United States General Accounting Office

GAO

Briefing Report to the Chairman, Subcommittee on Commerce, Transportation, and Tourism Committee on Energy and Commerce House of Representatives

July 1986

# HAZARDOUS WASTE

# EPA's Consideration of Permanent Cleanup Remedies






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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548



RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

July 7, 1986

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CHARLESTON, SC 29405-2413

The Honorable James J. Florio,
Chairman, Subcommittee on Commerce,
Transportation and Tourism
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, commonly known as "Superfund," the Environmental Protection Agency (EPA) is responsible for cleaning up the nation's worst hazardous waste sites. Selected remedies must be cost-effective and can range from containment of wastes onsite, to removal of wastes offsite, to permanent destruction of the wastes, to a combination of these approaches. Several different cleanup approaches may be selected for a site if it has multiple problems such as drummed wastes, contaminated soil, and contaminated groundwater which warrant different remedies. According to a 1985 study by the Congressional Office of Technology Assessment, containing wastes onsite or moving it offsite to a land disposal facility are not effective permanent remedies and may eventually cause leakage of toxic chemicals into the environment requiring repeat site cleanups and additional costs. On September 6, 1985, you requested that we determine the extent to which EPA has used permanent treatment technologies, such as incineration, in cleaning up Superfund sites.

We found that in the first 5 years of the program EPA selected permanent treatment technologies as cleanup remedies for Superfund sites in 27 of the 121 cleanup decisions, with incineration being selected in 13 of the 27 decisions. (Section V summarizes our analysis of the 121 cleanup decisions.) EPA indicated that the permanent treatment technologies were not selected more often, primarily because they were considered too costly or their effectiveness had not yet been proven. Our analysis of the cleanup decisions also indicated that EPA selected permanent treatment technologies more frequently each year the program operated--from 2 times in 1983 to 17 times in 1985. The large increase in 1985 is attributable to, among other factors, a revised cleanup policy announced in 1985 to encourage more use of permanent treatment technologies over land-based disposal options. Despite it's policy supporting increased use of

treatment technologies, EPA has identified a number of barriers which will hinder further progress toward this objective. These barriers include, for example, a lengthy permitting process required to assure the safety and reliability of any technology considered "new" and community resistance to undemonstrated technologies.

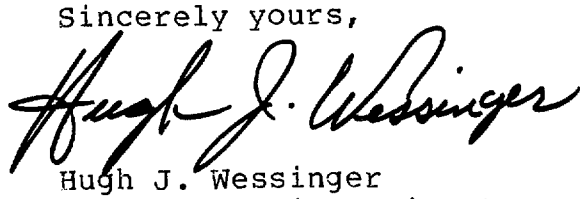
To overcome many of these barriers, EPA has established the Superfund Innovative Technology Evaluation Program to enhance the development, demonstration, and commercial availability of innovative technologies as alternatives to containment systems presently in use. The cornerstone of this program is the demonstration and evaluation of selected technologies so that cost-effectiveness information is available to users and decision makers. EPA has also created several task forces to develop strategies, policy guidance, and other solutions for dealing with many of the barriers. Because most of the efforts to overcome the barriers have just recently been initiated or are planned for the near future, we were unable to evaluate them.

To determine the extent to which EPA considered permanent treatment technologies at Superfund sites, we reviewed all 121 cleanup decisions issued by EPA since the beginning of the program through September 1985. We also interviewed numerous EPA program and research officials, its consulting engineering firms, state officials and representatives of industry associations to obtain their views on barriers which impede the use of permanent treatment technologies and possible solutions. Our audit work was performed between October 1985 and March 1986.

We obtained the views of directly responsible agency officials during the course of our work and incorporated their comments where appropriate. In accordance with your request, we did not ask EPA to review and comment officially on a draft of this briefing report.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this briefing report until 30 days after issuance. At that time, we will send copies to the EPA Administrator and other interested parties and will make copies available to others upon request. Additional information on this briefing report can be obtained by calling me at (202) 275-5489.

Sincerely yours,



Hugh J. Wessinger
Senior Associate Director

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## ABBREVIATIONS

| | |
|---|---|
| EPA | Environmental Protection Agency |
| GAO | General Accounting Office |

## SECTION I

## PROGRAM AUTHORITIES AND RESPONSIBILITIES

### BACKGROUND

Hazardous waste sites abound in the United States and poison our air, land, and water. They have been cited as contributing to many ill health effects including cancer, respiratory problems, birth defects, and blood disease. To address problems associated with the past disposal of hazardous wastes and the continuing threat of releases, in December 1980 the Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act--commonly known as "Superfund." This act created a 5-year, $1.6 billion hazardous waste cleanup fund and authorized the Environmental Protection Agency (EPA) to cleanup the nation's worst hazardous waste sites (called priority sites), which numbered 888 as of June 1986.

EPA's Office of Emergency and Remedial Response is responsible for Superfund emergency and long-term cleanup activities. This office develops national strategies, programs, policies, and procedures for ensuring effective discovery, investigation, containment, and control of abandonded hazardous waste sites. This office is also responsible for monitoring the performance and progress of EPA's regional offices, which conduct most of the steps in the Superfund remedial program.

Operating money for Superfund has come primarily from taxes on petroleum and certain chemicals. Although the taxing authority under Superfund expired on September 30, 1985, EPA continues to operate with existing revenues. The Congress also provided additional funding of $150 million through May 1986 while it considers reauthorization legislation for an expanded Superfund program.

The objective of cleanups at priority sites is to provide permanent, cost-effective responses. Cleanup remedies can range from no action, to containment of waste onsite or offsite, to waste destruction, to a combination of these approaches. Recent congressional and EPA studies have questioned the long-term reliability of widely used containment remedies. As requested, the objectives of this report are to determine the extent to which EPA has considered the use of treatment technologies that permanently destroy or detoxify wastes at Superfund sites, identify the barriers that inhibit their increased use, and identify current EPA efforts to overcome these barriers.

### KEY SUPERFUND PROVISIONS AND EPA PROCEDURES

The act provides for long-term, permanent, cost-effective cleanup remedies for hazardous waste sites. These remedies are called remedial actions and generally involve conducting an

investigation of the site to determine the type and extent of contamination and preparing a feasibility study that analyzes possible cleanup remedies. Because these activities involve extensive and complex studies, it may take 2 or 3 years before remedial action begins at the site. At any point in this process, however, a removal (short-term, emergency) action can be initiated if circumstances warrant.

During the feasibility study, technologies that are difficult to implement, perform poorly, or are not fully demonstrated are eliminated. Technologies that pass the initial screening process then undergo further screening to eliminate those that (1) are too costly, (2) provide inadequate public health protection or (3) have adverse environmental impacts. Those remaining alternatives then undergo a detailed evaluation that includes developing detailed costs estimates, evaluating the engineering feasibility of each alternative and comparing alternatives against others in terms of their effectiveness in protecting human health, welfare, and the environment and in mitigating and minimizing damage.

Out of this process, EPA selects the most cost-effective cleanup alternative(s) and presents it decision in a document known as a Record of Decision. As of September 30, 1985, EPA had issued 121 Records of Decision for 104 sites. In some cases where sites had multiple problems, rather than delay the entire cleanup because EPA did not have sufficient information to select a remedy for all site problems, often times EPA selected remedies for the problems it could address. EPA would note in the initial Record of Decision that future actions will be taken regarding remaining site problems once more information is available and another Record of Decision would be issued.

## DEFINITION OF "COST-EFFECTIVE"

According to the act and the procedures that implement it, cost-effectiveness is the primary criteria for selecting technologies to clean up Superfund sites. A cost-effectiveness analysis involves identification of costs and benefits of proposed actions (which are not translated into dollars but perhaps in terms of reduced risks or number of lives saved) and their alternatives. It allows a decision maker to identify the least costly means to accomplish a specific objective. Even though the purpose of a cost-effectiveness analysis is rather straightforward, its application can be difficult. Nonmonetary benefits, such as lives saved, are difficult to measure, and the omission of any effects or costs could result in an incorrect ranking of alternatives.

