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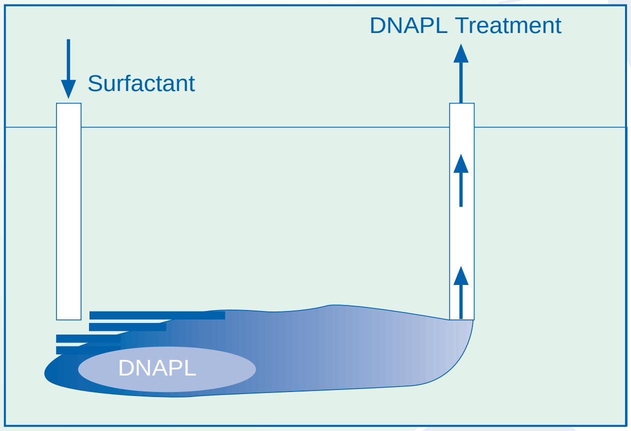
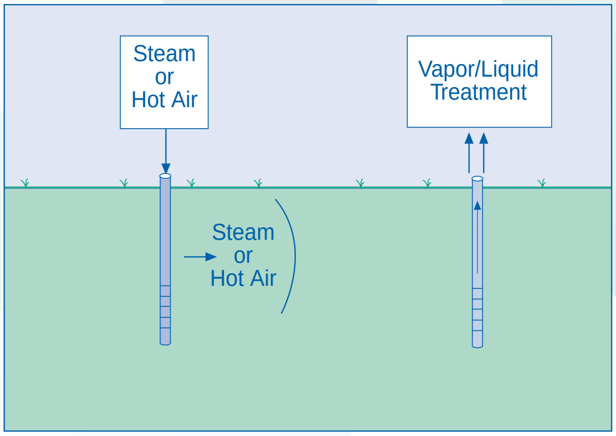
Treatment Technologies for Site Cleanup: Annual Status Report (Ninth Edition)





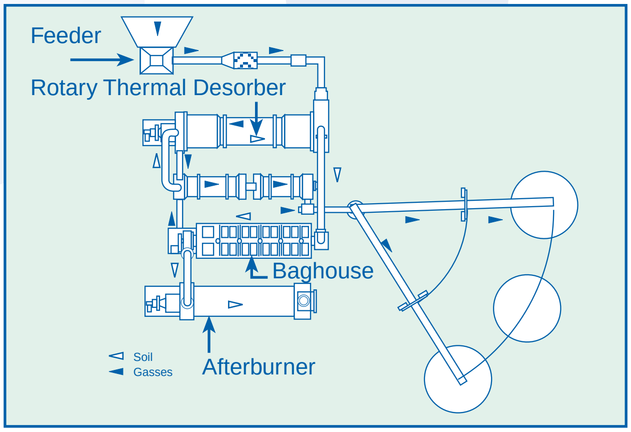


Table of Contents

Figures

Notice

Preparation of this report has been funded wholly or in part by the U.S. Environmental Protection Agency (EPA) under Contract Numbers 68-W5-0055 and 68-W-99-003. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. The *Treatment Technologies for Site Cleanup: Annual Status Report (ASR), Ninth Edition* is available free of charge by mail or fax from:

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A color version of the ASR is also available for viewing or downloading from the Hazardous Waste Cleanup Information (CLU-IN) web site at http://clu-in.org.

The data for the ASR have been incorporated into EPA's REmediation And CHaracterization Innovative Technologies (EPA REACH IT) on-line searchable database at http://www.epareachit.org. EPA REACH IT combines the ASR data with two other EPA databases containing information on innovative treatment and characterization technologies: the Vendor Information System for Innovative Treatment Technologies (VISITT) and the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS). EPA REACH IT fosters communication between technology vendors and users by providing information on the availability, performance, and cost associated with the application of treatment and characterization technologies.

Foreword

Over the next several decades, federal, state, and local governments, and private industry, will commit billions of dollars annually to clean up sites contaminated with hazardous waste and petroleum products. This planned investment will result in a continuing demand for site remediation services and technologies that provide better, faster, and cheaper environmental cleanups. The information contained in this report is designed to improve communication between technology users and those who are considering treatment technologies to clean up sites. Increased communication will help promote the use of new, less costly, and more effective technologies to address problems at Superfund and other contaminated sites. Also, the site-specific information will enable technology vendors to evaluate the market for possible site applications for the next several years.

