most State programs were created or existing ones enhanced to handle sites excluded by Superfund policy decisions. Widely held views that Superfund requirements are *too* stringent or costly and that its implementation is too burdensome and slow has supported political pressures to exclude certain types of facilities or substances from CERCLA.

Two cleanup problems—marine sediments and oil spills—not adequately covered by Superfund or other existing authority are being discussed; either could end up as separate programs or be closely linked to or subsumed into Superfund. The Superfund trust fund is excluded by statute from being used to clean up petroleum products, whether released on land or discharged into the Nation's waters. Under the NCP, however, the Superfund removal program or the Coast Guard responds to oil spill emergencies covered by section 311 of the

[26] South Carolina Department of Health and Environmental Control, ' 'Report to the South Carolina General Assembly, Hazardous Waste Cent.mgency Fund Activities, July 1, 1986- June 30, 1987, p. 14. ASTSWMO found in 1987 that 33 out of44 States had a total of $258 million available for contractors.

[27] Included were Metcalf and Eddy, CH2MHill, Dames and Moore, Tetra Tech, and *Ecology* and Environment.

Clean Water Act. Incidents such as the March 1989 spill in Valdez, Alaska, and the Ashland Oil spill in January 1988 have pointed out deficiencies. For instance, critical time delays can occur because of a presumption that, even in an emergency, the Federal Government should allow the responsible party to take initial action. Low funding has also limited Federal response capabilities. Congress is now considering legislation that would broaden Federal powers.[28]

Toxic marine sediments can be cleaned up under Superfund but, because few of the potential hundreds of sites are, a comprehensive, separate program is being advanced by advocates of an Aquafund. The majority of known sites are not in the Superfund program because current HRS scoring does not account for sediments as a unique media or for their biological impacts .29 Thus, an alternative to creating a separate program is to make relatively simple adjustments in Superfund. This would greatly increase the size and cost of the Superfund program but bring technically similar problems under the same authority. A National Academy of Science report says that contaminated marine sediments are widespread throughout U.S. coastal waters, Preliminary estimated costs of cleaning up just 10 of 30 known contaminated areas in the Great Lakes range from $2.9 to $3.4 billion.[30]

ARE OTHER PROGRAMS THE SOLUTION?

All of the actions taken and being taken to limit the Superfund program can be rationalized. They do not, however, necessarily assure that Superfund's environmental or public health benefits will remain intact. Limiting the Superfund program's scope and workload, however, might allow the Superfund program to improve its public image, Or, as some public interest groups say, ". . . maintain an illusion of progress on the NPL. ' '[31] Indeed, that objective seems to have overridden concerns about the potential for a reduction in environmental protection because of less stringent cleanups outside of Superfund.

The National Costs of Cleanup

The policy of reducing Superfund's work does not limit national costs. It just shifts costs around and in the process might even increase overall costs. If cleanups are necessary, someone pays and not always under the Superfund principle of "polluter pays. " Superfund monies come mostly from industry with a relatively small contribution from general revenues. All of the Federal programs-even those that rely on enforcement for cleanup-receive some funding from general revenues to pay for developing program rules and regulations and for oversight, monitoring, and enforcement costs.

Table 4-1 shows that the annual budgets of the programs, excluding Superfund, add up to at least $1.7 billion per year. Estimates for future national costs are very uncertain but may be greater than $600 billion. Comprehensive data on the current cost of all the State cleanup programs is not readily available. The Association of State and Territorial Solid Waste Officials (ASTSWMO) reported data on State funding mechanisms in 1988. Out of 50 States, 39 collected an average total of almost $300 million per fiscal year to pay for cleanups. Based on available, current budget data, OTA has estimated that States are spending about $500 million of their own funds for cleanups.[32]

The real issue is *how well these* other programs are funded and *how good our* knowledge is about future resource needs. If the other programs are underfunded they will have difficulties handling their own

[28]For example, the Senate passed S.686 in August 1989 that would create a $1 billion cleanup fund and provide for timely Federal emergency response. This bill would not necessarily set up a separate response capability but could, instead, enhance the existing structure.

[29]Examples of Sites that have scored hi@ enough to get on the NPL are Waukegan Harbor (Outboard Marine), Sheboygan Harbor, and Ashtabula (Fields Brook) in Region 5.

[30]Cate Leger, Northeast. Midwest Institute, "Cleaning up Great Lakes Toxics Hotspots: How Much Will It Cost; How Can h Be Paid For?' September 1989.

[31]"Comments of Natural Resources Defense Council, U.S Public Interest Research Group, and National Audubon Society on U.S. Environmental Protection Agency's Proposed Rule for National Oil and Hazardous Substances Pollution Contingency Plan, " op. cit., footnote 13, p. 6.

[32]Many States Supplement their resources with Federal Superfund monies. EPA's Superfund budget includes about $200 million each year for States, which are granted through Cooperative Agreements and CORE funding. Kansas, for instance, has been getting $300,000 per year; New Jersey, about *$2* million. Minnesota pays for 31 staff with Federal funds.

problems. This would create two problems for Superfund. First, other programs may be unable to take deferrals from Superfund. And, if resource needs for Superfund are based on deferrals that will not occur, then Superfund has underestimated its needs. Second, underfunded programs may be under pressure to compromise extent of cleanup. Sites with incomplete cleanups could eventually become Superfund problems. This ultimate outcome can also occur as the result of programs that are structured and funded as enforcement programs, for which current government costs are relatively low. As OTA has shown in chapter 3, enforcement cleanups that are the result of negotiated settlements tend to compromise cleanup goals.

If estimates about the future are based on poor information that causes underestimates, then the Superfund system will be in periodic, perpetual crisis. It appears that the Superfund program, although it frequently doesn't use it, has some of the best information available with which to predict the future need for cleanups. All cleanup programs tend to collect, with varying degrees of effort, their own list of potential or known sites needing cleanup. There is no coordination among lists, no common definitions, no understanding of possible duplications. These multiple, noncomparable lists severely complicate the Nation's ability to understand the full nature and extent of its cleanup needs (see ch. 2).

Comparative Costs, Availability of Funding

There is no evidence to suggest that programs other than Superfund are more efficient, i.e., provide quality cleanups at lower cost to the public. As discussed below, many cleanups outside of Superfund are less stringent than ones inside it, Nor is there evidence that other programs have the funding available to support deferred cleanups from the Superfund program. In some cases the programs do not have the resources to handle their own problems. State programs that emphasize enforcement do not do so because of the quality of site cleanup received but because it means that more sites can get attention. In other words, States rely on enforcement to expand their constrained resource base.[33]

Some States do assert that their programs, unencumbered by the "cumbersome bureaucratic/ administrative practices under CERCLA are more efficient, but there are no statistics to show whether State transaction costs are higher or lower than those of Superfund.[34] Available data on State average costs per site are considerably less than Superfund's (at $30 million per site) .35 California, among State programs, may have the highest average cost per site at $2.7 million; most States appear (o pay between $200,000 and $500,000 per site. These average costs are much lower than Superfund's because low cost containment and disposal options are often chosen by State programs and because States have a higher proportion of smaller sites to clean up than does Superfund. In fact, State cleanup spending is more comparable to the Superfund removal program.

The RCRA corrective action program relies totally on enforcement to get sites cleaned up. Even then, it has a budget that seems unrealistic, especially since that it may rival Superfund in number of sites needing remediation. For fiscal year 1989, EPA requested $14 million for this national program, an amount equal to 1 percent of the annual Superfund budget. The effect of low budgets is that Regions, which implement the program, either have to delay issuing orders to owners to clean up sites or to provide less oversight than necessary, or both. Either way, public health and the environment can suffer.[36]

The Federal UMTCRA program appears to be less efficient than Superfund. It has spent $474 million in its 10 years, through fiscal year 1988, and claims to have remediated 2 of the 24 sites in the program. The program projections are that another $500 million will be spent to finish remediation of all the sites, *excluding* contaminated groundwater. Funds for cleaning up groundwater, estimated at $800 million,

[33]Over 80 percent of *all* State cleanups are enforcement, according to a 1988 statement made by J. Winston Porter, then EPA assistant administrator in charge of Superfund.

[34]Minnesota spends 65 percent of its annual budget on administrative costs, half of which is to secure commitments from responsible parties. OTA has found (see ch. 1) that EPA spends 44 percent of the Superfund budget on administration and management activities.

[35]According t. Federal Register notices, current Superfund total cleanup costs are about $20 million, including capital and *Jong-term* operating and maintenance costs. EPA's June 1989 ''Management Review of the Superfund Program report states that costs are higher, about $30 million per site.