The act also required EPA to revise the National Oil and Hazardous Substances Pollution Contingency Plan (Plan)[1] to establish procedures that ensure that Superfund dollars are used as cost-effectively as possible in responding to releases of hazardous substances in the environment. Under the Superfund program, the Plan provides the basic policy directive for federal response actions and governs EPA's selection and implementation of cleanup remedies at priority sites.

In a 1982 revision to the Plan, EPA defined cost-effective as "the lowest cost alternative that is technologically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, or the environment." Because this definition hinged heavily upon interpretation of vague or ambiguous terms such as "technologically feasible," "reliable," "effectively mitigates and minimizes," and "adequate," it was open to a variety of interpretations. To clarify the meaning of cost-effective, in November 1985, EPA replaced the "lowest cost" language with language stating that cost should be taken into account as one of several factors considered in selecting cleanup remedies rather than the primary factor. It directs decision makers to select the least expensive remedy when all remedies are equally feasible, reliable, and protective. When all factors are not equal, the Plan requires the evaluation of all costs including capital and operation and maintenance costs, the level of protection, and the reliability of each cleanup alternative. EPA believes that this approach guards against selecting an action based solely on protection regardless of costs.

## TYPES OF CLEANUP REMEDIES

Hazardous waste sites differ in terms of size, proximity to people, geology, and wastes involved. Consequently, plans to clean up a site must be tailored to the physical characteristics of each particular site and the wastes it contains. Cleanup remedies at a site can range from no action, to containment of waste onsite or offsite, to waste destruction, to a combination of these approaches. Descriptions of these remedies are presented on page 8.

Unless a Superfund site contains only a single type of hazardous waste in a single form, a combination of approaches will most likely be used. For example, at the Taylor Borough site, a landfill near Scranton, Pennsylvania that had received municipal, mined, and drummed industrial waste for years, EPA used a combination of approaches to clean up the site. The remedial actions included removal of the drums and excavation of contaminated soil for disposal at an offsite facility, collection and treatment of contaminated surface water onsite, and placement of a soil and grass cover to prevent erosion.

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[1]Prior to Superfund, the Plan dealt primarily with oil spills.

## Land-based containment measures

The objectives of containment cleanup remedies are to (1) seal the hazardous waste, (2) restrict the movement of the contaminants and prevent further groundwater contamination and (3) reduce exposure to humans and the environment. Containment measures frequently used at Superfund sites include underground physical barriers such as slurry walls.[2] Other containment technologies include landfills, surface seals, and soil or vegetation caps. Caps are placed over a site to reduce surface water infiltration, prevent contact with contaminated materials and control gas and odor emissions. These containment techniques are often used in combination to increase their effectiveness. They also generally involve relatively low capital costs but require substantial operation and maintenance costs, which are borne by the state for as long as 30 years.

## Permanent treatment technologies

The purpose of permanent treatment technologies, as defined by EPA, is to permanently change or destroy the hazardous composition of waste through chemical, biological, thermal or physical means to reduce toxicity, mobility, or volume of hazardous wastes. Permanent treatment technologies consist of any technologies that are alternatives to land disposal or containment and generally involve high capital costs but low or no long-term operation and maintenance costs. A description of treatment technologies most frequently selected by EPA is presented in table 1.1 on the next page.

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[2]An underground wall used to keep groundwater and liquid wastes from leaving a site and additional groundwater from entering the site. It is generally constructed by excavating a trench around a site that is filled with a relatively impermeable substance such as bentonite clay.

Table 1.1: Description Of Treatment Technologies

| | Technology | Description |
|---|---|---|
| 1. | Incineration | Wastes are burned at high temperatures to destroy the hazardous constituents. |
| 2. | Stabilization/ Solidification/ Fixation | Wastes are mixed with a hardening or binding agent, called a fixative, to reduce the mobility of the wastes or to solidify them. |
| 3. | Soil flushing | Water is drawn through soil to remove the wastes and then the water is treated to remove the contaminants. |
| 4. | Soil aeration | Contaminated soil is exposed to air through tilling or with a submerged pump. The air reacts with the waste to detoxify or decontaminate it. |
| 5. | Biological treatment* | Microorganisms, particularly bacteria and fungi, are used to breakdown or remove contaminants from wastes, especially in wastewaters such as in sewage treatment plants. More recently, biological treatment is being used to detoxify or decompose the hazardous constituents in soil. This is known as landfarming. |
| 6. | Chemical treatment* | Contaminants in wastes are destroyed or rendered less toxic by using chemical reactions. |
| 7. | Physical treatment* | Hazardous constituents in wastes are not destroyed, but instead are separated and two waste streams are produced. One is a concentrated volume of hazardous material and a second is a nonhazardous soil or liquid. |

* Hazardous wastes can be chemically, biologically, or physically treated in place. This is known as in situ.

Groundwater treatment

The contamination of groundwater is a common occurrence at Superfund sites and may be the most difficult site problem because even with treatment there is no guarantee that the water can ever be completely cleaned up to its former condition. While some innovative techniques involve chemical or biological treatment of groundwater, the current practice is first to contain the

contamination with a slurry wall, for example, and then pump the contaminated water from the ground and through a treatment facility located onsite. Once the water is treated it can be reinjected into the ground or returned to a stream or river.

## RECOGNITION OF PROBLEMS WITH CONTAINMENT TECHNOLOGIES

Several recent studies have noted problems with land-based containment remedies. For example, in a January 1985 EPA study of hazardous waste land disposal facilities under different environmental settings, and with different kinds of wastes, EPA estimated that most landfills will likely attain high failure rates shortly after 50 years of operation. It also estimated that in semi-arid and humid climates nearly all landfills will experience failure within 200 years of operation.

In addition, the Groundwater Monitoring Survey published by the House Committee on Energy and Commerce in April 1985 indicated that 75 percent of all permitted land disposal facilities required to meet EPA's groundwater monitoring requirements are either in noncompliance with EPA regulations, have been leaking, or are in a condition that is unknown to EPA. For landfills that have received Superfund wastes, 87 percent are in unacceptable condition. Many of these sites may become future Superfund sites.

Further, an April 1985 report by the Congressional Office of Technology Assessment also questioned the adequacy and reliability of containment barriers to prevent the migration of waste because these techniques were developed out of the construction industry and have not been tested for long-term effectiveness for containing hazardous wastes. According to this study, there is significant risk that containment barriers will fail at some point, permitting migration of hazardous substances into the groundwater and the environment.

In May 1985, EPA issued a memo concerning offsite remedial responses which stated that several major landfills could no longer accept waste from Superfund sites. EPA also stated in the memo, that "it is EPA's policy to pursue response actions that use treatment, reuse or recycling over land disposal to the greatest extent practicable." In addition, in a February 1986 memo, the Assistant Administrator for Solid Waste and Emergency Response stated that a priority for the Superfund program will be to ensure that all technical cleanup options are considered, including innovative technologies. A number of other initiatives have also been undertaken by EPA since early 1986 to encourage more use of treatment technologies and are discussed in section IV of this report.

The Congress also recognizes the problems with land-based containment measures. For example, in 1984, the Congress amended the Resource Conservation and Recovery Act of 1976[3], to, among other things, reduce industry's dependence on land disposal because of concerns about potential groundwater contamination. Although the Superfund program is exempted from these amendments, the Deputy Director of the Superfund program told us that EPA has adopted these provisions and is encouraging the use of permanent treatment technologies at Superfund sites over land disposal options. In addition, in the proposed Superfund reauthorization legislation being considered as of May 1986, the Congress recommended that a $100-million Superfund research and demonstration program be established so that new and emerging treatment technologies could be demonstrated and made commercially available for Superfund cleanups. In addition, both the Senate and House versions of proposed Superfund reauthorization legislation include provisions to encourage the use of permanent treatment technology at Superfund sites.

[3]This act regulates the management and disposal of currently generated hazardous wastes while Superfund cleans up abandoned and uncontrolled waste disposal sites.