This report documents, as of the summer of 1998, the status of treatment technology applications for soil, other solid wastes, and groundwater at sites in the Superfund program, and selected Resource Conservation and Recovery Act (RCRA) corrective action, U.S. Department of Defense (DoD), and U.S. Department of Energy (DOE) sites. Previously titled *Innovative Treatment Technologies: Annual Status Report*, this ninth edition of the report has been renamed *Treatment Technologies for Site Cleanup: Annual Status Report* to reflect the inclusion of a broader range of treatment technologies (beyond innovative), such as off-site incineration and solidification/stabilization, to treat soil and other solid wastes. As described in the Introduction, EPA has expanded this edition to include sites using these two additional technologies, and has updated status information on more than 900 treatment technology projects. Access to more detailed project information has been made easier by incorporating the data for the treatment technology projects into a new, searchable EPA REACH IT system on the Internet. (See the Notice for more information.)

EPA plans to continue to publish annual updates on the status of more than 900 projects, and to add newly selected projects annually as well. Comments or questions concerning this report should be directed to the U.S. EPA, Technology Innovation Office (5102G), 401 M Street, SW, Washington, DC 20460, (703) 603-9910.

Acknowledgment

This document was prepared for EPA's Technology Innovation Office under Contract Numbers 68-W5-0055 and 68-W-99-003 by Tetra Tech EM Inc.

Special acknowledgment is given to the federal and state staff and other remediation professionals listed as contacts for individual sites, for providing the detailed information in this document. Their cooperation and willingness to share their expertise on treatment technologies encourages the application of those technologies at other sites.

Abstract

This report documents the status, as of the summer of 1998, of treatment technology applications for soil, other solid wastes, and groundwater at sites in the Superfund and several other national site cleanup programs. Previously titled *Innovative Treatment Technologies: Annual Status Report*, this ninth edition of the report has been renamed *Treatment Technologies for Site Cleanup: Annual Status Report* to reflect the inclusion of a broader range of treatment technologies (beyond innovative). The data in this report were gathered from site project managers for Superfund remedial and removal sites, RCRA corrective action sites, and Departments of Defense and Energy sites. The report looks at both source control technologies (addressing soil, sludge, sediment, and other solid-matrix wastes) and innovative groundwater treatment technologies. The principle technologies to treat soil and other solid wastes tracked in the report are: on- and off-site incineration, solidification/stabilization, soil vapor extraction (SVE), thermal desorption, and ex situ and in situ bioremediation. The innovative groundwater treatment technologies included in this report are air sparging, in situ bioremediation, in situ chemical treatment, dual-phase extraction (for soil and groundwater), and permeable reactive barriers (also known as passive treatment walls).

This report provides a summary of technology applications identified for each cleanup program, and a matrix listing each site and technology used. Changes in remedies over the nine editions of the report also are listed. The report includes data on 933 treatment technology projects, 747 of which are for Superfund remedial actions. For the most frequently selected technologies in the Superfund remedial program, the report analyzes selection trends over time, contaminant groups treated, quantities of soil treated (for soil treatment technologies), and project implementation status.

This report finds that for treatment technologies at Superfund remedial action sites:

- A total of 302 projects have been completed, and another 202 are operational
- The number of innovative groundwater technologies that are operational has doubled in the past two years to 38 applications

For all source control technologies:

- More than half (59 percent) are ex situ
- 60 percent of ex situ projects have been completed
- 23 percent of in situ projects have been completed
- Average time to cleanup for ex situ technologies was 13 months, and for in situ technologies 19 months

In situ SVE is the most frequently used treatment technology (26 percent of source control projects), followed by ex situ solidification/stabilization (18 percent) and off-site incineration (14 percent). For projects with available data, the total amount of soil being treated by in situ technologies is at least three times the amount of soil for ex situ technologies (32 million versus 10 million cubic yards). Based on available data, 69 percent (29 million cubic yards) of the total volume of soil treated is being addressed by SVE.

Results on contaminants treated at Superfund sites indicate that:

- Over three-quarters of the Superfund remedial projects in the report address organics alone.
- Only one-fifth of the remedial projects address metals alone or in combination with organics.

Access to more detailed project information has been made easier by incorporating the site-specific data used as the basis for this report into the new searchable EPA REACH IT system at http://www.epareachit.org. An HTML version of this report is available at http://clu-in.org.

Overview

Introduction

The *Treatment Technologies for Site Cleanup: Annual Status Report* (ASR), *Ninth Edition* was prepared by the Technology Innovation Office (TIO) of the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response (OSWER) to document the use of treatment technologies to remediate contaminated hazardous waste sites. The report contains a list and an analysis of Superfund sites (both remedial and removal actions), Resource Conservation and Recovery Act (RCRA) corrective action sites, and other non-Superfund sites (that is, sites addressed under other federal and state programs) where treatment technologies are being used. Site managers can use this report to evaluate cleanup alternatives for similar sites. Technology vendors can use it to identify potential markets. TIO also uses the information to track progress in the application of established and innovative treatment technologies.