[36]Low finding and these kinds of consequences are discussed in an EPA document, ''Draft Corrective Action Outyear Strategy,' that reflects the views of EPA headquarters and regional staff expressed during workshops held in early 1989,

are not yet budgeted. At $1.8 billion for 24 sites, the program is projected to cost over twice as much per site ($74 million) than the Superfund program. Although UMTCRA sites are large, they are all similar to one another (i.e., uranium mill tailings) and do not each present radically different engineering challenges. The standard remedy in the UMTCRA program is the relatively cheap option of earthen containment, which, even for large sites, is relatively low cost.

While a few States have managed to stretch their available Federal AML funds to cover needed mine cleanups, nationally the program has long been recognized as one that is underfunded. Given the program's tax rate (its source of funding) and the short time that is left under its authorization, DOI estimates-based on the numbers of projects remaining that qualify for AML funds—show that there may beat least a ***$2*** billion shortfall. The future viability of the program will be determined by whether *or* not and how Congress extends SMCRA taxing authority beyond 1992.

Limited Technical Expertise

When EPA defers cleanups from the Superfund program, the agency does not consider whether the programs to which the sites are deferred have adequate resources. All the cleanup programs are, in fact, linked together by the national pool of technical expertise and technology. Cleanups, whether they be asbestos from schools or mine wastes or toxic wastes, all require the same basic technical expertise and often the same technologies. People are needed to collect relevant site information, analyze the data, develop remedial alternatives, perform tests, and carry out remedial action. Similarly, the same commercial treatment and disposal facilities are the ultimate receivers of wastes from Superfund, Federal agency, and State cleanup sites.

Private contractors aggressively compete for expertise among themselves and with Federal and State agencies. A real possibility is that the expansion of other cleanup programs will only exacerbate the workforce and contractor problems felt by Superfund. The burgeoning growth of cleanup programs is causing the supply of expertise to be outstripped by the demand. For all programs, this will drive up the cost of cleanup (i.e., as wages are pushed up) but lower the quality of the work (as the pool of expertise is stretched thin).

The evidence of talent constraints is compelling. Staff in the RCRA corrective program say that EPA is at a disadvantage in negotiating cleanups with owners and operators of RCRA facilities. Not only do industrial representatives have better technical backgrounds and experience, they also have greater knowledge of EPA and its operations. As soon as EPA's people gain experience and skills, they are recruited by private industry and contractors and move to the other side of the table.

State programs always seem to be the most disadvantaged. Arizona, according to the assistant director of Arizona's waste programs, has a 36 percent personnel turnover rate; most leave for "better-paying jobs in industry. "[37] The New York program has identified "shortage of experienced staff' as one its major issues. The consequences are a slowdown in progress at State sites and reduction in the oversight of PRP field work. The latter will ''increase the risk that responsible party and other cleanups will be improperly performed and will require additional work in the future. ' '[38] New York claims that it is having to compete for qualified personnel with the Federal Government, other States, and consulting fins.

For two of the Federal cleanup programs—Superfund and asbestos in schools—the problems caused by the mismatch between supply and demand have been detailed. OTA's report, *Assessing Contractor Use in Super-fund* (and work by the General Accounting Office, EPA's Inspector General, and environmental groups), concluded that poor technical performance has been a problem in the Superfund program, not all of the time, but all too frequent.ly. As OTA said:

> Much of this results from the rapid initiation and expansion of the program and the enormous pressures imposed by the public and Congress to perform

[37] Norm Weiss, assistant director for waste programs, Arizona Department of Environmental Quality, as quoted in the Phoenix New *Times,* Mar. 15, 1989.

[38] New York State, Department of Environmental Conservation, ''New York State Inactive Hazardous Waste Site Remedial Plan Update and Status Report," Oct. 30, 1987, p. vii.

quickly. The limited number, limited experience, and high turnover of EPA's staff has made it very difficult for EPA to assure the environmental performance and economic efficiency of Superfund's contractors all of the time. And the problem is compounded by the inexperience and high turnover of workers for contractors, resulting from the explosive growth of that industry .39

The asbestos in schools program [under the Asbestos Hazard Emergency Response Act (AHERA)] has also shown the negative effect of expansive growth. Not only has demand for contractors increased but it appears that the expertise does not exist to properly oversee their work. Various business analysts have estimated that the demand for asbestos evaluation and cleanup has caused the creation of some 2,000 new firms in the past few years. The market is expected to grow from a current $2 billion per year to $6 or $7 billion in a few years and to $100 billion in 20 years.[40] During congressional hearings in 1988, a member of a school board in New York State told Congress:

> . . . a serious problem exists concerning the quality of work being performed by consulting and contracting companies . . . AHERA has set up a situation where the group that is calling the shots is the newly created group of asbestos consultants and removal contractors. These people are, by and large, not at all driven by health and safety considerations, but by economic considerations. And it is their economic self-interest, not the school districts', which concerns them most.[41]

The EPA Inspector General reported at the same hearings that proper asbestos work practices were expensive thus the incentive to circumvent them was great and results in large profits for contractors,[42]

Additionally, EPA, which is responsible for training and certifying asbestos abatement fins, doubts that the supply of trained asbestos professionals will be sufficient to meet the time frames set out in AHERA. The agency has used this inadequate infrastructure of accredited personnel and enforcement staff' as one of its major arguments against extending asbestos regulations to public and commercial buildings.[43]

On the plus side, the set of national cleanup programs offers an opportunity for sharing of technical expertise and knowledge that could improve the performance of all programs. This kind of technical transfer is difficult because each program has its own regulations and procedures that can cause individuals in one program to view the work or knowledge gained in other programs as irrelevant or inappropriate. Even within the Superfund program, OTA has found examples of poor technology transfer among regions, headquarters, and EPA's own Office of Research and Development. Although certain individuals may seek outside information, mechanisms have to be created to facilitate the sharing of information for the benefit to accrue systemwide.

Confusion Among Overlapping Programs

As the venn diagram in figure 4-1 shows, while some programs pick up where another leaves off, many have overlapping jurisdictions. At the same time, there are sites that remain outside the existing structure, such as marine sediments. While the problem of sites without cleanup authority is obvious, overlapping jurisdictions don't just double the coverage but cause competition for control of a site and can increase expenditures.[44] It is overlapping jurisdictions that makes the deferral of Superfund sites possible.

Overlapping jurisdictions are not necessarily intentional but are often caused by differing bases for programs, For instance, Superfund coverage is based on the presence of a hazardous substance. (Hazardous substances are a collection of pollutants defined

39U.S. Congress, Office of Technology Assessment, *Assessing Contractor Use in Superfund, OTA-BP-ITE-51* (Washington, DC: U.S. Government Printing Office, January 1989).

40See, for instance, "Why Throw Money at Asbestos, " *Fortune,* June 6, 1988, and "Cleanup Dollar Flow Like Water But industry Is Awash In Problems," *ENR Special Report,* Mar. 9, 1989.

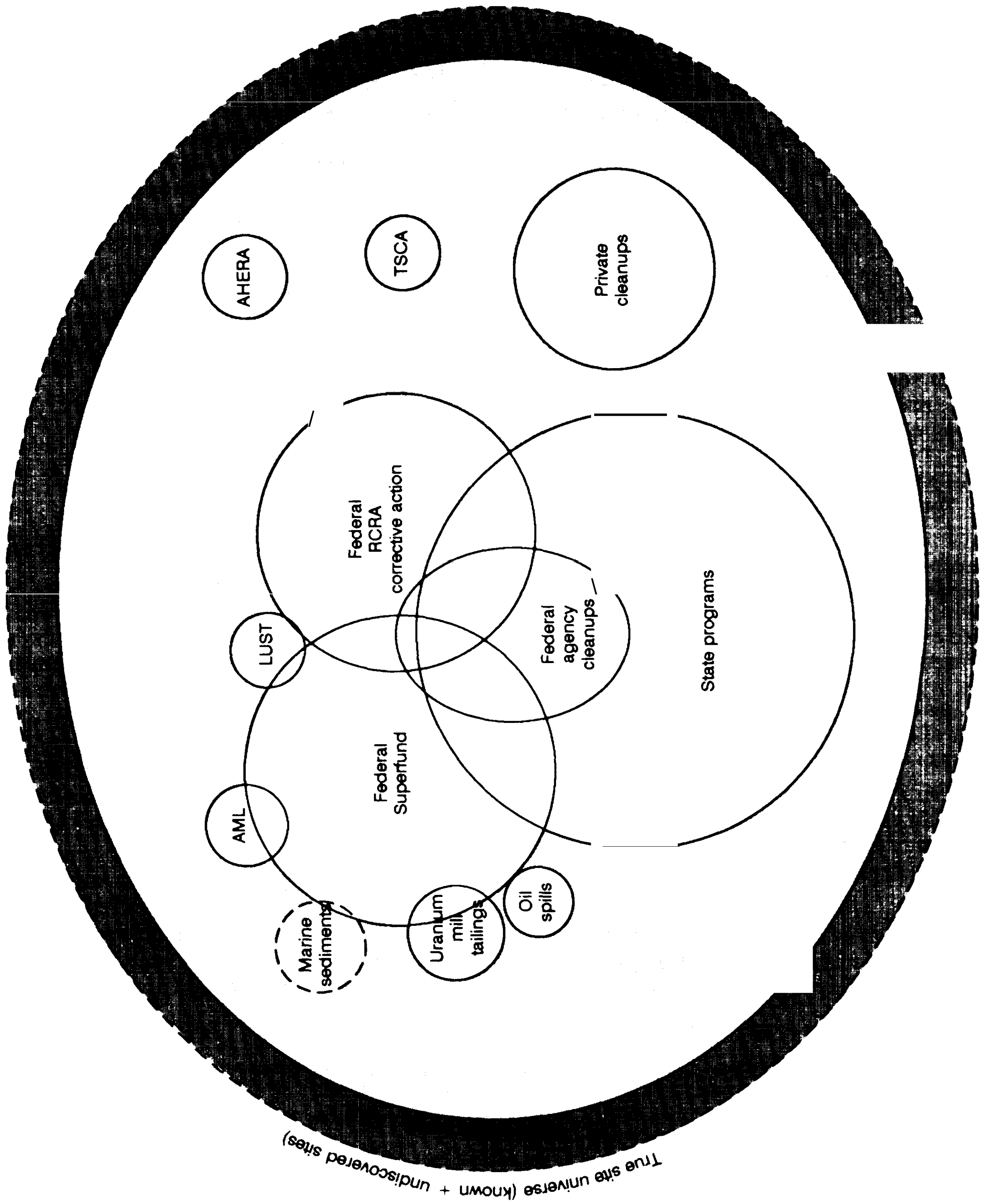
41Bill Kitchen, member of the Johnstown, N, Y., school board, hearings before the Environment, Energy, and Natural Resources Subcommittee of the Committee on Government Operations, House of Representatives, June 1, 1988.