## SECTION II

## OBJECTIVES, SCOPE, AND METHODOLOGY

On September 6, 1985, because of concerns about the long-term effectiveness of land-based containment remedies commonly chosen as cleanup remedies at Superfund sites, Congressman James J. Florio, Chairman of the Subcommittee on Commerce, Transportation and Tourism, House Committee on Energy and Commerce requested that we (1) determine the extent to which EPA considered and selected permanent treatment technologies as cleanup remedies at Superfund sites, (2) identify barriers that impede the use of permanent treatment technologies, and (3) determine EPA efforts to overcome them. To determine the extent to which EPA has considered permanent remedies at Superfund sites, we reviewed all cleanup decisions (121) issued by EPA from the beginning of the program in 1980 through September 1985, to identify and quantify cleanup remedies considered and selected. We also reviewed relevant studies and interviewed key EPA officials.

To identify barriers to the development and use of permanent treatment technologies to cleanup Superfund sites and EPA actions to overcome them, we reviewed files and interviewed EPA officials within the Office of Research and Development as well as the Office of Solid Waste and Emergency Response. We also discussed barriers with environmental officials from five states as well as representatives from environmental associations and EPA's three consulting engineering firms--Camp Dresser and McKee, CH2M Hill, and NUS Corporation. The five states we visited were California, Illinois, Michigan, Minnesota, and New Jersey. They were selected because EPA, its consulting engineers, and key environmental associations considered them to be leaders in the use of permanent treatment technology. They also represent about 22 percent of all hazardous waste sites across the nation. Further, we conducted discussions with experts including procurement, technical, and administrative officials to gain additional information about the barriers to better define the problem and identify possible solutions to overcome these obstacles.

Our audit work was conducted from October 1985 through March 1986 at EPA headquarters in Washington, D.C., and the five states that we visited. The views of directly responsible agency officials were sought during our work and their comments are incorporated where appropriate. In accordance with the Chairman's request, we did not ask EPA to review and comment officially on a draft of this briefing report.

## SECTION III

## EPA'S CONSIDERATION OF PERMANENT TREATMENT TECHNOLOGIES AT SUPERFUND SITES

Under the Superfund program, cleanup remedies have primarily been limited to onsite containment and offsite land disposal approaches. Permanent treatment technologies, such as incineration, have not been widely used, particularly prior to 1985. Of the 121 cleanup decisions that EPA issued since the beginning of the program in 1980 through September 1985, EPA considered permanent cleanup remedies, such as incineration and detoxification technologies, in 76 decisions and selected them in 27 decisions.[1] Incineration, the most frequently chosen permanent remedy, was selected in 13 of the 27 decisions. EPA did not select permanent treatment methods in the other 49 decisions primarily because it considered them too costly or unproven.

In fiscal year 1985, EPA issued 17 cleanup decisions where permanent treatment technologies were selected. This level of use of permanent treatment technologies in 1985 is primarily attributable to a change in EPA's policy which emphasized treatment technologies over land disposal options to the extent possible. In the four years prior to 1985, permanent treatment technologies were selected a total of 10 times and generally constituted a small part of the total cleanup remedy.

### CLEANUPS UNDER SUPERFUND THROUGH SEPTEMBER 1985

EPA issued 121 cleanup decisions, commonly known as Records of Decision, since the beginning of the Superfund program in 1980 through September 1985. Because some sites had multiple problems, such as drummed wastes, contaminated soil, and/or contaminated groundwater, combinations of remedies were often required and selected. As a result, the total number of cleanup remedies selected exceeds the 121 cleanup decisions issued. It is also worth noting that the cleanup decisions primarily constitute cleanup plans rather than completed actions. In fact, in the 5-1/2 years since the Superfund program was created, EPA has completed actions at only 15 of the 888 priority sites.

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[1]Depending on the type of wastes and their location, particularly in the case of groundwater, certain cleanup remedies or permanent treatment technologies are not appropriate and therefore were not considered by EPA in its remedy selection process. This generally accounts for the remaining 45 decisions in which permanent treatment was not considered.

In summary, we found that the cleanup actions presented below were selected for sites with drummed, containerized and bulk wastes, as well as contaminated soil:

- PERMANENT TREATMENT METHODS were selected in 27 of 76 decisions where it was considered or about 35 percent of the time considered.
  - INCINERATION was the most popular permanent treatment remedy--selected in 13 of 27 decisions.
  - SOIL FLUSHING AND OTHER LAND TREATMENT METHODS were the second most popular choice--selected in 7 of the 27 decisions.
  - STABILIZATION/SOLIDIFICATION/FIXATION were also popular permanent treatment choices--selected in 6 of the 27 decisions.
- OFFSITE DISPOSAL was selected in 58 of 83 cleanup decisions where it was considered or about 70 percent of the time considered.
- ONSITE CONTAINMENT was chosen in 45 of 88 decisions where it was considered or about 51 percent of the time considered.
- NO ACTION was chosen in 3 of the 121 decisions because detailed assessment of the site indicated very low or no contamination.

With regard to contaminated groundwater, our analysis indicated the following cleanup actions were taken:

- GROUNDWATER PUMPING AND TREATING was selected in 61 of the 121 decisions or about 50 percent of the time.
- ALTERNATE DRINKING WATER was the selected remedy in 10 of the 121 decisions or about 8 percent of the time.

Our analysis also shows that EPA has increased its selection of permanent treatment technologies over the last several years in terms of gross numbers and as a percentage of cleanup decisions issued, as shown in table 3.1.

Table 3.1: EPA's Increased Use Of Treatment Technologies

| Fiscal year | Total number of decisions issued | Total number of times permanent treatment selected | Treatment as a percent of cleanup decisions |
|---|---|---|---|
| 1982 | 4 | 0 | 0 |
| 1983 | 13 | 2 | 15.4 |
| 1984 | 38 | 8 | 21.1 |
| 1985 | 66 | 17 | 25.8 |
| Total | 121 | 27 | 22.3 |

A summary of the extent to which EPA considered and selected permanent treatment technologies for the 121 cleanup decisions appears in section V.

## REASONS WHY PERMANENT TREATMENT TECHNOLOGIES WERE SELECTED AT SOME SITES

As noted above, prior to 1985, EPA only selected permanent treatment technologies in 10 of 55 cleanup decisions. We found that generally in these 10 decisions the treatment technology constituted a small part of the total remedy. However, during fiscal year 1985, a number of factors, such as revisions to the National Contingency Plan, amendments to other environmental laws, and the pending reauthorization of a second phase Superfund program, contributed to a change in EPA policy and more emphasis was placed on selecting treatment technologies that permanently destroy or detoxify the waste. As a result, in 1985 EPA selected permanent treatment technologies as cleanup remedies in 17 Records of Decision.

Our analysis indicates that in the 10 cleanup decisions issued prior to fiscal year 1985 permanent treatment technology, such as incineration, was a small part of the total cleanup remedy. For example, in September 1984, EPA decided to address a host of hazardous waste problems at the Old Inger Site in Louisiana by closing an onsite well, pumping and treating groundwater, containing and capping slightly contaminated soils, and using onsite land treatment of heavily contaminated soils. The initial cost of this cleanup remedy was estimated at about $3,200,000, and the land treatment component--a permanent treatment technology--represented about $621,500 of this amount. A similar example is the Burnt Fly Bog site in New Jersey where the contents of certain drums of liquid wastes would either be incinerated offsite or disposed of at an offsite landfill at a cost of $50,000. The total cleanup cost for this site was estimated to be about $8 million, which also involved excavating

and disposing of liquids, sludges, drums, and contaminated soil from several lagoons and monitoring the groundwater for a 5-year period.

According to a section chief in EPA's Hazardous Site Control Division, as a result of a change in EPA policy during 1985 and in anticipation of provisions contained in the pending Superfund reauthorization legislation, which would require EPA to give preference to using permanent treatment technologies, these technologies were selected more often in 1985 than in prior years. In a May 1985 policy, for example, EPA announced that its new policy was to select permanent treatment technologies over land disposal remedies to the greatest extent practicable to clean up Superfund sites. This policy also stated that permanent treatment technologies should not be eliminated from consideration on the basis of costs alone and that more emphasis should be placed on the long-term effectiveness of these remedies as compared against other alternatives. Several examples of how this policy was implemented are presented below.