The treatment technologies report is usually updated annually. The eighth edition of this report published in November 1996 contained data from Superfund Records of Decision (RODs) through fiscal year (FY) 1995. This ninth edition updates and expands information provided in the November 1996 report by including data from FY 1996 and FY 1997 RODs. This document includes a list of sites and an analysis of 747 applications of treatment technologies for remedial actions, 97 applications for removal actions, 15 applications under RCRA corrective actions, and 72 applications under other federal and state programs. Information added to this update includes 69 applications of treatment technologies selected in Superfund RODs for remedial actions in FY 1996 and 51 selected in FY 1997. A ROD is the decision document used to specify the way a site, or part of a site, will be remediated. Detailed information on approximately 250 off-site incineration and solidification/stabilization projects selected in RODs from FY 1982 through FY 1997 has been added to the report which also includes information on more than 100 additional projects that have been completed since November 1996. Also in this report is information about innovative technologies being implemented at an additional 67 Superfund removal actions, six RCRA corrective actions, and 37 applications under other federal and state programs.

This report does not address sites that use nontreatment remedies, such as landfilling and capping. It contains only minimal information on sites that use pump-and-treat remedies. More information about RODs that specify these types of remedies is presented in the series of ROD annual reports published by the EPA's Office of Emergency and Remedial Response (OERR). For more information about those reports, call the RCRA/ Superfund Hotline at (800) 424-9346 (outside the Washington, D.C. metropolitan calling area) or (703) 412-9810 (inside the Washington, D.C. metropolitan calling area).

Highlights of this Report

- Increase in number of treatment technology applications to 933 from 419 in previous edition, including for the first time site-specific information on 250 Superfund solidification/stabilization and off-site incineration projects.
- More detailed analysis of 747 applications of treatment technologies for Superfund remedial actions.
- For the first time, soil vapor extraction and thermal desorption are defined as established technologies because of the large number of applications and availability of cost and performance information.
- Updated database system searchable on the Internet (http://www.epareachit.org).

What Treatment Technologies Are Covered in This Report?

Most RODs for remedial actions address the source of contamination, such as soil, sludge, sediments, and solid-matrix wastes. These "source control" RODs select "source control technologies." Groundwater remedial action—a non-source control action—may be a component of the "source control" ROD and the treatment technologies chosen for groundwater remediation are referred to as "groundwater technologies."

Treatment technologies are alternatives to on-site containment and off-site land disposal. Established treatment technologies are those for which cost and performance information is readily available. The most frequently used established technologies are on- and off-site incineration, solidification/ stabilization, soil vapor extraction (SVE), thermal desorption, and pump-and-treat technologies for groundwater. Treatment of groundwater after it has been pumped to the surface often resembles traditional water treatment; also, due to the availability of cost and performance data on pump-and-treat groundwater remedies, the pump-and-treat groundwater remedies are considered established technologies.

SVE and thermal desorption are two established technologies that were formerly considered innovative. Their large number of applications and the amount of documentation that has recently become available on their cost and performance have resulted in their transition to established technologies.

Innovative treatment technologies are alternative treatment technologies whose limited number of applications result in a lack of data on cost and performance. In general, a treatment technology is considered innovative if it has had limited full-scale application. Often, it is the application of a technology or process to a waste site (soils, sediments, sludge, and solid-matrix waste [such as mining slag] or groundwater) that is innovative, not the technology itself. Specific innovative technologies are discussed in Section 3. This report documents the use of the following treatment technologies to treat groundwater, soils, sediments, sludge, and solid-matrix waste:

Source Control Treatment Technologies

- Bioremediation (ex situ and in situ)
- Chemical treatment
- Cyanide oxidation
- Dechlorination
- Flushing (in situ)
- Hot air injection
- Incineration (off site and on site)*
- Mechanical soil aeration*
- Neutralization*
- Open burn/open detonation*
- Physical separation
- Phytoremediation
- SVE*
- Soil washing
- Solidification/stabilization*
- Solvent extraction
- Surfactant flushing
- Thermal desorption*
- Thermally enhanced recovery
- Vitrification

In Situ Groundwater Treatment Technologies

- Air sparging
- Bioremediation (in situ)
- Chemical treatment
- Dual-phase extraction
- Oxidation (in situ)
- Permeable reactive barrier
- Well aeration (in situ)

**Established technologies*

Contents of this Report

The following sections of this report contain summary information and analyses of sites where treatment technologies are being or have been applied. Section 1 discusses remedies selected in Superfund RODs through FY 1997. Section 2 discusses all Superfund projects that implement a treatment technology for source control. Information about the types of technologies used, their status, and the contaminants treated is presented. Section 3 presents information on innovative technologies and discusses some innovative technologies in detail. Section 4 presents information about applications of in situ groundwater technologies. Section 5 provides information on Superfund removal action sites. Removal actions are usually conducted in response to a more immediate threat caused by a release of hazardous substances. Threats addressed by remedial actions are less immediate. Section 6 covers non-Superfund sites being addressed under RCRA and other federal programs.