42Donald E. Kirkdendall, Deputy Inspector General, U.S. Environmental Protection Agency, June 1, 1988.

4354 Federal Register 13632, Apr. 4, 1989, p. 13636.

44Startup costs increase national costs. In the first 2 years of the LUST program, 50 percent of the fund money distributed to States was spent for administrative costs to develop programs.

Figure 4-l-The National Cleanup Effort



SOURCE: Office of Technology Assessment, 1969.

by other environmental statutes or regulations, less those substances that Congress has explicitly excluded from program authority.) The discovery of a hazardous substance, which has been released and is uncontrolled, any where in the Nation, can be remediated by the Superfund program.

RCRA and LUST corrective action programs, on the other hand, are based on a community of regulated facilities. In the case of RCRA, Subtitle C regulations cover the management of hazardous wastes by treatment, storage, and disposal facilities (TSDFs). Because all hazardous wastes are hazardous substances, all RCRA corrective actions could, theoretically, be included under Superfund. Only some are because EPA has decided-through its NPL policy—to keep cleanups in the RCRA fold to the maximum extent possible.[45]

Included in the LUST program are regulated underground storage tanks (USTs) that contain either petroleum products or hazardous substances (except those hazardous substances that are at the same time hazardous wastes). Because the Superfund statute excludes petroleum products from the definition of hazardous substances and most USTs store petroleum products, the Superfund program can only handle a minor portion of the problems caused by USTs. And, because of the exemption of hazardous wastes in the LUST statute, USTs with hazardous wastes fall into the RCRA program. Thus, cleanups resulting from leaking underground storage tanks can be (and are) handled by Superfund, RCRA, or LUST programs.

EPA's deferrals map the overlaps between Superfund and other programs. EPA has and is deferring cleanups to RCRA (Subtitle C facilities) and UMTRCA programs and would have been to the AML program except that restrictions on that program have prevented deferrals. But, one AML site--Colorado Tailings-has moved into the Superfund program. Pending deferrals are to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), RCRA (operating Subtitle D landfills), LUST, and States.[46] (EPA has also proposed deferring cleanups to PRPs, which would move cleanups outside of the government and into the private sector,)

Early in Superfund's history, EPA made open attempts to exclude mine site cleanups from the program. Those attempts were thwarted by court rulings and congressional action. Current policy is to defer mine waste cleanups to the AML and UMTRCA programs in the cases where those programs are broad enough to have authority. UMTRCA cleanup of tailing sites belonging to *inac[ive* mills is restricted to 22 sites identified specifically by statute, plus **2** sites added by DOE; CERCLA excludes these sites from Superfund. Superfund deferrals are made to the *active* mills cleanup program. The AML program for noncoal sites is restricted by the fact that any State has to cleanup its coal sites before it can proceed with noncoal problems, unless the Governor declares an emergency. So far, only Wyoming is reaching the end of its coal cleanups and is the only State that may in the near future be able to use AML funds for cleanups deferred from Superfund.

Except for those to the RCRA Subtitle C corrective action program, relatively few official deferrals have occurred from Superfund. It is the future that EPA may be most concerned about. For instance, OTA estimated in 1985 that 5,000 municipal landfills may require cleanup. EPA data indicates that, as of July 1988, only 220 landfills were on the NPL. While this is only 4 percent of a large universe, it is a significant fraction of the NPL (almost 20 percent) and represents a growth rate of about 10 percent per year since 1986.

Overlaps in program authority cause situations in which a particular site is simultaneously or sequentially handled by different programs. The decision of which authority prevails is sometimes made by the Superfund deferral policy but not always. For Federal agency NPL sites a negotiated agreement between EPA, the agency, and the State determine the cleanup authority. Under the UST regulations, EPA has made the UST implementing agency

[45]EPA policy on cleaning up RCRA Subtitle C sites under Superfund is based on criteria outlined in the Federal Register on June 24, 1988, pp. 23978-23986. Basically, a finding must be made that site owners are bankrupt or otherwise lack financial capability or have shown unwillingess to proceed with a RCRA corrective action.

[46]FIFRA has no corrective action provisions, and the proposed Subtitle D corrective action rules address groundwater only with no attention to contaminated soil, surface water, or air.

(which can be a State or local agency) the determinator of whether it or CERCLA will govern a cleanup qualifying for either program. And, States can effectively defer cleanups to themselves by not entering sites in EPA's CERCLIS inventory database.

Complying with a varying set of rules can be frustrating. At an Air Force installation where EPA and the State were pushing for an Interagency Agreement (IAG), a RCRA permit, and a State action, the base commander was quoted by a congressional report as saying:

> ,.. the use of these three separate procedural frameworks to address the same problem places the AF in an untenable if not impossible situation, questions of efficiency aside. Compliance with one set of procedures may or may not satisfy the requirements of the other's procedures. It is entirely conceivable that compliance with one set may violate another's, especially in the area of scheduling of activities and prioritization of sites.[47]

Two of the many sites with overlapping authorities are detailed in boxes 4-A and 4-B. The first covers a private sector site in Arkansas; the second, a controversy over Basin F, a part of the huge Rocky Mountain Arsenal site in Colorado.

There have been a few attempts to officially coordinate or integrate the various cleanup programs or the flows of sites between them. One recent example is EPA's "Environmental Priorities Initiative. " This plan routes potential RCRA corrective action sites through the existing Superfund program's preremedial site evaluation process. EPA argued that this initiative will ''enable the Agency and the States to identify and cleanup first those sites that present the greatest threat to human health and the environment. ' Since the system being used to evaluate RCRA sites is the system currently in use in the Superfund program and since, as OTA has shown in chapter 2, it does not necessarily accomplish that goal for Superfund sites very well, it should not be expected to do so for RCRA sites. Nevertheless, there may be gains from this initiative through the reduction in RCRA program costs by using art existing system, rather than developing a new one exclusively for RCRA, and because of the time saved by not having to wait for the development of a separate evaluation system. However, delays have occurred in implementation; the high priority sites that were to get preliminary assessments in fiscal year 1989 had not, as of July 1989, been entered into the CERCLIS inventory, a step that precedes evaluation.

Different Programs, Different Cleanups

If cleanups conducted by other programs are as permanent as Superfund cleanups are supposed to be, there should be no future impact on the Superfund program. Unfortunately, most evidence shows that other programs tend to choose containment onsite or removal of contaminants to commercial or especially designed land disposal sites. The Superfund program had the same focus before SARA was passed in 1986; its enforcement side still has.