At the 13-acre Bridgeport Site in New Jersey almost $58 million will be spent to incinerate waste oils and wastewater in several lagoons at the site because EPA considered it more effective than other less costly remedies. Further, the September 30, 1985, cleanup decision for the Bog Creek Farm site in New Jersey stated that the cost of incineration had not been fully determined because of uncertainties regarding the quantity of wastes to be incinerated and the availability and feasibility of onsite incineration versus offsite incineration. Even though the final cost of incineration was not known at that time, EPA selected incineration as the cleanup remedy because it provides the best protection to the public and the environment and complied with the intent of EPA's recent policy. By February 1986, EPA estimated that it would cost about $9 million to clean up the site, including incineration.

## REASONS WHY PERMANENT TREATMENT TECHNOLOGIES WERE NOT SELECTED AT SOME SITES

EPA officials told us that the requirement to select the most cost-effective remedy--which for the most part has been interpreted to mean lowest cost remedy--is the major obstacle to selecting permanent treatment technologies because generally they cost more than traditional land-based containment remedies. In addition, often these technologies are new and have not been demonstrated on a full-scale level at an actual Superfund site. Because the effectiveness and reliability of these technologies are frequently unknown, it is often difficult or impossible for EPA to adequately consider and select them.

High costs

In 34 of the 49 cases where permanent treatment technologies were considered, EPA did not select them because they were too costly compared with other alternatives. For example, EPA did not select incineration at the Beacon Heights Landfill site in Connecticut, which had operated as a dump for more than 50 years and accepted municipal refuse, rubber, plastics, and industrial chemicals and solvents, and other wastes. Although incineration was considered among the cleanup alternatives evaluated, it was not selected principally because it would cost $64 million versus about $17.4 million for onsite containment measures. The containment remedy selected, however, requires operation and maintenance of the site for at least 30 years at an annual cost of $235,000 to ensure the effectiveness of this remedy. The decision document for this site stated that incineration was the most complex remedy to implement of 13 alternatives considered.

At the Sinclair Refinery site in New York, incineration was also not selected because it would have cost as much as $45 million--far above the $9 million remedy selected of for onsite consolidation of wastes into one central landfill and covering it with a cap and offsite disposal of approximately 300 drums of wastes. EPA considered the annual operation and maintenance cost (of about $30,000 for 20 years) associated with the selected alternative minimal.

Additionally, at the Whitehouse Waste Oil Pits site in Florida, EPA did not select incineration because of its high cost. This site consists of seven unlined pits where wastes oil sludge, acid, and contaminated wastes from an oil reclaiming process were disposed. The first pit was constructed in 1958, and by 1968 the company had constructed and filled seven pits with wastes. The remedy that EPA selected for this site is estimated to cost about $3 million and includes (1) constructing a slurry wall around the entire site, (2) removing and treating contaminated groundwater (3) removing contaminated sediments in a creek, and (4) capping the entire site. EPA considered 17 possible remedies for this site, including incineration, that it estimated would cost between $87- and $137 million. In the decision document for the Whitehouse Waste site, EPA stated that incineration was not selected because it was cost-prohibitive when compared against the selected remedy.

Unproven technology

In 25 of the 49 decisions in which permanent treatment was considered but not selected, EPA considered these treatment technologies unproven and did not select them for this reason. For example, biodegradation techniques were not selected as final remedies at a number of sites because EPA considered them unproven technologies. Further, land treatment technologies were also rejected in some cases because EPA viewed them as unproven

technologies, such as at the Western Sand and Gravel site in Rhode Island and Enterprise Avenue site in Pennsylvania. Due to lack of demonstration and proven effectiveness, EPA also rejected solidification technologies for at least six sites, including Cemetery Dump in Michigan and Tysons Dump in Pennsylvania.

## CONCLUSION

Since the beginning of the Superfund program in 1980 to September 1985, EPA selected permanent treatment technologies as cleanup remedies at Superfund sites on a limited basis. More often, EPA relied on land-based containment strategies, which are not permanent solutions to the site problems, and there is significant risk that containment technologies will fail at some point in the future as is noted in section I. Our analysis indicates, however, that EPA recognizes the concerns with regard to the use of land-based technologies and in mid-1985 changed its policy of favoring lower cost containment methods to encouraging more use of permanent treatment technologies at Superfund sites wherever it is cost-effective, and EPA stated that cost should not be the sole consideration. According to EPA officials, however, the cost-effectiveness requirement has limited the use of treatment technologies because their initial costs are generally higher than containment measures. In addition, the effectiveness of these technologies may not be fully known because they have not been demonstrated at actual sites. As a result, the selection of treatment technologies is often viewed by potentially affected communities and users with suspicion and skepticism. EPA's efforts to address these and other barriers which impede increased use of permanent treatment technologies at Superfund sites are discussed in the following section.

## SECTION IV

## BARRIERS TO THE USE OF PERMANENT TREATMENT TECHNOLOGIES AT SUPERFUND SITES

Although most response actions at Superfund sites have involved containment and other land-based disposal alternatives, some have used alternative treatment technologies which offer a more reliable permanent solution to cleaning up hazardous waste sites. The increasing selection and application of these techniques, as discussed earlier, illustrates the availability and presumed benefits of these technologies over other traditional land-based methods. Despite EPA's recognition that alternative treatment technologies that permanently destroy or detoxify the wastes need to be encouraged as preferred cleanup remedies, a number of informational, regulatory, and institutional barriers discourage use of these technologies. Because permanent treatment technologies have not been used extensively, few examples exist to illustrate the significance and effect of these barriers. Consequently, we relied on the views of various parties involved in the cleanup of hazardous waste sites such as EPA, state, and industry representatives.

Based on our discussions, a general consensus exists that lack of performance and cost data are major barriers to greater use of permanent treatment technologies at Superfund sites. To solve this problem, we were told that a technology demonstration program was needed to provide decision makers with necessary information to evaluate the cost and effectiveness of these technologies so that these methods can seriously be considered during the cleanup remedy selection process. In February 1986, EPA created such a program. In addition, EPA has also recently issued guidance encouraging increased use of permanent treatment technologies at Superfund sites. It is too early to assess the effectiveness of these efforts since most of them have just been initiated. Table 4.1 summarizes the barriers and EPA's current efforts to address them.

Table 4.1: Summary of Barriers to the Use of Permanent Treatment Technologies

| Barriers to the use of treatment technologies | Approaches to overcoming barriers |
|---|---|
| 1. Lack of reliable and comparable performance and cost data | Provide demonstrations under the Superfund Innovative Technology Evaluation Program. |
| 2. Cost-effectiveness requirements favor low-cost containment technologies | Develop guidance on how to consider long-term risks and costs of containment-based technologies. |
| 3. Lack of cleanup standards | Develop toxicity and risk data on high priority wastes so that cleanup levels can be decided. |
| 4. Lengthy and costly permitting process | Create a work group to analyze permitting policies and regulations that can be modified to reduce time, costs, and complexity and give higher priority to processing permits. |
| 5. Delisting | Modify the delisting process and develop a policy to identify when treated residual can be considered "delisted." |
| 6. Federal procurement | Establish a 2-step procurement process based on performance rather than technology standards. |
| 7. Public acceptance | Keep communities informed of the effectiveness of treatment versus land disposal. |
| 8. Lack of liability insurance | Indemnify contractors through pending legislative changes. |
| 9. Marketing uncertainties | Meet with treatment industry associations to ensure their concerns are being addressed and study incentives needed to motivate commercialization of innovative technologies. |

Lack of performance and cost data

As noted in section III, the lack of reliable and comparable performance data and standardized cost data were two major reasons EPA did not select treatment technologies more frequently.