Sources of Information for this Report

EPA initially used RODs to compile information on remedial actions, and used pollution reports, on-scene coordinators' (OSC) reports, and the OSWER Removal Tracking System to compile data on emergency response actions. The U.S. Army Corps of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise in Omaha, Nebraska, and RCRA corrective action statements of basis (SBs) were consulted to compile information on projects under federal programs. EPA then verified and updated the draft information through interviews with remedial project managers (RPM), OSCs, and other contacts for each site. The data on project status supplements data in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), EPA's Superfund tracking system, by providing more detailed information on the specific portion of the remedy that involves a treatment technology. In addition, information about technologies and sites identified here may differ from information found in the ROD annual reports and the RODs database. Such differences are the result of changes in the remedy during the design phase of the project. The changes may not have required official documentation (that is, a ROD amendment or an explanation of significant differences [ESD]).

Definitions of Specific Treatment Technologies

This document reports on the use of the treatment technologies listed above. The technologies reported in the following sections treat contaminants in different ways. This section provides brief definitions of the 21 types of source control (primarily soil) treatment technologies, and six types of in situ groundwater technologies as they are used in this document. The source for the definitions of treatment technologies is the Remediation Technologies Screening Matrix and Reference Guide, Version 3.0, which can be viewed at the Federal Remediation Technologies Roundtable (FRTR) web site at http://www.frtr.gov. Pictures are provided for some of the newer innovative treatment technologies.

Source Control Treatment Technologies

EX SITU BIOREMEDIATION uses microorganisms to degrade organic contaminants in excavated soil, sludge, and solids. The microorganisms break down contaminants by using them as a food source. The end products typically are carbon dioxide and water. Ex situ bioremediation includes slurry-phase bioremediation, in which the soils are mixed in water to form a slurry to keep solids suspended and microorganisms in contact with the soil contaminants; and solid-phase bioremediation, in which the soils are placed in a cell or building and tilled with added water and nutrients. Land farming and composting are types of solid-phase bioremediation.

IN SITU BIOREMEDIATION techniques stimulate and create a favorable environment for microorganisms to grow and use contaminants as a food and energy source. Generally, this means providing some combination of oxygen, nutrients, and moisture, and controlling the temperature and pH. Sometimes, microorganisms adapted for degradation of the specific contaminants are applied to enhance the process. Bioventing is a common form of in situ bioremediation. Bioventing uses extraction wells to circulate air with or without pumping air into the ground.

CHEMICAL TREATMENT typically involves reduction/oxidation (redox) reactions that chemically convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, or inert. Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). The oxidizing agents most commonly used for treatment of hazardous contaminants are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.

In CYANIDE OXIDATION, organic cyanides are oxidized to less hazardous compounds through chemical reactions.

DECHLORINATION is a chemical reaction that removes or replaces chlorine atoms contained in hazardous compounds, rendering them less hazardous. Typically, contaminated soil is screened, processed with a crusher and pug mill, and mixed with sodium bicarbonate. The mixture is heated to above 330°C (630°F) in a reactor to partially decompose and volatilize the chlorine atoms. The volatilized chlorine atoms are captured, condensed, and treated separately.

For FLUSHING (IN SITU), large volumes of water, at times supplemented with treatment compounds, are applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Injected water is isolated within the underlying aquifer and recovered.

With HOT AIR INJECTION, hot air or steam is injected below the contaminated zones to heat contaminated soil. The heating enhances the release of contaminants from the soil matrix so they can be extracted and captured for further treatment or recycling.

Both on-site and off-site INCINERATION use high temperatures, 870 to 1,200°C (1,600 to 2,200°F), to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. Often auxiliary fuels are employed to initiate and sustain combustion. The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99 percent requirement for hazardous waste and can be operated to meet the 99.9999 percent requirement for polychlorinated biphenyls (PCBs) and dioxins. Off gases and combustion residuals generally require treatment. On-site incineration typically uses a transportable unit; with off-site incineration, waste is transported to a central facility.

MECHANICAL SOIL AERATION agitates contaminated soil using tilling or other means to volatilize contaminants.