Superfund is the only Federal cleanup program that has a statutory basis for cleanup standards (''applicable or relevant and appropriate' standards, called ARARs) and has been pushed by Congress toward permanent remedies through the use of treatment technology. Both the basis for standards and the cleanup preference came with the 1986 reauthorization of, and were reactions to deficiencies in, the Superfund program. All of the other Federal cleanup programs-by statute and regulations-leave the definition of *protection of health and the environment* pretty much up to individual site decisions. While this, by itself, does not necessarily mean that site cleanups will be inconsistent around the country, it does mean that there is no guarantee that they will be consistent with Superfund cleanups.[49] As for State cleanup programs, J. Winston Porter, then EPA's assistant administrator responsible for the Superfund program, said in 1988: "There is some concern about cleanup standards-whether

[47] U.S. Congress, "A Report to the Committee on Appropriations, U.S. House of Representatives, on the Department of Defense Environmental Restoration Fund," August 1987, p. 23.

[48] U.S. Environmental protection Agency, Office of Solid Waste and Emergency Response, "Annual Report, Fiscal Year 1988, " EPA/68-01-7259, November 1989.

[49] During the Senate debate on the SARA amendments, Senator Chafee stressed that the Superfund standards were the minimum allowable for Superfund cleanups and that 'compliance with standards promulgated under the authority of other laws will not necessarily assure compliance with this general standard. " [132 Congressional Record S14925, Oct. 3, 1986.]

Box 4-A—From RCRA to the State to Superfund: Vertac Site, Arkansas

The Vertac site is an **example of a RCRA enforcement site that turned into a State site and a Superfund site. A cleanup delay of almost 2 years, so far, has** occurred because enforcement **failed and the State** did not have sufficient funds to contract for the necessary work. Now, Superfund is involved in supporting the State cleanup action and has taken on the responsibility to finish the extensive cleanup remaining for the site. And, if an impermanent initial action done by the responsible party fails, Superfund may have to redo that work.

Vertac Inc., was still operating a chemical plant on the property when it became a Superfund site in 1983 with an HRS score of 65.46. **Also in 1983 a RCRA consent order was signed; Vertac agreed to set aside $10.7 million (a trust** fund plus a letter of credit) for necessary cleanup and to handle an initial cleanup that consisted of onsite disposal of contaminated liquids and solids. Although both the State **and EPA objected to the way** Vertac proceeded with the work, the judge on the case ruled that **Vertac was** complying with the order.

In January 1987, Vertac abandoned the property and subsequently filed for bankruptcy. That left the State with the job of finding a treatment company to incinerate over 27,000 drums of materials contaminated with dioxins and chlorinated phenols that had been found onsite. Meanwhile, the trust fund had become caught up in litigation by the shareholders of **Vertac, and** questions were raised as to whether there were sufficient funds to cover incineration. Negotiations with the first company selected by the State for the incineration job failed because IT Corp. asked for $15 million, which the State could not afford. As of June 1989, the State has found one company-MRK-who has agreed to incinerate the drums and material for the available $10 million.

But, more cleanup remains. The Region 6 Superfund program tried in early 1988 to obtain approval for funds to supplement the incineration project (including an air monitoring plan, ash disposal, and a delisting petition) and to proceed with an RIFS to cover the remaining contamination onsite, which includes the plant, buildings, tanks, and surrounding areas. The funds were denied in fiscal year **1988.** Region 6 has now completed a plan for an interim action, costing $2 million, to support the incineration job, and those funds are available. The region is also in negotiation with Hercules Corp., who owned the plant prior to Vertac, to do an RIFS for the additional work needed onsite. There are also offsite problems involving contaminated creeks, a sewage treatment plant with contaminated sewer lines, and a stream with contaminated sediment yet to be studied.

Although site cleanup appears to be finally underway, there is future uncertainty about the initial onsite disposal facility completed under RCRA in 1986. It is leaking and a more permanent solution-a second cleanup may be necessary for "Mt. Vertac" as the initial cleanup is known locally.

cleanup levels are equivalent [to Superfund], and so forth. ' '[50]

Federal Programs and Their Regulations

EPA has acknowledged a difference between Superfund and other Federal program cleanups. Under the proposed deferral policy, EPA said other Federal programs". . . do not necessarily present the same level of assurance of remediation that meet the environmental protection standards of CERCLA' '[51]

A partial review of the basis for some programs' cleanups provides insight into the varieties of cleanups that are to be expected, since there is no reason to assume that any program will follow rules other than its own:

- For the LUST program, EPA decided to allow a site-specific approach to standards that it says will "adequately protect human health and the environment. '[52] Earlier EPA suggested three options: 1) national standards, 2) site-specific standards, or 3) a combination of both dependent on groundwater classification schemes. Site-specific standards were chosen not for their environmental strengths but because they would accommodate existing State programs, minimize the overall regulatory impact on

50 J. Winston Porter, speech at *Superfund* '88, 9th National Conference and Exhibition, Nov. 28, 1988.

51 53 Federal Register 51394, Dec. 21, 1988, p. 51418.

52 53 Federal Register 37082, Sept. 23, 1988. p. 37174.

Box 4-B-CERCLA v. RCRA: Basin F at Rocky Mountain Arsenal

Federal agencies often find themselves caught between EPA and CERCLA and States and RCRA. CERCLA gives States only a consultant role in Federal agency cleanups. States view this role as inadequate and the enforcement relationship of EPA, the Department of Justice, and Federal agencies as one with a high potential for conflict of interest. Thus, States with RCRA authority generally prefer that Federal agency cleanups be conducted under RCRA giving States greater leverage. Portions of Federal agency NPL site cleanups are officially placed under RCRA corrective action through an interagency agreement drawn up on sites.

The cleanup of Basin F, part of the Rocky Mountain Arsenal site in Colorado, has been caught up in this CERCLA/RCRA issue. The dispute between the State and the Army involves which authority takes precedence and ultimately what kind of cleanup will occur and how fast. Basin F has also been affected by changing EPA deferral policy.

Basin F was added to the existing Rocky Mountain Arsenal NPL site in March 1989. It had been originally excluded when Rocky Mountain was proposed for the NPL because EPA believed that Basin F would be subject to RCRA corrective action and thus, under the agency's RCRA deferral policy of September 1983, might be appropriate for deferral. Subsequently, EPA decided that Federal agency facilities that qualify for RCRA corrective action will not be deferred from listing (as is done for non-Federal sites).[1] That changed policy meant that Basin F should be included instead of excluded.

The U.S. Army constructed Basin Fin 1956 to store and dispose of contaminated liquid wastes; Shell Oil also contributed wastes. Approximately 240 million gallons of hazardous liquids and an estimated half a million cubic yards of contaminated soils resulted. The Army has projected the cost of cleaning up Basin F to be about $42 million; a ROD is scheduled for 1993.

The Army implemented a two-part strategy; an interim action has been taken to reduce existing migration pending the decision on a final, permanent remedy. The liquids were moved to holding tanks and surface impoundments and the soil was excavated and placed in a double-lined waste pile. The State and local citizens have been against the Army taking the interim action, preferring that the contaminated materials be removed from Basin F and disposed of elsewhere. They have subsequently criticized the effectiveness of the interim solutions. The case of Basin F went to court over whether or not CERCLA can preempt the State's ability to enforce its own regulations and RCRA corrective action. The judge issued a memorandum of opinion that the State of Colorado has authority over the Basin. Thus, the legal answer here seems to be that CERCLA does not preempt RCRA. According to the ruling:

> It is not inappropriate that the present and future victims of this poison legacy, left in their midst by the Army and Shell, should have a meaningful voice in its cleanup. In RCRA, Congress has plainly provided them that voice through representation by the State. I hold that RCRA enforcement by the State is not precluded by CERCLA in the circumstances here presented.[2]

[1] 54 Federal Register 13296, Mar. 31, 1989.

[2] "Memorandum Opinion and Order," in *Colorado* v. *the U.S Army*, U.S. District Court, Denver, CO, Feb. 24, 1989.

small businesses, and reduce the cost of compliance for all owners.[53]

- When cleanups of PCBs occur under the Toxic Substance Control Act (TSCA), the cleanup levels are based on the standards in the regulations but can vary, as occured in the Texas Eastern Pipeline case (see later).
- Cleanup rules for uranium mill tailings differ depending on whether the cleanup is of an active or inactive mill. For active sites, RCRA corrective action regulations apply and cover both radioactive substances and hazardous wastes; for tailings at inactive sites only radioactive substances are covered. EPA stated in proposed groundwater standards that inorganic and organic hazardous constituents *should* be assessed rather than stating they must despite the conclusion that the "concentrations

[53] 52 Federal Register 12662, Apr. 17, 1988, p. 12681. EPA asserted that national standards would not necessarily assure national consistency.

of (nonradioactive) materials vary from pile to pile, ranging from 2 to more than 100 times applicable standards. ' '[54]

- For the AML program, neither SMCRA nor the resultant regulations require the use of any specific methods or application of specific cleanup standards. Implementing agencies are directed, instead, to a guidance document written in 1980, which suggests that containment methods be used for toxic materials.[55] A National Academy of Sciences report that reviewed the program in 1986 supports that approach and suggests covering the materials with ''impermeable clay or capping them with synthetic materials. "[56] There is no requirement for groundwater cleanup.