According to EPA, the lack of information in these areas has inhibited the commercial development and use of innovative treatment technologies because potential users and EPA decision makers are unable to judge the cost, effectiveness, and benefits of permanent treatment technologies. Several EPA and state officials and representatives from EPA's three principal consulting engineering firms also told us that the costs of using many of the newer permanent treatment technologies are not fully known because they have not been demonstrated on a full-scale level. In turn, there are no clear cut or objective means of judging the effectiveness of many of the permanent treatment technologies. Because of major data gaps in connection with cost and performance or effectiveness, the use of these innovative or alternative treatment technologies is viewed by communities with suspicion and skepticism.

EPA has taken some initiatives to overcome barriers to using permanent treatment technology imposed by lack of performance data and high or unknown cost. Its major effort was the creation in February 1986 of the Superfund Innovative Technology Evaluation program known as the SITE Program. The purpose of this program is to enhance the development, demonstration, and commercial availability of innovative technologies at Superfund sites as alternatives to containment systems currently in use. This program will develop procedures and policies which encourage selection of permanent treatment remedies at Superfund sites. The program is a joint effort between EPA's Office of Research and Development and its Office of Solid Waste and Emergency Response.

The demonstration and evaluation segment is the cornerstone of the SITE program and is intended to be a significant ongoing effort requiring the assistance of various components within EPA and the private sector. The objective of the demonstration program is to evaluate fully developed technologies so that cost-effectiveness information will be available to Superfund decision makers. Thus, they will have the necessary information to effectively consider permanent treatment technologies in future cleanup projects. Additional activities will include development of testing, quality assurance, and quality control data evaluation procedures.

Under the demonstration program, EPA plans to select 10 projects for demonstration that will represent various combinations of priority waste sites and alternative treatment technologies; however, EPA has estimated that significant lead time is needed to solicit, evaluate, prioritize, select, and match technologies; proposed for actual demonstration to hazardous waste sites. As a result, the first actual demonstration is not planned to begin until late 1987. EPA considers this delay unacceptable and in the interim plans to select technologies that appear to be particularly applicable to some problems being experienced at Superfund sites on an ad hoc basis for earlier demonstration. It is EPA's intent to have the private sector conduct the

demonstration at their own expense, with EPA evaluating the results. The end result will be a series of reports issued by EPA evaluating specific technologies and their applicability to Superfund cleanups and a companion technology transfer program to emphasize the Agency's commitment to using alternative treatment technologies now and in the future.

As part of the SITE program, the Office of Emergency and Remedial Response plans to develop evaluation and selection methodologies that will help decision makers choose remedies that effectively balance cost and reliability. They also plan to establish performance criteria for alternative technologies. Although EPA has stated that developing guidance in this area is very difficult, in May 1986, the Director, Office of Emergency and Remedial Response was briefed on an approach that is being developed to handle the cost issue. Although the policy is in the very preliminary phases, EPA's objective is to develop a policy that gives greater weight to the long-term effectiveness of permanent treatment technologies and places less emphasis on costs. EPA officials hope that this policy will achieve the objectives of proposed provisions in the Superfund reauthorization legislation, which prefers the selection of permanent remedies that reduce volume, mobility, and toxicity of hazardous wastes.

EPA's cost-effectiveness criteria

EPA's definition of a cost-effective remedy as the lowest cost option results in favoring land-based containment and offsite disposal remedies that are cheaper than permanent treatment technologies. Often times, neither the costs nor the effectiveness of the treatment technologies are fully known, making it virtually impossible to determine whether these technologies are cost-effective remedies. Therefore, it is almost impossible to consider permanent treatment technologies for Superfund site cleanups and select them as the final remedy over other established and traditional remedies. The Director, Hazardous Site Control Division also said that the National Contingency Plan's requirement to select the most cost-effective treatment technology is the major stumbling block in selecting permanent treatment technology because EPA has not developed guidance for evaluating the long-term effectiveness of containment remedies versus permanent treatment methods. Nor does EPA include cost for repeat actions if the initial cleanup action fails.

As a possible solution to the problem presented by the cost-effectiveness criteria, EPA believes that long-term risks and both long-term and short-term costs of land-based containment technologies should be considered when comparing the costs of alternative treatment technologies. EPA's Office of Emergency and Remedial Response is currently developing guidance and policy changes to address this problem. In addition, EPA is developing guidance that both defines cost-effectiveness and promotes

alternative treatment technologies by allowing selection of remedies that are not the lowest capital costs. EPA hopes that the revisions in the National Contingency Plan to clarify the meaning of cost-effectiveness will alleviate problems in this area as well.

Lack of cleanup standards

Although Superfund provides funding and authority for cleaning up hazardous waste sites, it does not provide standards for determining the degree of cleanup required at these sites. We reported in March 1985[1] that the absence of cleanup standards is one of the most important issues confronting the Superfund program and it has a direct bearing on the program's costs and the extent of cleanup tp the environment. In the absence of Superfund cleanup standards, EPA has established a policy of applying environmental standards from other laws at hazardous waste sites; however, those standards do not address all of the substances and conditions found at Superfund sites. Consequently, developers of treatment technologies do not know the degree of cleanup that is expected or needed or how stringent the new technology should be. In effect, they do not have a design target. One of EPA's engineering consultants told us that until toxicology data are available on the potential adverse effects of hazardous substances found in wastes at Superfund sites, it is unrealistic to set cleanup standards.

To overcome this problem, EPA plans to provide toxicity and risk data on high priority wastes so that EPA decision makers can select the most appropriate cleanup levels. In addition, since about October 1985, EPA establishing cleanup standards for Superfund sites based on site-specific characteristics.

Permitting

Superfund cleanup remedies that call for taking the wastes offsite must have environmental permits to assure the safety and reliability of any technology considered "new" and to control the discharge of hazardous substances into the environment. Because of the long lead time needed to obtain permits and the agency emphasis on urgency in cleaning up the sites, permitting is viewed as a barrier to the use of innovative and alternative treatment technology. Obtaining permits for established technologies such as landfills, containment technologies, and incineration is less complicated than obtaining permits for many new treatment technologies.

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[1]Cleaning Up Hazardous Wastes: An Overview of Superfund Reauthorization Issues (GAO/RCED-85-69, Mar. 29, 1985).

An EPA engineering consulting firm official told us that he viewed the time needed to obtain permits, which in many cases has taken up to 2 years, as the greatest impediment to the use of treatment technology. According to EPA, it usually takes at least 18 months to obtain a permit, and in some situations, the permit application process often cannot begin until the study of site characteristics is completed which usually takes about 9 to 12 months. An EPA official also told us that the use of alternative technologies can result in a series of treatments resulting in the need for a permit for each technology used which further complicates and potentially delays the cleanup process.

Although current Superfund legislation and procedures do not require environmental permits be obtained for onsite response actions, permitting-related impediments still exist and are significant because Superfund onsite responses must still meet technical requirements contained in other environmental laws associated with permitting. In addition, many states require that state permits be obtained. An EPA official at its research lab in New Jersey told us that EPA wanted to bring a mobile incinerator to the Hyde Park Superfund site in New York but did not because it would have taken 18 months to obtain state air permits. One of EPA's engineering firms told us that they found that individual state permitting requirements vary making the permitting process more confusing.

Another area of concern with regard to permitting relates to deciding what technical requirements must be met to obtain a research, development, and demonstration permit and how specific the operating conditions must be. EPA officials told us that the research projects will be constrained if all potential operating conditions must be specified upfront or if permit modifications are required for changing conditions.

To address permitting concerns, EPA has created a work group to identify and analyze permitting policies, regulations, and guidance that can be modified to reduce permitting time, costs, and complexity. Also, a mobile treatment task force was formed to look at the concept of using a mobile treatment unit in Illinois to clean up several hazardous waste sites.

Delisting

Another barrier is the delisting requirement which involves users of treatment technology petitioning EPA to exclude a specific waste from a specific generator or facility from regulation because it has gone through a treatment process and proven nonhazardous. With regard to the Superfund program, for example, even if wastes are incinerated, the residual ash although treated and rendered nonhazardous, would still be subject to additional and often costly disposal requirements, such as being placed in a double-lined cell, unless the waste had been excluded from regulation as a result of going through the delisting process. This delisting process is long (taking well over 1 year on average), costly, complex, and the final outcome is uncertain.