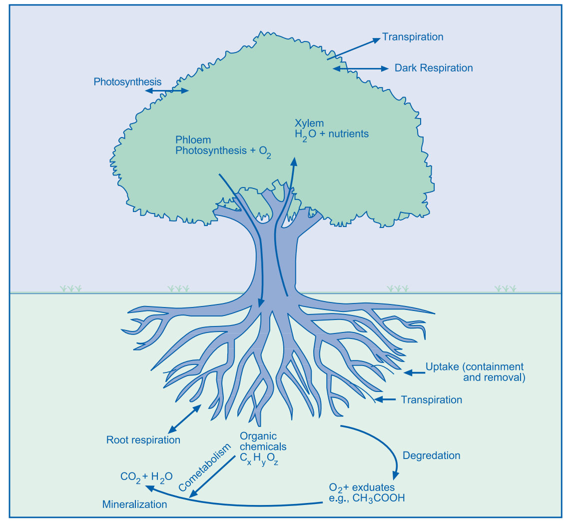
NEUTRALIZATION is a chemical reaction between an acid and a base. The reaction involves acidic or caustic wastes that are neutralized (pH is adjusted toward 7.0) using caustic or acid additives.

OPEN BURN (OB) and OPEN DETONATION (OD) operations are conducted to destroy excess, obsolete, or unserviceable (EOU) munitions and energetic materials. In OB operations, energetic or munitions are destroyed by self-sustained combustion, which is ignited by an external source such as flame, heat, or a detonation wave. In OD operations, detonatable explosives and munitions are destroyed by detonation, which is generally initiated by the detonation of an energetic charge.

PHYSICAL SEPARATION processes use different size sieves and screens to concentrate contaminants into smaller volumes. Most organic and inorganic contaminants tend to bind, either chemically or physically, to the fine fraction of the soil. Fine clay and silt particles are separated from the coarse sand and gravel soil particles to concentrate the contaminants into a smaller volume of soil that could then be further treated or disposed.

PHYTOREMEDIATION is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation (takes place in soil immediately surrounding plant roots), phytoextraction (also known as phytoaccumulation, the uptake of contaminants by plant roots and the translocation/accumulation of contaminants into plant shoots and leaves),

Model of Phytoremediation



phyto-degradation (metabolism of contaminants within plant tissues), and phyto-stabilization (production of chemical compounds by plants to immobilize contaminants at the interface of roots and soil). That definition applies to all biological, chemical, and physical processes that are influenced by plants (including the rhizosphere) and that aid in cleanup of the contaminated substances. Plants can be used in site remediation, both through the mineralization of toxic organic compounds and through the accumulation and concentration of heavy metals and other inorganic compounds from soil into aboveground shoots.

SOIL VAPOR EXTRACTION (SVE) is used to remediate unsaturated (vadose) zone soil. A vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. SVE is usually preformed in situ, however, in some cases, it can be used as an ex situ technology.

FOR SOIL WASHING, contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.

SOLIDIFICATION/STABILIZATION (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. S/S is preformed both ex situ and in situ. For ex situ S/S, contaminants are physically bound or enclosed within a stabilized mass. Ex situ S/S requires disposal of the resultant materials. In situ S/S uses auger/caisson systems and injector head systems.

SOLVENT EXTRACTION uses an organic solvent as an extractant to seperate orgainic and metal contaminants from soil. The extractant is mixed with contaminated soil in an extraction unit. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use. Organically-bound metals may be extracted along with the target organic contaminants.

SURFACTANT FLUSHING is the extraction of contaminants from the soil using surfactants. Surfactant flushing is accomplished by pumping the surfactant through in-place soils using an injection or infiltration process. Contaminants are leached into the groundwater, which is then extracted and treated.

For THERMAL DESORPTION, wastes are heated to volatilize and strip out water and organic contaminants. Typically a carrier gas or vacuum system transports volatilized water and organics to a gas treatment system. Based on the operating temperature of the desorber, thermal desorption processes can be categorized into two groups: high temperature thermal desorption (HTTD) (320 to 560°C or 600 to 1000°F) and low temperature thermal desorption (LTTD) (90 to 320°C or 200 to 600°F).

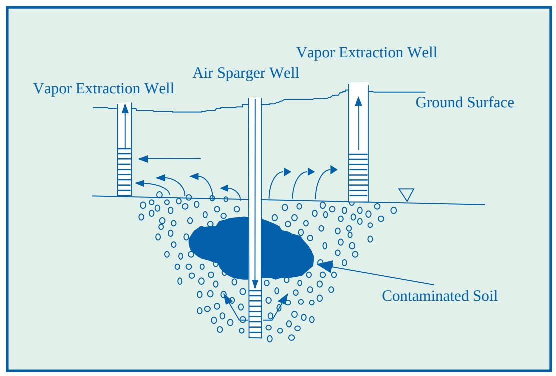
THERMALLY ENHANCED RECOVERY techniques use heat to increase the volatilization rate of semi-volatile organics and facilitate extraction. Specific types of thermally enhanced recovery techniques include contained recovery of oily waste (CROW™), radio frequency heating, steam heating or in situ steam stripping, dynamic underground stripping, in situ thermal desorption and electrical resistance heating.