For the RCRA corrective action program, no cleanup regulations have yet been issued. EPA has made a number of statements that the RCRA rules. when published, will be similar to Superfund's. In testimony before Congress in 1987, the head of EPA's Superfund program claimed that 'the level of environmental protection provided by a cleanup proceeding under RCRA authority should be the same as that under CERCLA. ' '[57] Meanwhile, cleanups underway are based on existing regulations (that only cover groundwater contamination) and a guidance document, ''National RCRA Corrective Action Strategy,' issued in 1986. The only advice in that document about cleanup standards is: ''. . . final remedies will . . . be required to meet applicable health and environmental standards promulgated under RCRA and other laws' [emphasis added] .5x There is no statement about preference for permanent cleanups.

Currently, differences do exist between Superfund and RCRA as a report released by the House Committee on Appropriations on DOD's Environmental Restoration Fund pointed out. The report says that ''generally RCRA remedial actions tend to favor containment as a technical solution, while SARA remedial actions are mandated to favor permanence of remedy for treatment technologies. "[59] In an example covering one potential cleanup, the report said an EPA RCRA program manager stated that he would approve a remedy that consisted of containment with monitoring for metal-contaminated soils. The CERCLA program manager stated that he would not approve of containment and that perhaps soil washing combined with other emerging technologies would be required.

How closely RCRA cleanups eventually resemble Superfund cleanups and avoid being Superfund problems some day may await the outcome of negotiations between EPA, who has drafted proposed rules, and the office of Management and Budget (OMB) who has taken over 7 months so far to review them. OMB apparently does not agree with EPA's rules for permanence, for not allowing facilities to postpone cleanup until groundwater outside its property is contaminated, and for setting cleanup targets in the same range as Superfund's, OMB also wants only direct contact by the public to trigger a RCRA cleanup. Conversely, the HRS that identifies Superfund sites uses various indirect pathways, and direct contact will be an added Superfund pathway if the new HRS is approved.

RCRA corrective action is an enforcement program and whatever the rules, RCRA cleanups may eventually be similar to and have the same problems as Superfund enforcement cleanups. One difference will persist, however. EPA has no backup funding under RCRA corrective action as it does with the Superfund trust fund. Thus, when an owner or operator of a RCRA facility is intransigent, a cleanup waits resolution. In some instances, clean up will await transfer of sites to the Superfund program for attention,

[54] 52 Federal Register, "Standards for Remedial Actions at Inactive Uranium processing Sites, " Sept. 24, 1987, p. 36001.

[55] A GAO report in 1988 (*Surface Mining: Information on the Updated Abandoned Mine Land Inventory)* quoted one State official as complaining because the Office of Surface Mining had never provided any policy guidance on acceptable reclamation methods.

[56] National Research Council, *Abandoned Mine Lands: A Mid-course Review of the National Reclamation Program for Coal*, November 1986, p. 26,

[57] J. Winston Porter, former assistant administrator, U.S. Environmental Protection Agency, statement before the Environmental Restoration Panel of the Readiness Subcommittee of the Committee on Armed Services, No\. 19, 1987.

[58] U.S. Environmental Protection Agency, "National RCRA Corrective Action Strategy, ' p. 13.

[59] U.S. Congress, ''A Report to the Committee on Appropriations, U S. House of Representatives, on the Department of Defense Environmental Restoration Fund, " August 1987, p. 26.

Actual Cleanups Differ

Another, better way to assess the difference between Superfund and other program cleanups is to obtain information on what has actually happened. Unfortunately, little of this information is available at the national level and some not even at the State level.

Federal Agency Programs—For Federal agency cleanups CERCLA provisions only apply to NPL sites. Out of the thousands of potential cleanups, only 115 so far are on the NPL. Thus, most agency cleanups will take place under States laws or other Federal corrective action programs, such as RCRA or LUST Even some NPL sites or portions of NPL sites will be cleaned up under RCRA corrective action rather than CERCLA.[60] Still, it may be too early to make comparisons based on actions. Agency programs are, in general, behind most other programs. The U.S. Department of Energy (DOE) program indicates in its fiscal year 1988 report that all NPL sites are still in the site evaluation stage; the report has no information on non-NPL sites.[61]

DOD seems to be furthest along, but little permanency has been achieved. Its annual report for fiscal year 1989 says that 36 NPL sites have had some kind of interim action and one has a final remedy completed.[62] Although the report claims some action underway at over 1,000 sites, it only provides details on types of remedies selected for the interim actions. Forty-one percent were waste removals (i.e., contaminated soils or liquids were transported off site for disposal) and 28 percent were classified as site treatment/remediation. (The latter category might more properly be titled ' 'miscellaneous. According to information DOD supplied OTA on the individual remedies, none used treatment technology.) The balance of the interim actions involved providing alternative water supplies (13 percent), groundwater treatment (6 percent), long-term monitoring (9 percent), or decontamination of munitions (3 percent). At one site, explosive contaminated soil is being incinerated.

State ***Programs—For*** State cleanup programs, information on actual remedy selection varies from nonexistent to comprehensive:

- The Illinois State program has a reputation for choosing incineration, and officials told OTA that mobile incineration has been used at four sites of the 45 sites cleaned up so far. Details about what remedies were selected for the other 41 sites are unknown by the State office.[63]
- Little specific information is available at the State level in Florida; the program is independently implemented by six districts. The State does produce an annual "The Sites List" that gives the status of hundreds of Florida sites under various kinds of cleanup programs, but information on remedy selection is not included.
- A Kansas State report for 1988 provides many statistics on site cleanups including the status of sites. The only information in the report on remedies is a statement that remediation may involve removal, onsite detoxification, or containment. No weight or preference is given to the three options.[64]
- New York State included a breakdown of remedies in a 1986 report but has not done the same in successive annual reports. The 1986 data shows that (for 129 projects) 62 percent of the actions taken were onsite containment, 15 percent were removals of soils for offsite disposal, and 33 percent involved treatment of

[60] EPA has left this determination to be made on a site-be-site basis in the interagency agreement signed between an agency, EPA, and the State.

[61] U.S. Department of Energy, "Annual Report to Congress for Fiscal Year 1988, ' December 1988. Under CERCLA Section 120, all Federal agencies are required to report annually to Congress on the status of their cleanup programs. Of the 16 agencies with sites in the Federal Docket, OTA could only locate reports from 6 agencies.

[62] Of the total 8,139 sites identified by the agency, more than half (4,435 sites) are expected to need an RIFS and 96 percent of those have a completed RIFS or one underway. For the 2,486 sites expected to need a remedial design or action, 60 percent (1 ,482 sites) have had or are undergoing a removal or an interim remedial action or longterm monitoring.

[63] Illinois' annual report says: "The Agency now requests the use of alternative treatment technologies such as incineration, and is less dependent on landfill disposal of hazardous wastes generated from cleanup operations. [Illinois Environmental protection Agency, 'Cleaning Illinois, ' Spring 1988, p. 8] For sites discussed in the report for which sufficient detail was given, OTA found that onsite containment was *used* at five sites, contaminated soils from six were sent to offsite landfills. incineration was chosen at one site, and soil flushing was used at one site.

[64] Kansas Department of Health and Environment, " 1988 Summary of Bureau of Environmental Remediation Sites in Kansas, " January 1989, p. 3.

groundwater,[65] The 1987 report stated that New York was inconsistent with the Federal Superfund program, and the 1988 report listed a goal to establish policies and regulations to increase consistency in site cleanups.

- In South Carolina, 5 remedial actions were conducted between July 1986 and June 1987. All contaminated soils were taken to commercial landfills; liquids were incinerated.[66]
- A 1988 report on the Tennessee State Superfund program says that many of the 24 cleanups accomplished are of "dubious effectiveness" because of inadequate attention to groundwater, use of clay caps over buried wastes, and no long-term monitoring.[67]

OTA was able to obtain more comprehensive, up-to-date information from California, Minnesota, and New Jersey. California's report for 1988 says: ''State law and (agency) policy . . . support the use of cleanup solutions other than excavation and redisposai of untreated waste. "6[8] And, the State does have an extensive program to test alternative technologies. Still, California data show that 80 percent of actions in 1987 and 79 percent in 1988 involved moving soil offsite to landfills. Incineration was used for one action in 1988 and in each year one action consisted of soil bioremediation.

In New Jersey, there are four separate State programs that have cleaned up or overseen the cleanup of almost 40 sites. Ten cleanups in one program consisted primarily of groundwater pumping and treating or monitoring. OTA was told that when contaminated soil was involved it was usually land disposed (in some other State). In one case, PCBs were incinerated. Three cleanups in another program involved sending most contaminated soils and materials to landfills, liquids were usually incinerated or, in one instance, sent through a municipal water treatment plant. The enforcement program under the State's Environmental Cleanup Responsibility Act is credited with the most completed cleanups (about ***20), New*** Jersey was unable to supply OTA with information on remedy selections, however.