As a result, decision makers are hesitant to use more costly treatment technologies if residues from the treatment process must still be managed according to additional, expensive requirements. To resolve this issue, EPA's Office of Emergency and Remedial Response is currently developing a policy to identify when treated residual waste can be considered "delisted."

Procurement

Opinions regarding the significance of procurement as a barrier to the use of treatment technologies varied. Two EPA officials in the Office of Research and Development, as well as one official in the Superfund procurement area, and one of EPA's contractors told us that federal procurement regulations have impeded the use of innovative cleanup technologies at Superfund sites because many of these technologies are proprietary in nature and can only be obtained from a single individual or one company. As a result, these technologies would have to be procured on a sole-source basis which does not involve competition, as is generally preferred under federal procurement regulations.[2] A representative of one of EPA's consulting engineering firms told us that experience has shown that support for sole-source awards generally does not hold up in bid protest situations, which are almost inevitable, because it is difficult to prove that the options excluded were not as good as the one selected in the sole source contract. Others we met with, such as another one of EPA's engineering consultants, told us they did not perceive procurement regulations as a barrier to the use of treatment technology. Consequently, the issue is whether EPA's reliance on competitive procurement precludes EPA from selecting treatment technologies if the technology must be procured on a sole-source basis.

According to the Chief, Procurement Policy and Quality Assurance Branch at EPA, until April 1986, EPA's approach to procurement involved specifying a cleanup technology and then soliciting three or more bids on designing and implementing that remedy. According to one of EPA's engineering consultants, this approach, described as a technology-based process, excluded alternative treatment technologies where there was only a single source for the technology since sufficient competition to comply with federal procurement regulations could not be obtained. For example, he said that at one site they recommended that an innovative technique be used but it was not done because it would have involved a sole-source contract. He told us that one way to overcome this barrier would be to use performance standards that would present expected results and allow owners of any kind of

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[2]Sole source refers to the situation where, regardless of the marketplace, there is only one source possessing a performance capability for the purpose of the contract being awarded. Sole source is used interchangeably with the term single source.

technology an opportunity to bid if they can achieve the expected results regardless of the technology used.

Based on discussions with EPA's Chief, Procurement Branch and a member of a government-wide task force on federal procurement policies and practices, however, we learned that existing legislation and regulations give EPA the authority to issue sole-source contracts in circumstances where there is only one responsible source; or in unusual and compelling urgency; or with experimental, developmental, or research work; or when it is in the public interest.

In addition, according to the Director of the Hazardous Waste Research Lab in Cincinnati, Ohio, if EPA wants to deviate from the general government-wide policy of full competition in awarding contracts, EPA could issue a written policy stating that because landfilling is not an effective long-term solution, EPA encourages the use and development of alternative treatment technologies; even though they are more expensive than traditional cleanup remedies used to date and will likely require the awarding of sole-source contracts to obtain them.

In response to comments and concerns expressed with regard to the procurement practices as a barrier to the use of treatment technologies, in April 1986, EPA established a new two-step process that uses performance-based rather than technology-based standards. Under this process, EPA will first request bids based on a performance requirement criteria, such as attaining a specific level of risk reduction. All interested bidders can submit a qualification statement based on technical capability. EPA reviews the qualifications of the bidders and selects the most qualified ones based on technical capability and then requests cost information from them. After reviewing the cost information, EPA would then select the cleanup technology.

Public acceptance

The issue in the area of community acceptance revolves around three concerns outlined below:

--Communities prefer waste management at distant locations--the "not in my backyard" syndrome.

--Communities prefer proven technologies and object to being used as "guinea pigs."

--Communities want to be informed and participate in the decisionmaking.

An EPA official told us that the community resistance to alternative treatment technology is one of the most difficult barriers to overcome. The concerns identified above were repeatedly voiced by EPA and state environmental officials, EPA's contractors, and members of environmental associations.

To address these concerns, EPA plans to develop supplemental community relations guidance for innovative technology demonstrations to inform communities of treatment versus land disposal issues and of the effectiveness of alternative treatment technologies. In addition, EPA plans to keep communities involved in major decision points on the use of alternative technologies.

## Growing unavailability of liability insurance

Under the current provisions of Superfund, cleanup contractors, generators, and others who disposed, managed or cleaned up wastes at the site are responsible indefinitely and are held strictly liable for any accidents or harm that may occur. According to EPA's consulting engineers, because the risks associated with cleaning up hazardous waste sites are not fully known even when using traditional technologies and exist indefinitely, the rates charged by the insurance industry for liability insurance to hazardous waste cleanup contractors are extremely high if available at all. This situation worsens with regard to the use of innovative technologies because they generally lack any kind of performance record; therefore, there is greater uncertainty about the long-term effectiveness of these remedies. Because of this uncertainty, there is a tendency within the insurance industry to impute an increased probability of failure for alternative technologies.

Recognizing the scarcity of liability coverage, EPA's consulting engineering firms told us that some cleanup contractors have responded by relying on only demonstrated technologies, such as containment, as a means of minimizing their potential liabilities and avoiding the additional financial risks associated with using alternative technologies. Firms that are unable to self-insure because, for example, they have minimum assets, are consequently discouraged from entering the market for alternative technologies.

In an effort to address these problems, the proposed Superfund reauthorization legislation contains a provision that would indemnify cleanup contractors for any liabilities arising from cleanup actions that were not the result of negligence on the part of the contractor or its agent. EPA believes such a provision could serve to effectively eliminate liability as a barrier to use of innovative treatment technologies.

## Economic and marketing uncertainties

New technologies for the cleanup of hazardous waste sites are generally developed because of and based on regulations imposed by the federal government and states. These regulations determine which materials are considered hazardous, the extent to which they should be controlled, and how they should be controlled. Economic and marketing uncertainities exist because private firms

interested in developing innovative treatment technologies for hazardous waste sites are not sure how much of a market there is. A Minnesota state environmental official told us that the federal government's support and commitment to innovative technologies has been limited in terms of the level of funding for research and demonstration projects. In addition, others stated that because of the lack of cleanup standards it is unclear what level of cleanup would be required in terms of quantity and type of technologies. Consequently, private firms are reluctant to invest large sums of money given the uncertainty of the market and find it difficult to attract capital to finance the development of innovative technologies. Also, those that could be users of these technologies may not be willing to pay for generally higher priced alternative treatment technologies.

To promote and encourage private industry development of treatment technologies and to minimize market uncertainties, EPA plans to

--issue a policy or regulation to define the future role of both the federal government and the private sector in increasing the use of treatment technologies,

--meet with treatment industry associations to ensure that their concerns are being addressed,

--study the incentives needed to motivate commercialization of innovative technologies, and

--publish Superfund cleanup schedules.

## CONCLUSION

EPA has made a commitment to use permanent treatment technologies as often as is practicable; however, the adoption of permanent treatment technologies at Superfund sites faces a number of institutional, regulatory, and informational barriers. EPA recognizes that some barriers, such as procurement procedures, where administrative changes are needed, can be dealt with in the near term. Others which require regulatory or legislative changes, such as permitting, may take longer to overcome. EPA has recently initiated a variety of efforts to resolve these obstacles. We believe these efforts could help to encourage greater use of permanent treatment technologies at Superfund sites; however, EPA has not had sufficient time to implement many of its initiatives--particularly the demonstration program. As such, it is premature at this time for us to assess the effectiveness of EPA's early actions.