VITRIFICATION uses an electric current to melt contaminated soil at elevated temperatures (1,600 to 2,000°C or 2,900 to 3,650°F) The vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock. The process destroys and/or removes organic materials. Radionuclides and heavy metals are retained within the vitrified product.

In Situ Groundwater Treatment Technologies

AIR SPARGING involves the injection of air or oxygen through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps to flush the contaminants into the unsaturated zone, where a vapor extraction system is usually implemented in conjunction with air sparging to remove the generated vapor-phase contamination. Oxygen added to the contaminated groundwater and vadose zone soils can also enhance biodegradation of contaminants below and above the water table.

Model of an Air Sparging System



With IN SITU GROUNDWATER BIOREMEDIATION, substrates nutrients, or an oxygen source (such as air), are pumped into an aquifer through wells to enhance biodegradation of contaminants in groundwater. Specific types of enhanced in situ bio-remediation include biosparging and bioslurping.

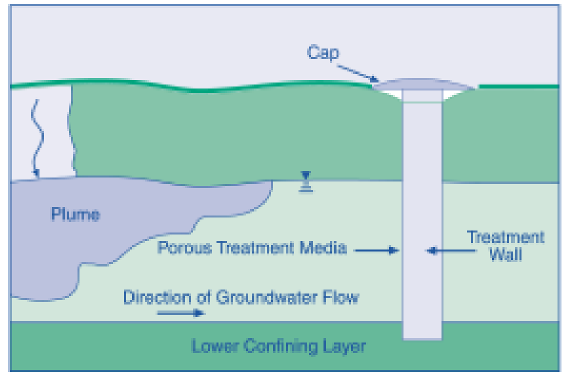
DUAL-PHASE EXTRACTION, also known as multi-phase extraction, uses a vacuum system to remove various combinations of contaminated groundwater, separate-phase petroleum product, and vapors from the subsurface. This technology applies soil vapor extraction techniques to contaminants trapped in saturated-zone soils, which are more difficult to extract than those in the unsaturated zone. In some instances, this result may be achieved by sparging the groundwater section of a well that penetrates the groundwater table. Other methods also may be employed.

OXIDATION (IN SITU) oxidizes contaminants that are dissolved in groundwater, converting them into insoluble compounds.

PERMEABLE REACTIVE BARRIERS (PRBs) also known as passive treatment walls, are installed across the flow path of a contaminated plume, allowing the water portion of the plume to flow through the wall. These barriers allow the passage of water while prohibiting the movement of contaminants by employing such agents as zero-valent metals, chelators, sorbents, and microbes. The contaminants are either degraded or retained in a concentrated form by the barrier material.

For IN SITU WELL AERATION, air is injected into a double screened well, allowing the VOCs in the contaminated groundwater to transfer from the dissolved phase to the vapor- phase by air bubbles. As the air bubbles rise to the water surface, the vapors are drawn off and treated by a SVE system.

Model of Permeable Reactive Barrier



Section 1: Overview of RODs

As of September 1998, there are 1,193 sites on the National Priorities List (NPL). An additional 55 sites are proposed for the NPL. Up to this date, 176 sites have been deleted from the NPL. Through fiscal year (FY) 1997, approximately 1,992 records of decision (ROD) (including ROD amendments) had been signed. 1,333 RODs for remedial actions address the source of contamination, such as soil, sludge, sediments, non aqueous phase liquids (NAPLs), and solid-matrix wastes. These actions are referred to as "source control" RODs. Although not itself a source control, groundwater remedial action may also be a component of a source control ROD. Other, non-source control RODs address groundwater only or specify that no action is necessary. Figure 1 shows the number of source control RODs compared with the total number of RODs for each fiscal year since FY 1982.

RODs Signed by Fiscal Year

Since 1988, the total number of RODs signed in each fiscal year has fluctuated between about 150 and 200. The total number of source control RODs has varied between approximately 100 and 150. Source control RODs have represented between 58 percent and 74 percent of all RODs signed in each of these years. In FY 1997, source control RODs represented 59 percent of all RODs signed that year, the second lowest percentage since FY 1984.