The Minnesota Superfund program has completed 38 NPL and non-NPL cleanups since 1983 and "is recognized nationally as being very effective at insuring the cleanup of hazardous waste sites. "[69] Out of 27 completions for which information was provided to OTA, soil treatment (of some unknown kind) occurred at two sites. The balance of remedies were: containment onsite, excavation and transport to landfills offsite, monitoring of wells, and providing alternate water supplies. Extensive groundwater pumping and treating is done in Minnesota.[70] Box 1-B (ch. 1) discusses in detail one recent cleanup decision made by Minnesota authorities. Given the statistics available on the program, that decision seems to be representative of the overall trend of cleanups in Minnesota.

Federal Programs-OTA contacted several States that have used the Federal AML program to clean up mine wastes. A Montana State official said that cleanup standards are chosen on a site-by-site basis; they rely on their consulting engineers for advice.[71] In Wyoming, State disposal standards ' [n]

materials similar to those found in mine wastes are the guide to cleanup levels. The usual option is to move contaminated materials to a land disposal cell where natural materials are used to protect against future migration. Copper tailings, for instance, have been moved from a river bed site and disposed in a

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65 New York State, Department of Environmental Conservation, Divisions of Solid and Hazardous Waste, ''New York State inactive Hazardous Waste Site Remedial Plan," Oct. 15, 1986, p. V-5.

66 The South Carolina Department of Health and Environmental Control, ' 'Report to the South Carolina General Assembly-Hazardous Waste Contingency Fund Activities—July 1, 1986 to June 30, 1987, op. cit., footnote 27.

67 Kirsten Dow et al., ''Tennessee Superfund After Four Years: A Critical Appraisal, " May 6, 1988. The report was sponsored by the Legal Environmental Assistance Foundation and the Tennessee Environmental Council.

68 California Department of Health Services, "Expenditure Plan for the Hazardous Substance Cleanup Bond Act of 1984, ' revised January 1988, p. 13.

69 ''Minnesota Pollution Control Agency's Report on the Use of the Environmental Response, Compensation and Compliance Fund During Fiscal Year 1988," November 1988, p. 15.

70 In a 1988 report, the Minnesota Pollution Control Agency said that site-specific groundwater cleanup goals were being established. Meanwhile, ''targets for soil contamination will be developed later. ' ["Minnesota Pollution Control Agency's Report on the Use of the Environmental Response, Compensation and Compliance Fund During Fiscal Year 1988, " November 1988, p. 14.]

71 Ben Mundie, Montana AML program, personal conversation, April 1989.

cell above the water table. Monitoring is ongoing to evaluate any leachate. Tailings from a gold mining site contaminated with mercury and arsenic will be similarly disposed. Clay materials are used to stabilize metals in mine pits, and contamination in groundwater is left to naturally attenuate after sources have been cleaned up.

In some programs, especially those covering mine wastes, the use of containment can often be justified because of the huge volumes of contaminated material. Still there is fiction between Superfund and other programs regarding the appropriate kind of containment to use and whether the materials should be treated frost. One case, the Colorado Tailings mining site in Montana, has been caught between the AML program and Superfund (see box 4-C).

In the UMTCRA program, most cleanup plans call for containing the tailings in place or somewhere onsite or offsite, using natural materials and no leachate collection systems. The UMTCRA choice is driven by a requirement in the regulations that a remedy be effective up to 1,000 years and at least 200 years.[72] No one can, of course, assure that a remedy that does not destroy contaminants will last 200, much less 1,000 years. The DOE program has decided that-since radioactive materials cannot be destroyed-the best way to approach that requirement is to construct simple earthen containment systems that have no mechanical components to avoid the need for human intervention over 200 years.

An EPA publication for the Superfund program on radioactive sites, *Technological Approaches to the Cleanup of Radiologically Contaminated **Superfund Sites,*** offers many treatment alternatives to containment.[73] The publication says that excavation and containment in ''either permanent or temporary above-ground containment facilities" has been the choice in most remedial decisions and that the 1,000 year requirement is applicable to uranium mill tailings only and thus is not necessarily "applicable or relevant and appropriate" (a SARA phrase) for Superfund site cleanups. It also points out that ''some Superfund (radioactive) sites contain various types of hazardous wastes, and the radioactive portion may pose a relatively minor problem, "

This difference between UMTCRA and Superfund suggests that better interactions between the programs on a technical level might change the ways *both are* doing their job, if regulations allowed changes. From one perspective, the kind of containment remedies the UMTCRA program is selecting have been abandoned as inappropriate for hazardous substances. However, the 1,000 year requirement is based on the UMTCRA perspective that it is the radioactive emissions from the materials that harm human health and that over a period of time those emissions will decay, resolving the problem. Metals that are hazardous substances, however, have intrinsic toxicity that does not decay and are toxic forever. Thus, the RCRA requirement-used in Superfund—for containment with a 30-year lifetime for materials that never decay may not be an improvement.[74] However, the simpler UMTRCA solution may not retain its integrity longer than 30 years, much less 200 to 1,000 years.

Classifications Create Problems

Cleanups can also differ because of the ways substances are classified. When they do differ, especially when they are inconsistent with CERCLA, future Superfund cleanup costs and problems may be increased.

RCRA hazardous wastes area subset of CERCLA hazardous substances so that a cleanup under RCRA covers fewer substances. However, the differences may not be profound. Mine wastes and radionuclides, for instance, are not hazardous wastes, but they are only infrequently found in the TSDFs that RCRA corrective actions cover. And, while mine wastes are not classified as hazardous wastes, some of their constituents, such as heavy metals, are.

Asbestos is an example of a hazardous substance, the cleanup of which under AHERA, State, and Superfund programs may lead to future Superfund sites. Under current law and regulations, asbestos can be considered *dangerous* enough to be removed from schools—and from Superfund sites—but *safe*

[72] 40 Code of Federal Regulations 192.02(a)(1).

[73] U.S. Environmental Protection Agency, Office of Research and Development, *Technological Approaches to the Cleanup of Radiologically Contaminated Superfund Sites,* EPA/540/2-88/002, August 1988.

[74] RCRA systems, double-lined with synthetic materials, have leachate collection systems for which periodic monitoring is necessary.

Box 4-C-From *AML to* Superfund *to the State: The Colorado Tailings Site*

Colorado Tailings in Butte, Montana is part of the Silverbow **Creek site, which was placed** on NPL in 1982. As early as 1979, however, the Montana AML program was involved in the Colorado Tailings site. Now, despite its NPL status, State negotiations may settle on the basis **of State, rather than CERCLA, cleanup provisions.**

The initial AML cleanup plan for the tailings contaminated with heavy metals was estimated to cost $1 million, but Montana was denied the funding by DOI's Office of Surface Mining Reclamation and Enforcement. In fiscal year 1984 Congress appropriated the money as a special line item in the budget for the AML program. Because the **site was by that time on the NPL, the State AML office worked with EPA on the cleanup plan. Both agencies agreed on a land disposal option for the tailings but disagreed on its extent. EPA's version was estimated at** $3 million and included multiple liners and a monitoring system; the AML program wanted a lesser $1 million cleanup. The State was told by EPA that if it did the Colorado Tailings cleanup it **could become liable (a PRP) if the cleanup adversely affected the Silverbow Creek site. According to a current Montana AML official, this liability issue, more so than the disagreement over the cleanup method led to the State declining to handle the cleanup.**[1] However, **a former State official told OTA that the project was rejected because of the $3 million cost and the belief that the imposition of EPA performance standards** *were unnecessary, as* **well as the question of liability.**[2]

The project reverted to the Superfund program in 1984. Colorado Tailings is now part of one operable unit of the Silverbow Creek NPL site. The feasibility study was completed in October 1986. As of early 1989, no cleanup decision had been made. Meanwhile, the State-which has the lead on the site-was under negotiation with the PRPs for settlement. A State official told OTA that they would not necessarily settle under provisions of Superfund even though the site is on the NPL because CERCLA does not take precedence over State laws.

[1] Ben Mundie, Montana AML program, personal conversation, April 19s9.

[2] Richard Jutunen, former Bureau chief, Montana AML program, personal conversation, October 19ss.

enough to end up in a municipal solid waste landfill. Under EPA's offsite policy there is now some protection against hazardous substances ending up in an out-of-compliance landfill at a subtitle C facility. That policy does not cover subtitle D facilities. Thus, it is possible to move asbestos from a Superfund site (or a school under AHERA) to **any** municipal landfill, including ones that are already contaminating groundwater and may have to be cleaned up.[75] The Sup-fund removal program has **taken** asbestos from over **30** sites. OTA was told that only when State laws require it is this material sent to a hazardous waste landfill.