SECTION V

GAO ANALYSIS OF PERMANENT TREATMENT TECHNOLOGIES CONSIDERED AND SELECTED

AT SUPERFUND SITES THROUGH SEPTEMBER 30, 1985

| Region | Site name and location | Date of cleanup decision | Was groundwater addressed? | Treatment technologies selected | Treatment technologies considered but not selected | Reason(s) treatment was not selected |
|---|---|---|---|---|---|---|
| I | Beacon Heights, CT | Sept. 23, 1985 | T | | Incineration | 1, 2, 5 |
| | McKin Site, ME | July 15, 1983 | N/A | | Incineration | 1, 2 |
| | McKin Site, ME | July 22, 1985 | T | Soil aeration | Incineration | 1, 2, 4 |
| | | | | | Biological | 2 |
| | Resolve Site, MA | July 1, 1982 | N/A | | Solidification | 3 |
| | Charles George, MA | Dec. 29, 1983 | A | | | |
| | Charles George, MA | July 11, 1985 | T | | | |
| | Hocomonco Pond, MA | Sept. 30, 1985 | N/A | | Incineration | 1, 3 |
| | | | | | Biodegradation | 2 |
| | Cannon Engineering, MA | Sept. 30, 1985 | N/A | | Fixation | 2 |
| | Nyanza Chemical, MA | Sept. 04, 1985 | T | | | |
| | Sylvester Site, NH | July 29, 1982 | T | | | |
| | Sylvester Site, NH | Sept. 22, 1983 | T | Biological | | |
| | Keefe Environmental Services, NH | Nov. 15, 1983 | T | | Incineration | 1, 2 |
| | | | | | Solidification | 3 |
| | Picillo Farm, RI | Sept. 30, 1985 | NO | | Solidification | 2, 3, 9 |
| | | | | | Biological | 3 |
| | | | | | Incineration | 1, 5 |
| | Western Sand & Gravel, RI | Sept. 28, 1984 | A | | Landfarming | 3 |
| II | Lipari Landfill, NJ | Aug. 03, 1983 | T | | | |
| | Lipari Landfill, NJ | Sept. 30, 1985 | T | Incineration Soil flushing | | |
| | Chemical Control, NJ | Sept. 20, 1983 | N/A | | | |
| | Price Landfill, NJ | Sept. 20, 1983 | T | | | |
| | Burnt Fly Bog, NJ | Nov. 16, 1983 | M | Offsite incineration | | |
| | | | | | Onsite incineration | 5, 6 |
| | | | | | Chemical stabilization | 2 |
| | | | | | Landfarming | 2 |
| | Krysowaty Farm, NJ | June 20, 1984 | N/A | | Incineration | 1 |
| | Pijak Farm, NJ | Sept. 30, 1984 | T | | | |
| | Spence Farm, NJ | Sept. 30, 1984 | T | | | |

| Region | Site name and location | Date of cleanup decision | Was groundwater addressed? | Treatment technologies selected | Treatment technologies considered but not selected | Reason(s) treatment was not selected |
|---|---|---|---|---|---|---|
| II | Bridgeport Site, NJ | Dec. 31, 1984 | T | Incineration | | |
| | D'Imperio Property, NJ | Mar. 27, 1985 | T | | | |
| | Friedman Property, NJ | Apr. 30, 1985 | M | NO CLEANUP ACTION SELECTED | | |
| | Gem Landfill, NJ | Sept. 27, 1985 | T | | | |
| | Goose Farm, NJ | Sept. 27, 1985 | T | Soil flushing | Neutralization | 1, 3, 4 |
| | Helen Kramer Landfill, NJ | Sept. 27, 1985 | T | | Polymerization | 1, 3, 4 |
| | Swope Oil, NJ | Sept. 27, 1985 | NO | Incineration | Soil washing | Still under |
| | Bog Creek Farm, NJ | Sept. 30, 1985 | T | Incineration | Physical | consideration |
| | Lone Pine Landfill, NJ | Sept. 28, 1984 | T | | | |
| | Hudson River PCB, NY | Sept. 25, 1984 | D | | | |
| | PAS Oswego Site, NY | June 6, 1984 | T | | | |
| | Love Canal, NY | May 6, 1985 | N/A | | | |
| | Olean Well Field, NY | Sept. 24, 1985 | T | | | |
| | Sinclair Refinery, NY | Sept. 30, 1985 | N/A | | Incineration | 1, 2, 3 |
| | | | | | Biological | 2, 8 |
| | | | | | Solidification | 2, 8 |
| | Wide Beach, NY | Sept. 30, 1985 | N/A | Chemical | Immobilization | 1, 8 |
| | | | | | Biological | 1, 3, 4 |
| | | | | | Chemical | 1, 2 |
| III | Bruin Lagoon, PA | June 02, 1984 | T | Fixation | | |
| | Drake Chemical, PA | Sept. 30, 1984 | T | | Solidification | 2 |
| | | | | | Chemical | 2 |
| | | | | | Incineration | 2 |
| | Enterprise Ave., PA | May 10, 1984 | N/A | | Aeration | 1, 2, 3 |
| | | | | | Composting | 1, 2 |
| | Fischer & Porter, PA | May 4, 1984 | N/A | | | |
| | Lehigh Electric, PA | Feb. 1, 1983 | N/A | | Chemical | 3 |
| | | | | | Biological | 3 |
| | | | | | Incineration | 1 |
| | McAdoo Site, PA | June 5, 1984 | N/A | | | |
| | McAdoo Site, PA | June 28, 1985 | N/A | | Solidification | 7 |
| | | | | | Physical | 2 |
| | | | | | Chemical | 2 |
| | | | | | Biological | 3 |
| | | | | | Incineration | 2 |
| | Wade Site, PA | Aug. 30, 1984 | T | | Soil aeration | 9 |
| | | | | | Landfarming | 3 |
| | Heleva Landfill, PA | Mar. 22, 1985 | T | | Incineration | 1, 4, 5, 6 |
| | Lackawanna Refuse, PA | Mar. 22, 1985 | N/A | Incineration | Solids treatment | |
| | Landsdowne Radiation, PA | Aug. 2, 1985 | N/A | | | |
| | Taylor Borough, PA | June 28, 1985 | T | | Stabilization | 3, 8 |
| | | | | | Biological | 2 |
| | | | | | Chemical | 2 |
| | | | | | Gas treatment | 9 |
| | | | | | Incineration | 9 |

| Region | Site name and location | Date of cleanup decision | Was groundwater addressed? | Treatment technologies selected | Treatment technologies considered but not selected | Reason(s) treatment was not selected |
|---|---|---|---|---|---|---|
| III | Tysons Dump, PA | Dec. 21, 1984 | T | | Solidification | 3 |
| | | | | | Biological | 3 |
| | | | | | Incineration | 1, 4, 6 |
| | Douglassville, PA | Sept. 27, 1985 | T | | Incineration | 2, 4, 5 |
| | Moyer Landfill, PA | Sept. 30, 1985 | T | | Incineration | 1, 4, 9 |
| | Harvey-Knott, DE | Sept. 30, 1985 | T | | Landfarming | 2 |
| | | | | | Bioreclamation | 2 |
| | | | | | Neutralization | 2 |
| | | | | | Chemical | 2 |
| | | | | | Solidification | 2 |
| | | | | | Incineration | 2 |
| | Matthews Electro-plating Site, VA | June 2, 1983 | N/A | | | |
| | Sand, Gravel and Stone, MD | Sept. 30, 1985 | T | | Incineration | 1 |
| IV | Miami Drum Services, FL | Sept. 13, 1982 | N/A | | Incineration | 2 |
| | American Creosote, FL | Sept. 30, 1985 | NO | | Physical | 2 |
| | | | | | Chemical | 2 |
| | | | | | Incineration | 2, 5 |
| | Biscayne Aquifer, FL | Sept. 16, 1985 | T | | | |
| | Varsol Spill, FL | Mar. 29, 1985 | | NO CLEANUP ACTION SELECTED | | |
| | White House Waste, FL | May 30, 1985 | T | | Incineration | 1 |
| | Davie Landfill, FL | Sept. 30, 1985 | N/A | Stabilization | Incineration | 1, 5 |
| | | | | | Fixation | 1 |
| | | | | | Biological | 1 |
| V | A&F Materials, IL | Nov. 23, 1983 | NO | | Solidification | 3 |
| | | | | | Incineration | 1 |
| | A&F Materials, IL | June 14, 1985 | T | | Solidification | 7 |
| | | | | | In situ | 7 |
| | Outboard Marine, IL | May 15, 1984 | NO | Solidification | Solid treatment | 1 |
| | | | | | Separation | 1 |
| | | | | | Chemical | 1 |
| | | | | | Biological | 1 |
| | | | | | Incineration | 1 |
| | Acme Solvents, IL | Sept. 27, 1985 | T | Incineration | | |
| | Byron Johnson, Salvage Barn, IL | Mar. 13, 1985 | N/A | Incineration<br>Chemical | | |
| | Cross Brothers, IL | Mar. 25, 1985 | NO | | Detoxification | 2 |
| | Wauconda Sand, and Gravel, IL | Sept. 30, 1985 | T | | | |
| | Main Street, IN | Aug. 2, 1985 | T | | | |
| | Berlin & Ferro Site, MI | Feb. 29, 1984 | N/A | Incineration | Solidification | 3 |
| | Charlevoix Site, MI | June 12, 1984 | A | | Physical | 2 |
| | Charlevoix Site, MI | Sept. 30, 1985 | M | | Chemical | 2 |
| | | | | | Biological | 3 |
| | Verona Well Field, MI | May 1, 1984 | T | | | |
| | Verona Well Field, MI | Aug. 12, 1985 | T | Soil washing | | |