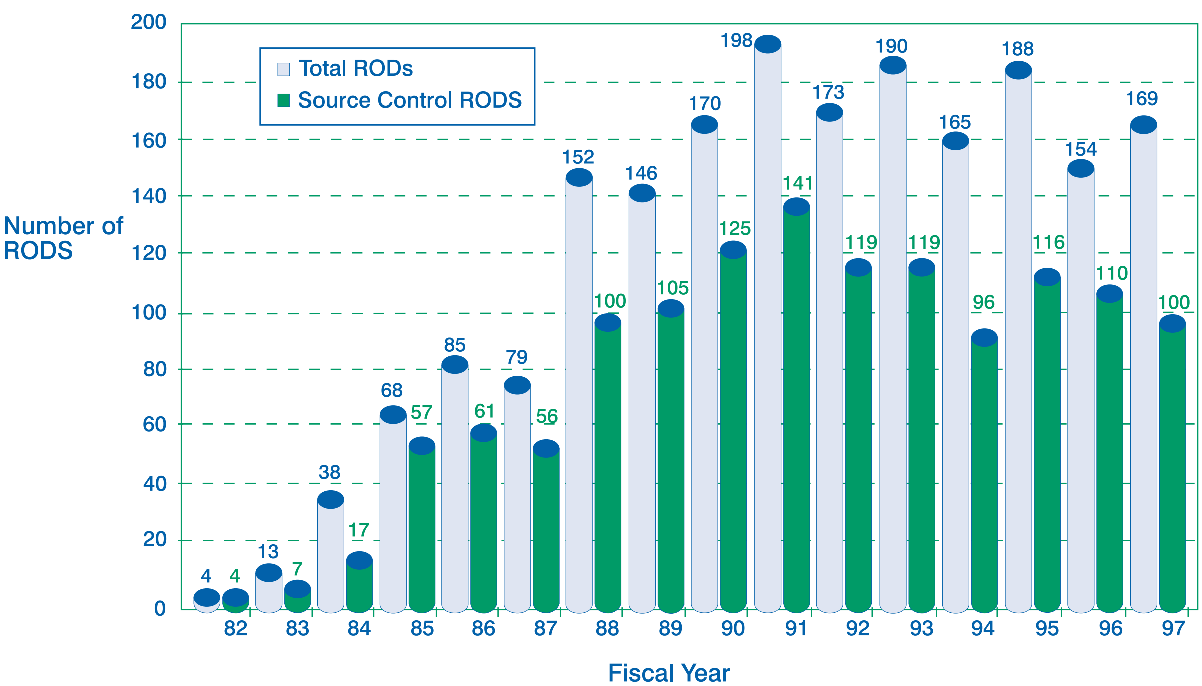
Added to this year's report are data for FY 1996 and FY 1997 RODs. As shown in Figure 1, although 15 more RODs were signed in FY 1997 than in FY 1996, 10 fewer source control RODs were signed in FY 1997, indicating that a greater percentage of RODs signed in FY 1997 were groundwater only or no action RODs.

Source Control RODs

Source control RODs can be classified by the general type of technology selected: (1) RODs specifying treatment, (2) RODs specifying on-site containment or off-site disposal only, and (3) RODs specifying institutional controls or other actions (such as monitoring, or relocation of the affected community).

Figure 2 shows the number of source control RODs that fall under each category. RODs that select treatment may also include containment of treatment residues or waste from another part of the site. The percentage of RODs specifying on-site containment or off-site disposal only has increased since FY 1992. In FY 1996 and FY 1997, the percentage of RODs specifying containment/disposal only was 46 percent and 42 percent, respectively, an increase from 22 percent of source control RODs in FY 1992. Figure