This movement is legal because asbestos, although a hazardous *substance* under CERCLA, is not a hazardous *waste* under RCRA. **Air** emissions of asbestos are considered the primary source of harm to public health and the environment. The reasoning for not listing asbestos under RCRA has been that RCRA rules are meant to protect groundwater and, since asbestos tends to bind to soils, it will not leach from landfills into groundwater. (Data from one Superfund site—Asbestos Dump, where asbestos has been found in groundwater—may refute this theory, but it is being ignored at that site, and it is doubtful that the information is being transferred elsewhere.) Although asbestos can be treated and the fibers that cause harm destroyed, treatment is rarely the option of choice in the Superfund or AHERA program.[76]

The way asbestos waste is managed suggests that once placed in a landfill it may cause or help a landfill to qualify for the Superfund program and thus have to be moved again. The general management practice for asbestos is to wet the materials and place them in plastic bags prior to disposal. Once at a landfill, they may be segregated from other wastes (although no Federal regulation requires segrega-

[75] The amount of asbestos that may be deposited in landfills because of the A HERA program is not trivial. One rural county in California has estimated that it must reserve landfill space for 50 tons of asbestos. A conservative estimate is that about 500,000 tons of asbestos will be placed m the Nation's landfills.

[76] In the ROD for the Asbestos Dump—Millington Site in New Jersey treatability studies are included in the post-ROD remedial design phase. However, EPA and the PRPs are negotiating over whether or not the conclusions from the treatability Studies will change the ultimate cleanup, scheduled to be onsite containment.

tion), placed in a specially dug trench, and covered with soil. These practices can vary if State or county regulations differ from Federal regulations. They also vary because of poor enforcement. According to an EPA IG report and EPA's own statement, "many asbestos removals and the subsequent waste disposal operations are performed out of compliance with [the existing regulations]. ' '[77] The IG also reported that inspections and enforcement are weak and penalties for violations are inadequate.[78] As EPA administrator William K. Reilly has said:

> I still fear where it goes [when asbestos is removed from buildings], whether it really is disposed of in a place where we can trust that it's been put to rest and it won't come back again in the future.[79]

Sites containing PCBs are cleaned up under Superfund and TSCA. When PCBs are cleaned up under TSCA only the PCB contamination is considered even though a site may contain other hazardous substances as well. This occurred when Texas Eastern Pipeline Co. agreed to pay a $15 million fine and cleanup costs (estimated at $400 million) for areas contaminated by PCBs (89 sites in 14 States) along its 10,000-mile natural gas pipeline. The cleanup agreement did not cover any substances other than PCBs and Superfund cleanup standards were not invoked. The agreement also did not require offsite or groundwater cleanup nor does it set any compliance schedule for the company to meet. PCB levels of cleanup were based on Federal PCB standards and varied depending on the area being cleaned up (. . . pits, surrounding soil, etc.) and three rankings of sites. The agreement requires the company to test for other hazardous substances but does not set any cleanup requirements for them if found. While it does not foreclose EPA or States from moving under Superfund to handle such eventualities, doing so will require that new cases are brought against the company. For Superfund to use trust funds to clean up any of these 89 sites, they would first have to be individually taken through the NPL listing process.

OTA was unable to obtain details on actual LUST cleanups, which mostly deal with petroleum liquids and contaminated soils. Although petroleum products are relatively easily destroyed by incineration and are amenable to microbial biodegradation, an OUST handbook, *Cleanup of Releases From Petroleum USTs: Selected Technologies, says* that excavation and disposal of contaminated soil is the "most widely used corrective action. "[80] Soil contaminated with petroleum is not a RCRA hazardous waste, but some States regulate it as hazardous. In States that do not regulate it, contaminated soils removed from petroleum tank sites can be put in low-cost municipal landfills. In some cases, it is cheaper to pay shipping costs and transport excavated soils from a State that considers them hazardous to a State that does not.[81] Once petroleum wastes are put in a landfill, they can--depending on the actual substance--qualify as hazardous substances and secondary cleanup under Superfund.

Other Programs Are Also Slow

Assessing the pace of cleanup is, to most observers, the relevant way to determine program effectiveness. Thus, many argue that a benefit of using other cleanup programs is that cleanups can be done quicker because they are not encumbered with the inflexible process and procedures of CERCLA and the NCP. But, some other cleanup programs are experiencing delays in getting down to cleanup. Meanwhile, the cleanups assigned to them wait.

Some State data does show that State enforcement cleanups are quicker than State-funded cleanups.[82] But, State-funded cleanups appear to take the same time as CERCLA-funded cleanups. Conclusions from a 1987 ASTSWO survey show that, on

[77] 54 Federal Register 912. Jan 10, 1989, P. 915.

[78] U.S. Environmental Protection Agency, Office of the Inspector General, ''Consolidated Report on EPA's Administration of the Asbestos National Emission Standard for Hazardous Air Pollutants, " Mar. 24, 1988.

[79] A8 quoted in "Good Riddance?" *National Journal*, July 29, 1989, p. 1930.

[80] U.S. Environmental Protection Agency, Office of Underground Storage Tanks, Cleanup *of Releases From Petroleum USTs: Selected Technologies,* EPA/530/UST-88/001, April 1988, p. ix.

[81] The OUST handbook, cited above, cites a ' 'reasonable $12 per square yard' for soils sent to nonhazardous landfills and ''up to $160 per square yard if the soil is considered hazardous" [p. ix].

[82] OTA compared all Superfund sites which gained a ROD in fiscal year 1988. There was no difference between enforcement and fund sites in the average time it took the program to move them from placement on the NPL to ROD completion.

average, State staff have to work a little harder on NPL sites than non-NPL sites but that the elapsed time is about the same.[83] Data from California shows that an RIFS on a State-funded site takes from 11 to 42 months compared to EPA's 21 to 38 months for an RIFS.[84] That is, an RIFS in California can consume less *or more* time than a Superfund one. In New York State the average time for an RIFS is 24 months v. EPA's average 32 months, as determined by OTA in *Are We Cleaning Up?* In another example of pace, New York State said in a 1987 report that only 2 of the 15 planned starts (13 percent) for the State program actually were initiated while 12 of the 22 planned starts (54 percent) under the Superfund program in the State were initiated. The identified causes of the difference were: 1) resources shifted to oversee work by responsible parties, 2) lengthy contract procurement procedures, 3) a shortage of experienced staff, and 4) a liability insurance problem.[85] This performance measure improved the following year. The reason may have been that staff had been added to the State program.

Under RCRA, some cleanup regulations have been in place since 1983, but EPA's authority was greatly expanded in 1984. Five years later, several thousand sites are just beginning the initial assessment process, the new regulations covering cleanup have not been proposed, and OTA was only able to identify 12 sites with completed Corrective Measures Studies (CMSs).[86] Although some cleanups may have been completed as part of permits in the RCRA program, information on progress is not available. Out of some 5,000 RCRA facilities in the country, initial site evaluations have been done at 1,372 facilities. Of the 1,122 of those facilities determined to need further evaluations, EPA regions have formally required owners to proceed with 499 of them, either through orders or as part of permits.

For other Federal programs, the pace varies. The UMTRCA inactive mills program has been authorized for 10 years and by the end of fiscal year 1988 had only claimed to have completed the cleanup of 2 out of 24 sites.[87] On the other hand, the LUST program, whose statutory authority dates from 1984 and 1986, appears to be moving briskly. A recent annual report claims that responsible parties are beginning cleanups at "thousands of sites' and that more than 155 corrective actions have begun using fund monies.[88] But over 300,000 tanks may need attention, so the program's pace is an unknown. The AML program has moved fairly aggressively on coal mine cleanups, but substantial work is left to be done at noncoal mines because they are the third priority of the program.

Not Enough Public Participation

Congress has not, for other cleanup programs, given nearly as much attention to public participation as it has under CERCLA, where an entire section outlines the scope of public participation. Lack of statutory direction does not necessarily mean that public participation will not be as broad under other programs. But the level of complaint about how public participation slows the process in Superfund suggests otherwise. However, Superfund's public participation has been a significant factor in moving Superfund implementation toward more compliance with statutory requirements. When other cleanup programs have less public participation, the prospect for less stringent cleanup (and potential for creating future Superfund sites) increases.

Not everyone agrees that EPA allows the public to adequately participate in the Superfund program and certainly not to the extent that PRPs do, But CERCLA does encourage public participation at an early stage and throughout the cleanup process, and

83 The work effort required of State staff is 4.5 work years on a State-lead NPL site and 3.4 years On a non-NPL site. The average time elapsed per site is 5.5 years on an EPA-lead NPL site, 5.6 years on a State-lead NPL site, and 4.7 years on a non-NPL site. [Association of State and Territorial Solid Waste Management Officials, "State Programs for Hazardous Waste Site Assessments and Remedial Actions, ' June 1987.]