| Region | Site name and location | Date of cleanup decision | Was groundwater addressed? | Treatment technologies selected | Treatment technologies considered but not selected | Reason(s) treatment was not selected |
|---|---|---|---|---|---|---|
| V | Forest Waste, MI | Feb. 28, 1984 | N/A | | | |
| | Cemetery Dump, MI | Sept. 11, 1985 | NO | | Solidification | 3 |
| | | | | | Biological | 3 |
| | | | | | Incineration | 8 |
| | | | | | Incineration | 2 |
| | Northernaire, MI | Sept. 11, 1985 | NO | | Solidification | 3 |
| | | | | | Biological | 2 |
| | | | | | Landfarming | 7 |
| | | | | | Soil flushing | 7 |
| | New Brighton, MN | June 24, 1983 | T | | | |
| | New Brighton, MN | Sept. 19, 1983 | A | | | |
| | New Brighton, MN | Aug. 2, 1984 | A | | | |
| | Reilly Tar, MN | June 6, 1984 | T | | | |
| | Morris Arsenic, MN | Aug. 7, 1985 | | NO CLEAN UP ACTION SELECTED | | |
| | Kummer Landfill, MN | June 12, 1985 | A | | | |
| | LeHillier Mankato, MN | Sept. 27, 1985 | T,A | | | |
| | Laskin Poplar Oil, OH | Aug. 09, 1984 | NO | Incineration (Offsite) | Incineration (onsite) | 1, 4 |
| | | | | | Chemical | 3 |
| | Chem-Dyne, OH | July 5, 1985 | T | | | |
| | New Lyme Landfill, OH | Sept. 27, 1985 | T | | Incineration | 1, 6 |
| | Old Mill Rock Creek, OH | Aug. 7, 1985 | T, A | | Incineration | 1, 4, 5 |
| | Eau Claire Municipal Well Field, WI | June 10, 1985 | T | | Physical | 2, 9 |
| | | | | | Chemical | 2, 9 |
| | | | | | Biological | 2, 9 |
| | Schmalz Dump, WI | Aug. 13, 1985 | NO | | Incineration | 1,5 |
| VI | Bio-Ecology Systems, TX | June 6, 1984 | T | Stabilization | | |
| | Highland Acid Pit, TX | June 25, 1984 | T | | Land treatment | 2 |
| | | | | | Fixation | 2 |
| | | | | | Incineration | 2 |
| | Motco, TX | Mar. 15, 1985 | N/A | Incineration (offsite) | Incineration (onsite) | Still being considered |
| | Triangle Chemical, TX | June 11, 1985 | T | Soil aeration Incineration | Solids treatment | 1 |
| | Old Inger, LA | Sept. 25, 1984 | T | Land treatment | | |
| | Bayou Bonfouca, LA | Aug. 15, 1985 | T | | Biological | 3 |
| | | | | | Incineration | 1 |
| | South Valley, NM | Mar. 22, 1985 | NO | | Solidification | 1, 2, 3 |
| | | | | | Physical | 2, 3 |
| | | | | | Chemical | 2, 3 |
| | Tar Creek Site, OK | June 6, 1984 | M | | | |

| Region | Site name and location | Date of cleanup decision | Was groundwater addressed? | Treatment technologies selected | Treatment technologies considered but not selected | Reason(s) treatment was not selected |
|---|---|---|---|---|---|---|
| VII | Aidex Site, IA | Aug. 24, 1983 | NO | | Incineration | 6 |
| | | | | | Biological | 2 |
| | Aidex Site, IA | Sept. 30, 1984 | NO | | Fixation | 2 |
| | | | | | Chemical | 1, 3, 5, 9 |
| | Times Beach, MO | Jan. 13, 1984 | NO | | Incineration | 1, 3 |
| | | | | | Solids treatment | 1, 3 |
| | Ellisville, MO | July 10, 1985 | N/A | | Biological | 1, 3 |
| VIII | Milltown, MT | Apr. 14, 1984 | A | | | |
| | Milltown, MT | Aug. 7, 1985 | A | | | |
| | Woodbury Chemical, CO | July 19, 1985 | T | Incineration | Biological | 3 |
| IX | Celtor Chemical, CA | Oct. 4, 1983 | NO | | Incineration | 2 |
| | | | | | Biodegradation | 2 |
| | | | | | Wet air oxidation | 2 |
| | | | | | Neutralization | 2 |
| | | | | | Solidification | 2 |
| | Celtor Chemical, CA | Sept. 30, 1985 | N/A | | Solidification | 7 |
| | | | | | Soil flushing | 9 |
| | | | | | Incineration | 7 |
| | | | | | Biological | 7 |
| | McColl, CA | Apr. 11, 1984 | N/A | | Chemical | 7 |
| | | | | | Biological | 7 |
| | San Gabriel, CA | May 11, 1984 | T | | Solids treatment | 7 |
| | Stringfellow Acid Pits, CA | July 22, 1983 | T | Neutralization | Fixation | 1 |
| | Stringfellow Acid Pits, CA | July 17, 1984 | T | Physical Chemical | Incineration | 1, 4, 6 |
| | Jibboom Junkyard, CA | May 9, 1985 | N/A | | Incineration | 2 |
| | | | | | Solidification | 1, 9 |
| | | | | | Chemical | 2 |
| | | | | | Biological | 2 |
| | | | | | Soil flushing | 4, 8 |
| X | Del Norte, CA | Sept. 30, 1985 | T | | | |
| | Mountain View Globe, AZ | June 2, 1983 | N/A | | | |
| | Taputimu Farm, AS | July 22, 1983 | N/A | | | |
| | South Tacoma Well, WA | Mar. 18, 1983 | T | | | |
| | South Tacoma Well, WA | May 3, 1985 | T | Soil flushing | | |
| | Ponders Corner, WA | July 1, 1984 | T | | | |
| | Ponders Corner, WA | Sept. 30, 1985 | T | | Incineration | 1 |
| | Western Processing, WA | Aug. 5, 1984 | M | | Incineration | 6 |
| | Western Processing, WA | Sept. 25, 1985 | T | Stabilization Soil washing | Solidification | 7 |

Legend:

1 = Too costly compared to other alternatives

2 = Technically unfeasible/technology is not appropriate for particular type of wastes

3 = Unproven technology

4 = Long processing time required to implement (because of permitting process, for example)

5 = Adverse environmental effects

6 = Lack of available equipment/mobile incinerators

7 = No reasons given

8 = Difficult or complex to implement

9 = Ineffective

A = Alternative water supply provided

D = Dredging

M = Groundwater monitored

N/A = Not applicable

T = Groundwater pumping and treating done

(089324)