Figure 1. Superfund Remedial Actions: RODs Signed by Fiscal Year

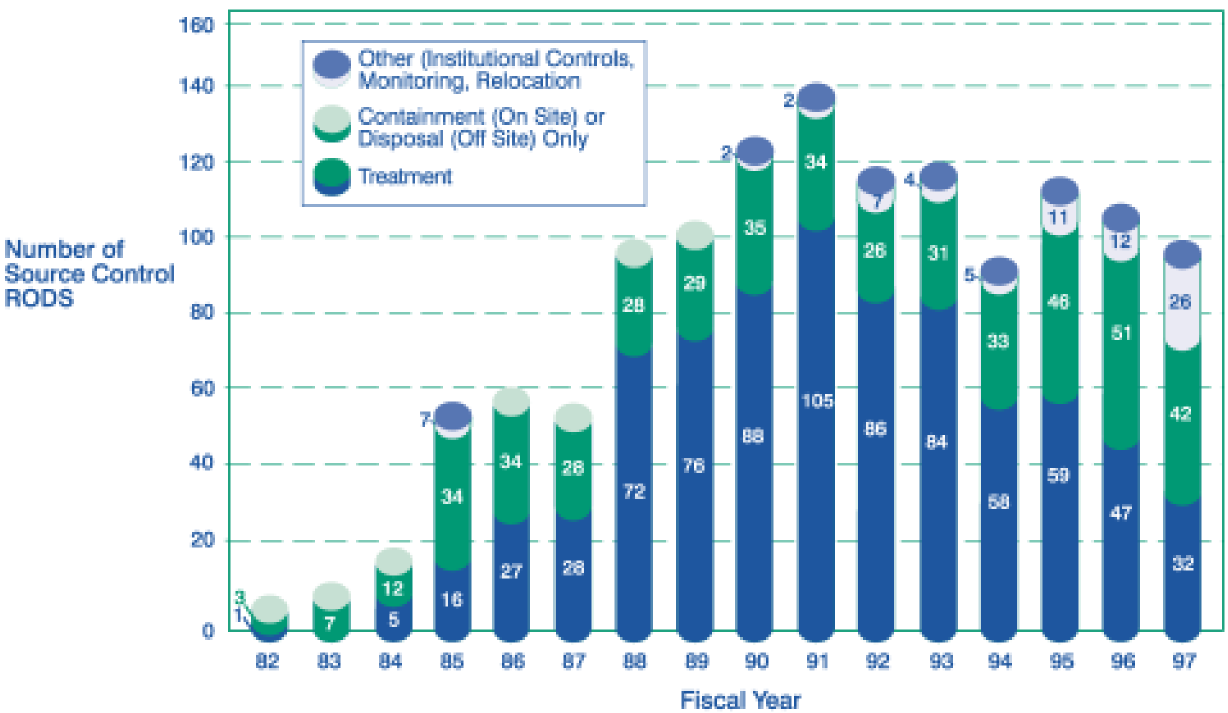


Source: EPA Office of Emergency and Remedial Response and EPA Technology Innovation Office, 1998. FY 1996 and 1997 data are preliminary.

Note: The difference between the total number of RODs (1,992) and the number of source control RODs (1,333) is the number of "groundwater treatment only" or "no action needed" RODs (total of 659). For purposes of this analysis, source media does not include: leachate, NAPL, surface water, or landfill gas.

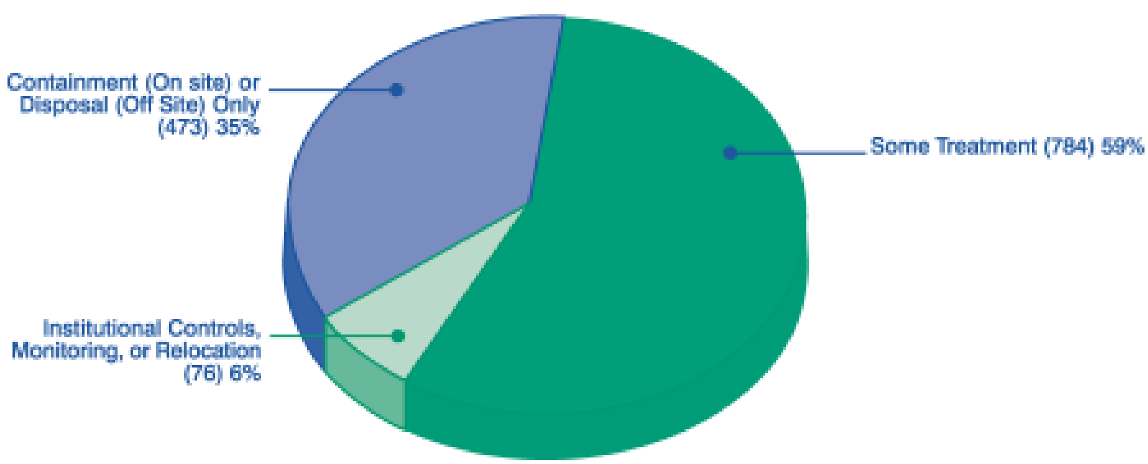
2 also shows that since FY 1991, the number of RODs specifying other remedies such as institutional controls, monitoring, relocation or nontreatment remedies increased. In FY 1995 and FY 1997, RODs specifying other remedies were at their highest percentage, representing approximately 15 percent and 26 percent of source control RODs. Nevertheless, on a cumulative basis these other remedies remain a small portion (approximately seven percent) of all historical remedies for source control (Figure 3). Overall, for 62 percent of all source control RODs (from FY 1982 through FY 1997) at least one treatment technology for source control was selected. Although the percentage of RODs specifying on-site containment or off-site disposal only increased in FY 1996 and FY 1997, approximately 31 percent of all source control RODs signed since 1982 have selected on-site containment or off-site disposal only. This percentage is lower than the cumulative percentage (34) through FY 1995. This decrease is due to the increase in the number of RODs specifying other actions rather than an increase in the number of RODs specifying treatment.

Figure 2. Superfund Remedial Actions: Source Control RODs by Fiscal Year



Source: U.S. EPA Office of Emergency and Remedial Response and U.S. EPA Technology Innovation Office, 1998. FY 1996 and 1997 data are preliminary.

Figure 3. Superfund Remedial Actions: Source Control RODs Through Fiscal Year 1997 (Cumulative)



Source: U.S. EPA Office of Emergency and Remedial Response and U.S. EPA Technology Innovation Office, 1998. FY 1996 and 1997 data are preliminary.