84 California data from ' 'Expenditure Plan for the Hazardous Substance Cleanup Bond Act of 1984, Revised January 1988, ' op. cit. footnote 69. Data on EPA from OTA's *Are We Cleaning Up?*

85 New York Department of Environmental Conservation, ''New York State inactive Hazardous Waste Site Remedial Plan Update and Status Report, " Oct. 30, 1987.

86 A RCRA corrective action CMS is comparable to a Superfund RIFS, but it includes the facility owner's suggested remedy.

87 OTA did not review active mill cleanups.

88 U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ' 'Annual Report, Fiscal Year 1988, " op. cit., footnote 48.

participation is set up to be active, rather than passive. For remedial actions, the regional community relations program is supposed to establish contact with local citizens before any action is planned or undertaken and follow up with notice of proposed and final remedial actions. Once a preliminary decision has been made on the selected site remedy, the public has an opportunity to comment and EPA must respond to those comments. For removal actions, an onsite public coordinator is assigned to answer any questions the public may have. In addition, under CERCLA the public has been given the right to sue to enforce the law.

Unique to Superfund is the provision for awarding technical assistance grants to public citizen groups. TAGs were meant to assist the affected community at sites at understanding and evaluating the problems posed and to help assure that cleanups were chosen in accordance with SARA. However, the concept has not necessarily been well implemented by EPA. Criticism has been raised by Congress and public interest groups about the way EPA translated statutory language into practice. For instance, one congressional survey found the system so complex and cumbersome that it tended to discourage groups to participate.[89] Still, groups who have obtained TAGs have been helped (see box 3-F in chapter 3).

Despite the implementation flaws, public participation with the Superfund program is supposed to be very broad. TSCA has no provisions for public participation and since cleanups under TSCA are enforcement cases, the public may have no knowledge of how their interests are being protected until a court settlement has been completed and avenues for changes are essentially closed. The same kind of public closeout occurs in the Superfund program at enforcement sites. When EPA wrote the regulations for the UST program, provisions for public participation were included only for the last of six possible phases prior to actual cleanup. When a confirmed release requires a cleanup plan, the implementing agency must notify the public and release information but has the option to decide whether or not to hold a public meeting to discuss the plan.

Under RCRA the public must be notified when EPA intends to issue a permit (which may include cleanup requirements) and hold a hearing. Under an enforcement order, citizens only become involved after a facility has completed its investigation and recommended a cleanup plan. As in the LUST program, a public hearing is only held if the authorities decide there is enough interest to merit one.

Information Tough To Get

Most other programs receive less public scrutiny than Superfund and even Federal ones are largely implemented at the State level. This can make gathering information to understand what is happening in these programs difficult and time-consuming. For those programs that rely on enforcement, information is even less available because of its negotiation value.

It is possible to track progress at most Superfund sites by examining a copy of the Superfund Comprehensive Assessments Plan. No such national database exists for any of the other programs, although the RCRA program is attempting to put one together. So far, not all information originally designed for the system is maintained and regions have been inconsistent in entering data. Thus, to make sure how many CMSs have been finished under RCRA, OTA had to call 10 EPA regional offices. For the LUST program, most relevant information resides at the State or local level. OTA was not able to, for instance, obtain from the EPA headquarters office any specific information about sites that have been cleaned up under the LUST program. If one wants to know about a LUST site, it is necessary to first find the relevant agency in charge. Because of the flexibility that EPA has built into the UST programs, the mix of responsible agencies is broad. According to a 1987 report, five were in ''the State Fire Marshall's Office, one in the State Corporation Commission, about eight in the water program and the remainder in the hazardous waste program. ''[90]

Specific sites deferred from the Superfund program are discussed in the Federal Register when

[89] U.S. House of Representatives, Representatives Edward J. Markey (D-MA) and James J. Florio (D-NJ), ''EPA's Superfund TAG Game, A Report on the Implementation of the Superfund Technical Assistance Grant Program by the U.S. Environmental Protection Agency,' Mar. 2, 1989.

[90] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, ''Solid and Hazardous Waste Report for Fiscal Year 1987," November 1987, p. 3-2.

EPA makes a decision. For instance, in 1988 EPA announced and listed the names and location of 30 sites on the NPL to be moved from Superfund to RCRA and 15 to be retained. For those gone from Superfund, the public tracking system disappears. EPA's proposed policy in December 1988 discusses the relevance of the NPL as a source of public information but claims that reducing the numbers of sites qualifying for the NPL will "... provide **more meaningful** information to the public and the States" [emphasis added].[91] What EPA may mean is that with an NPL confined to sites actually being cleaned up by the Superfund program, the public will not get confused about who is responsible. To keep the public informed about sites that have been deferred, EPA discusses various alternatives, such as notices in local newspapers or letting States handle notification.

The way information about non-Superfund cleanups is diffused throughout the Nation makes it all the more difficult to ascertain the extent to which cleanups in other programs may eventually produce new work for Superfund.

CONCLUSIONS

The job of cleaning up past mismanaged hazardous wastes has only just begun. While it is clear that the Superfund program needs to get its own house in order, **there are compelling reasons to worry that cleanups occurring outside of Superfund may one day provide it with a whole new class of sites-sites for which cleanup has been mismanaged. This is** not occurring-like past mistakes did—because we do not understand the consequences or do not have enough information to do things better. It is happening because we have created one premier cleanup program that gets all the attention, while the others operate in the shadows.

Given the large estimates for numbers of potential sites for each program, it is impractical to suggest that there ought to be ONE cleanup program. But, there are ways to coordinate actions among the cleanup programs so as to minimize failures and their impacts. As discussed in chapter 1, a set of national cleanup standards is one option. With cleanups so widely dispersed, better program cleanup tracking systems (and ones that are compatible with each other) would help Congress and the public know what is happening so that when cleanup failures occur they could be corrected early. The programs could be partially integrated and long-term savings accrue to all through a national site discovery program (see ch. 2). Solutions for the technical resource stresses of the Superfund program, if *not* viewed from the perspective of the ongoing national cleanup effort, might be only a partial or patchwork affair. And, mechanisms could be constructed to encourage sharing of technical knowledge.

9153 Federal Register 51394, Dec. 21, 1988, p. 51416.

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Other Related OTA Reports

- **Assessing Contractor Use in Superfund—Background Paper.** Describes how the Super-fund program uses contractors, and what their role is relative to that of' EPA staff'. The history and extent of contractor use in Superfund are described, as well as why the original masons for EPA's heavy dependence on contractors may no longer be valid. The paper also gives some ideas for improving the environmental performance and economic efficiency of Superfund over the long term. BP-ITE-51 , 1/89; 52 p.

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- **From Pollution to Prevention: A Progress Report on Waste Reduction—Special Report.** Examines opt ions for reducing the generation of all hazardous wastes and environmental pollutants; the effectiveness of Federal actions taken so far; and summarizes what industry and State and local governments have done to implement waste reduction. ITE-347, 6/87; 64 p.

  (;PO stock #052-003-0107 1-2; $2.75
  NTIS order #PB 87-208062

- **Superfund Strategy.** Examines future Superfund needs and how permanent cleanups can be accomplished in a cost-effective manner for diverse types of sites; describes the interactions among many components of the complex Superfund system; and analyzes the consequences of pursuing different strategies for implementing the program. ITE-252, 4/85; 292 p.

  Free summary available.
  NTIS order #PB 86-120 425/AS

- **Technologies and Management Strategies for Hazardous Waste Control.** Assesses the criteria for defining hazardous waste and for judging the relative health and environmental hazards of a given waste; evaluates technologies for cleaning up current waste disposal sites that are hazardous to health and the environment; assesses technologies and approaches for the safe treatment, storage, or disposal of hazardous waste; and examines technologies and approaches for reducing the volume of hazardous waste. M- 196, 3183; 408 p.

  NTIS order #PB 83-189241

- **Habitability of the Love Canal Area: An Analysis of the Technical Basis for the Decision on the Habitability of the Emergency Declaration Area —A Technical Memorandum.** Based on a report published by the L'. S. Environmental Protection Agency which was reviewed by a multidisciplinary team of consultants for several Federal agencies, the U.S. Department of Health and Human Services judged the Love Canal, N. Y., to be as habitable as the control areas with which it was compared.. OTA critically reviewed EPA's habitability decision. TM-M-13, 6/83; 60 p.

  NTIS order #PB 84-114917

- **Nonnuclear Industrial Wastes: Classifying for Hazards Management—A Technical Memorandum.** Addresses basic issues surrounding a degree-of-hazard classification approach; the potential for incorporating a degree-of-hazard concept through classification in the Resource Conservation and Recovery Act regulations; and examines various methods of applying a degree-of-hazard classification system. TM-M-9, 11/81 ; 36 p.

  NTIS order #PB 82-134305

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